ORAL HISTORY TRANSCRIPT

CALDWELL C. JOHNSON
INTERVIEWED BY MICHELLE KELLY
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[This oral history with Caldwell C. Johnson was conducted in the offices of Space Industries, League City, Texas on April 1, 1998. This oral history was conducted by Michelle Kelly, Summer Chick Bergen, and Carol Butler for the Johnson Space Center Oral History Project.]

JOHNSON: ...[The Pilotless Aircraft Research Division, PARD] at Langley. It was formed after World War II, and it was going to exploit some ordnance that the military had developed for essentially solid propellant rockets which were used as missiles. They were available, they were cheap, the Army had more than they knew what to do with. Robert [R.] Gilruth and perhaps some other people decided that that might be a very effective way to do aeronautical research in the transonic regime. That is just below and just above the speed of sound. Wind tunnels had a very difficult time at that time coping with that particular speed range, and so there were very few data available.

They formed this Pilotless Aircraft Research Division [PARD] to exploit that technique of building models, launching them from Wallops Island—they acquired that site—out over the Atlantic Ocean, and using telemetry and tracking radars to acquire a great deal of data.

It started off with—I don't know, there probably were a dozen people recruited from different places at Langley, all engineering people, for the most part, were very young men, just out of the Army, people like [Maxime A.] Faget. He was from the Navy, but a fellow named [Joseph G. "Guy"] Thibodaux was his buddy. They both were from Louisiana, and he [Thibodaux] had just come back from Burma. I just picked those two. These were young engineers who were eager beavers and bright, really wanted to do something.

I had already been working at NACA [National Advisory Committee for Aeronautics] the time. This was before NASA, and I was working in the engineering side of the house, not the research side of the house. It was a part of the organization that implemented concepts that were—got the machines built and the equipment built to use by the research people. It takes both sides. And then the shop fabrication types of people formed the third group of people. So there were the research engineers, the design engineering people, and then the shop people. So it was a little close-knit group of people.

In the course of doing that [pilotless aircraft] research work, velocities of these craft were getting higher and higher and higher, and we were finding out more and more things about heating and the reentry into the atmosphere, because they were practically going out of the atmosphere before they entered. It was inevitable that, sitting around at lunchtime, maybe playing hearts or pinochle or something like that, you'd start kind of bullshitting about the thing, and somebody says, "Why don't we put a man in one of these things? We're damned near orbital speed."

KELLY: Do you remember who said that?

JOHNSON: And we'd say, "Yeah. Big deal," you know, something like that, and pretty soon it started to get more and more serious. The management was certainly aware of it, but there was no mechanism that I know of in the agency to officially begin a project like that. You know, you can't—[Daniel] Goldin can't just up and think of a whole new thing and say, "Let's do it." It's just politically impossible.

So what you do is you get a group of people interested in it, start kind of faking their time sheets. You know, you charge it to something that's chargeable, but you're spending some time working on it, and the management agrees not to look too close. They know what's going on, and they sense that it's a good thing. And finally you get it to that place, you

know, between guys like Faget and [Charles W.] Mathews and maybe John [H.] Disher at headquarters, only a few people kind of knew about this, and the first thing you know, there's enough data to get everybody's attention.

The Air Force was in the game. They were doing their things, too, and there was kind of a competition going on. I don't know, I can't remember exactly what happened that it [Mercury] was finally gelled into a recognized formal project, but somewhere along the line it happened, and it all came about through this informal evolution of an idea. And I've thought of it since then. One time there was a group of people at Johnson Space Center. They were called the Advanced Projects Office or something like that, New Projects or something, and they were formed not because—this doesn't sound very nice, but not because they had any great ideas about what to do, but they didn't have anything else to do. The Center said, "We ought to have a New Projects Office." So they picked these people and said, "You're the New Projects Office. Invent a new project."

Well, they didn't have the foggiest notion how to do it, of course, and so they asked some people, myself included, they said, "How do you get started?" And I told them more or less what I just told you. They didn't believe it, and they just walked away, paid no attention. Because a thing like that emerges from the ranks. If there's a good idea, it gets developed because somebody's enthusiastic about it. And a lot of them [ideas] die. Some of them are not good ideas. Only one in a thousand of them gets through. You can't just pick some people and say, "Go off and invent something." You've got to wait until somebody does it, and then you do something with it. And I think that's the way Mercury started. I'm sure it started that way.

KELLY: Do you know who came up with the idea?

JOHNSON: Well, of course, the Russians were in the game, too, you know, and pretty soon it was pretty clear that other people were working on the same thing, and there was a desperate attempt to be the first to do that. It's remarkable how close things came out to be. You know, [Yuri A.] Gagarin's flight and [Alan B.] Shepard's [Jr.] flight were only months apart. You would think that, given all these years that they've been in the aircraft business, it seems kind of strange for two big events like that to come within a couple of months of one another, as opposed to years apart. But anyway, that's what happened.

KELLY: How did you get to Langley?

JOHNSON: Well, I was born and raised in Hampton, and that's where Langley was, and I don't think there was any—it was inevitable I'd end up there. When I was a kid, the neighbors, several of them, were young engineers that had come to work for Langley, and I would hear them talking about things, you know, and sit around and listen. The families were socializing together. And somehow or another I just knew that was what I was going to end up doing, one way or the other, and talking to these guys.

And of course, they would help, too. If they noticed some kid that showed some interest, they would go out of their way to—you know, I remember one time one of the guys invited me to come to Langley. He had to work, but he introduced me to a couple of people and let me sit around and watch things that were happening, you know, and he picked me up at the end of the day and took me home. That was a big deal, boy. That was a big deal. So that's how I happened to be there and it worked out all right for me.

KELLY: Now let me ask you a little bit about Mercury itself. How did you actually start designing it, or what ideas were thrown around to design something that would hold a man on top of a rocket?

JOHNSON: Well, first off, part of the research that was going on between a man named Bill [William E.] Stoney and Robert [O.] Piland and Max Faget involved—one of the problems was reentering the atmosphere. A great deal of heat is generated in braking. You can't slow something up without something happening, you know. You've got to absorb all that energy somehow. And it was enough to melt metals. The Army was dealing with it with ballistic missiles, and they were developing one shape. In the course of this research at Langley, of all things, it turned out that a blunt face, give Mercury a kind of blunt face, you would think that that's a horrible way to enter, that you really should have a nice point. The trouble is, with something pointed, it doesn't have much drag, and it keeps going fast a long, long time, and it gets [into] denser and denser atmosphere, and it just gets [into] a situation worse and worse. The best thing to do is slow yourself down as quickly as you can while you're still high so that you can dissipate the energy at that point instead of getting so hot, and this blunt body did that. And it would get so hot that a shield of gas around the front of the thing almost essentially insulated it. And it kept shedding…[the hot air]—all the hot air was hitting this one little place, getting so hot right on the surface, it was re-radiating its heat back out.

So, everything considered, it was a far, far superior way to enter. Now, it turned out when you've got that blunt shape, all of a sudden now it was reasonable that they could put a man lying on his back with his feet up like this and it doesn't take such a big thing to do it. If you notice the pictures of the Mercury, that thing was only six feet across, and the man was almost six feet, but by the time he drew up his legs like this, sitting, you see, and all the G forces, that is, the acceleration forces on your back—that's why you saw the pig in that couch there on his back.

So, see, it all worked out exactly right. It all came from doing the research work and devising this blunt body concept, and that's persisted on the spacecraft as a better way to do it up until the time of shuttle.

Now, the down side of it is it cannot land on the Earth without a parachute or something like that. That's the down side. The real thing that made it was the fact that it could survive the heat of entry into the thing, and that came about just by these several young fellows exploring this regime and using their heads, and they came up with that. I would like to claim some credit myself, but I can take no credit for that, I'll guarantee you.

KELLY: From what I understand, some of those people came up with the data and realized what they wanted to do, but you were the one who translated that onto paper.

JOHNSON: Well, yes, in a sense that's just about what I did. I took their ideas and the concept and would simply reduce it to a geometric presentation that you could understand. Of course, there's some practical things. You have to fit the people inside, and you've got to get the parachutes in there and all the other paraphernalia. So it takes two sides of the thing. But we never worked like this group here and this group here. It was just kind of like this. There was no doubt that the flow went from the research people to people like myself and then to the shops. That was the direction that things moved. But all of them were just like that. There wasn't there and here and here, and there was not a big paper transfer from here to there.

We all worked in the same building, and so it was just a matter of—you know, you just talked to one another, and after you do that a while, first thing you know, you understand what the other people are talking about, don't have to write a lot of paper about it. Unfortunately, the world is no longer that way. You know, it's now nothing but a big paper trail between everything. The down side of that is you have a hard time tracking it because there wasn't any paper left. That's the down side of it.

KELLY: How did you communicate between, as you call it, the shops and as well as management, and how did those ideas come across for Project Mercury?

JOHNSON: Well, the management consisted, as far as I know, of about—I shouldn't talk about that because I didn't penetrate the top management, but there was only enough people like this. The Washington headquarters just almost purposely seemed to stay aloof of the thing. I think they were frightened that it would—in fact, Dr. [Hugh L.] Dryden, he was a good man, but he said it was just a stunt, you know, of no practical consequence, just a stunt. I think they were politically frightened that it would turn out bad and then they would get smeared with this thing.

So I believe it was people like George [M.] Low, he and John Disher. There may have been more at headquarters, but those two guys, as far as I know, were the only guys at headquarters that ever seemed to pay attention to it that much. Abe Silverstein was involved in it a lot, but he was at another lab, the Cleveland lab [Lewis Research Center], and it seemed like the different NASA, NACA centers, the same rivalry went on then as it does now. One center was not very enthusiastic of something the other center was promoting. They didn't fight it, but, you know, they were never enthusiastic.

But, by and large, I was busy doing my thing, and I wasn't fretting about how the management of the thing went. In fact, it was when McDonnell…got the contract to build a Mercury, the first thing they did, they were building parts, and we decided to fly a boilerplate of one. Not a boilerplate, but we were going to take parts from McDonnell and just put it on a rocket and launch it from Wallops Island, I think. I forget whe[n]. Anyway, I was in charge of getting this thing all assembled from all the parts and doing that, and it was in an area of the shop maybe half as large as this building, and it was roped off, to make it small enough.

I just happened to be there one day, and here this guy was standing around the other side of the ropes, and pretty soon he stepped over the ropes—didn't have a badge or anything—stepped over the ropes, and he came up and started looking at this thing that was going together. I was an eager—probably a little asshole or something like that, and I went over, and I said, "What's your business?" He apologized and said, oh, he was sorry and didn't meant to interfere, and he left. And about then I saw somebody else there, and I said, "Who is that guy?" He said, "That's George Low. He's head of the whole program." That's how much I knew about the management. [Laughter]

KELLY: That's a good story. I like that.

JOHNSON: Next day when I came to work, I was kind of surprised that I didn't find a pink slip there, but George wasn't that kind of guy. That's kind of the way he was.

KELLY: Can you tell me a little bit about how you worked with the contractors? After you designed the capsule, so to speak, how did that transfer into actually building the thing?

JOHNSON: First off, McDonnell…—it was McDonnell [Aircraft Corporation] then—McDonnell, they were a very capable group of guys. They'd been building airplanes and they knew how to build this. And this machine, the Mercury, was more an airplane. It didn't have wings, but it was built like an airplane is built. And those guys knew ever so much more than we did about the practical aspects of fabricating a man-carrying machine. We really didn't know anything about—some detailed things about it. We understood the theory, but we didn't know how one really goes about doing it, see, and McDonnell did. Every now and then there would be a little bit of friction between us. That is, they knew they knew more about how to design something than we did. On the other hand, we were the government's

representatives, and we really could call a shot. So every now and then there would be a little bit of friction, but it turned out that all the people involved were sensible enough that we overcame that.

It worked ever so much better than it did when a similar situation developed with North American for Apollo. That got to be kind of nasty. But maybe once a month there would be a more or less formal get-together with a dozen people on either side and compare notes on the status and how things were going and what the problems were. In fact, I just showed you the agenda of one of the meetings I just happen to have. It worked quite well, because there would be no more than a dozen people involved from either side, not great hordes of people.

KELLY: Who was on that team, do you remember?

JOHNSON: If I had some chance to think about it, I could probably name them. Of course, John [F.] Yardley was running the thing at McDonnell. Somewhere along the line, Jim [James A.] Chamberlin, who was head of the group of people that had come from Canada, from AVRO, he had been their chief aero dynamicist. I think that's what he was. When AVRO was breaking up, he assembled a bunch of guys to come to work in the U.S., and they were not just random people. He had gone around and picked them.

So you can imagine the level of capability you get if you can take a company of several thousand people and you go around and you pick three dozen of them. Now, he may have picked some that decided they didn't want to come to the United States, I don't know, but, anyway, he picked the best of the bunch, and in my view, they saved us. I don't believe we could have done the job without those guys. They were crackerjack engineers. One or two of them turned out to be not so good, but most of them were just red hot.

Some of them had a tough time moving from Canada to Hampton, Virginia. It's a different world altogether, and a lot of them were English. Their wives didn't much like the idea. We used to joke about a thing they called the—I think it was the $5,000 cure, and what it was, was that the families would move to Hampton, the wives would be in tears most of the time, they didn't know anyone, and we didn't even speak English, as far as they were concerned. So they would take the $5,000 cure; they would have to go back to England for several months. But then they would come back, and after the wives found out that the plumbing here is so much better and the grocery stores have got so many more things and the automobiles were everywhere, and all that, they finally decided it wasn't so bad here after all.

KELLY: Can I ask you what that group specifically contributed to the project?

JOHNSON: Every aspect of it. There were guidance and control people there. There were structures people. There were aerodynamicists. There were operations people, which is very important. They had people that were accustomed to the operational world, not just the engineering and design world. But they were spread across the whole spectrum, and they contributed a great deal. We'd have never done it without them, I don't believe.

Generally on these things I personally, as the thing really got going, I seemed to have less and less to do with it. It wasn't that I was disinterested, but there would be other things coming along. See, by the time we were halfway through Mercury, we were starting to talk about Apollo, and Gemini was getting started. In fact, when the first Mercury flew, we already had configured a lot of things on Apollo, and it just seems like there's some people that like to deal at the early phases, and some like to deal later in the middle phases, and some like to operate it when it's all through. So I just happened to always be on the starting side of the thing.

By the time that thing [Mercury] was finished, I had no idea how the damned thing worked, I mean, and all the details. I knew the principles, but if somebody showed me a part of something, I couldn't tell you what it was. I didn't really worry about the nuts and bolts on the thing by that time. Don't misunderstand, I'm not saying that's not an important part. All the parts are important. There's no such things as one thing being—and the operational people, we always had a rivalry with the people that are going to operate it. They always poke fun at the people who designed it, say they did it stupid, and, you know, we would always say, well, if they flew the damned thing right, it would be all right, but they always screw it up flying it.

The fact is, we both did it the right way. For instance, Jerry [Jerome B.] Hammack [phonetic], you talk to Jerry. Now, Jerry, see, was on the operational side of the thing, and it was his business to deal with what happens in the real world when you start to fly this thing, what happens when it lands out in the ocean, how in the hell do you get it back? Say you send a ship out there and pick it up and bring it back. That's easy to say, but there's a hell of a lot of things you have to do about that. But we really got along fine. We all knew each other well.

KELLY: I understand you also hold some patents, even with Mr. Hammack. Can I ask you a little bit to describe them?

JOHNSON: Yes. I'm not quite sure how—I think there were seven of us that jointly hold the patents. I could probably tell you their names now. I know Jerry was one, Allen [B.] Kehlet, Max. There's got to be more, but I don't know. I don't know who selected those names. Now, some of them were obvious, certainly Faget and some of the others, but I don't really know how we picked those names out, but I'm glad they picked my name as one of them.

[Laughter] Like I told you, you could take a dollar and that patent and buy a Coca-cola, but it's nice to have my name written on that thing.

KELLY: Absolutely.

JOHNSON: I'm rattling on like I know what I'm talking about.

KELLY: No. That's okay. We want to hear whatever you have to say. I was also then going to ask you a little bit about the automatic control systems, and you may not have delved into it so much, being that you were more the theoretical side of development, but did you debate whether or not it should be completely automatic—

JOHNSON: Yes, there was—

KELLY: —or whether it should have some manual controls for the astronauts to maneuver the Mercury spacecraft?

JOHNSON: Well, it was a manned spacecraft, and I think that's the bottom line. It was a manned spacecraft. It was not an automatic spacecraft with a man in it; it was a manned spacecraft, M-A-N-N-E-D. And there's nothing wrong with making it automatic, but to do it in a manner that the man no longer had any control would have defeated the purpose. Now, I'll tell you frankly, just as an engineer, sometimes I can't think of anything worse than to let that guy have anything to do with it. They can tell you countless tales of how often they save the day, and I can tell you countless tales of how often they damned near wrecked the thing, but it was a manned spacecraft, and, by God, it ought to be able to be flown by the man. But we would argue about it.

I'm supposed to have promoted the idea of putting a chimpanzee in there, and I'm sure everybody joked about such things like that, but nobody seriously thought about doing it. But what we did argue about, though, was why in the world should you pick a 190-pound man to do something that a 130-pound man could do? That just made life very, very tough. On the other hand, there are no 130-pound test pilots around the world, and naturally he should be a test pilot. You had already weeded out—you know, he would not have been a test pilot if he was unfit to do that kind of thing. But some things were awkward.

[Virgil I. "Gus"] Grissom was the shortest stature of all, and yet he was the longest torso. Between his seat and his shoulders he was the longest, and yet he was overall the shortest. So that made it very awkward to design things like a couch and controls to reach, that would fit him and at the same time fit some of the guys that would have long legs and long arms but a short torso. And so that was kind of awkward.

KELLY: How did you get around that problem?

JOHNSON: Well, I don't know, we just compromised, you know, and nobody would complain. Not any one of them was about to complain, because if he complained, he might be erased off the list. So he may complain after the flight. He may have said, "That was the dumbest goddamned thing I've ever seen," you know, but he never said a word before the flight. "It was perfect, perfect, fits me like a glove," that kind of thing. They were a gung-ho bunch, I'll tell you that.

KELLY: Did you work with them in any of your designs?

JOHNSON: Yes, in Apollo especially. We would have questions of how quickly can you bail out of this thing in case you crash on the ground. I remember once John [W.] Young—for

four or five days we had this damned plywood mock-up sitting there in the shop, and it had a door that would open and a mattress on the floor, and at a given signal he would see how long it would take him to scramble out of that thing and dive out through the thing. Well, it was made out of three-quarter-inch plywood, and you know how the edges were all like that, and that guy was blood from bottom to top at times. But noontime would come, you know, and he'd banged against the side and missed the mattress and done all these things and skinned up all of his arms. They'd say, "Just one more time, John, and let's try it this way." "Okay." He'd get back in there, you know, and out he would come again. They really did their job.

KELLY: Very determined. Well, at that time did you transition directly into Apollo, or did you transition in Gemini and adapt the spacecraft?

JOHNSON: I don't know. I kind of jumped Gemini mostly at the beginning. Well, see, Apollo had started by the time Gemini was going, and what Gemini was, was really exploiting the Mercury. It was with McDonnell, and there were some things that had been learned on Mercury that they decided, "Well, we'd better do it different," if you had to do it over again, and decided it was very necessary to explore this business of rendezvous to see whether that concept would work. You couldn't do it with Mercury, so they decided to do it with Gemini. But at the same time, there was a group of us working on Apollo, in the early stages of Apollo.

I saw something here that I might say something. It says, "NACA-2 Space Task Group."

KELLY: That's right.

JOHNSON: You may have heard this story before, but they wanted X number of people there [Space Task Group], and Robert Gilruth went to Floyd [L. "Tommy] Thompson, who was the chief engineer of Langley, and he said, "I need," whatever it was, "fifty people."

Floyd Thompson said, "Well, that's fair enough."

Gilruth said, "Well, I'd like to go around to pick them."

Floyd said, "Well, I can't quite agree to that." He said, "You want fifty, you pick twenty-five and I'll pick twenty-five."

And to this day, no one knows which side of that twenty-five they were on, whether Floyd wanted to get rid of us or— [Laughter]

KELLY: [Laughter] Did you ever find the story of how you got chosen?

JOHNSON: No, I decided not to ask. I decided not to inquire. Besides, Floyd Thompson is now passed away, and Gilruth is not in good shape, so I wouldn't know anyway.

KELLY: For the American space program, we're very fortunate.

JOHNSON: Well, whatever it was, I sure like the way it came out.

KELLY: In the Gemini program, were you involved with the rendezvous and docking mechanisms at all?

JOHNSON: No. It seems kind of strange now, but I wasn't. Well, it was really, like I said, by that time I was busy with Apollo.

KELLY: How did you get started on Apollo?

JOHNSON: Same way with Mercury. I know people were speculating, once you see that you can orbit—it really hadn't been done, but everybody had convinced ourselves that it was a piece of cake. So then we were speculating about the moon, and it was the next place to go. It was out of the question to go to any of the planets, but the moon seemed reachable. I must admit, I didn't have a lot of confidence in the whole thing, but somehow it struck me that how in God's world are you going to ever hit the moon in the right place that far away to go, you know? But after a while I became convinced, too, with a lot of other people.

KELLY: How did you know that it wasn't made out of green cheese?

JOHNSON: Well, I didn't. The scientific community was no help at all. Those guys are so proud of their own claims of what something is like, they will not cooperate or get together, and big guys like Nobel laureates would say, "Hey, the thing is nothing but a bunch of pools of dust miles deep. You hit these pools of dust, and you're going to go [makes a sound indicating descending]."

One of the guys, an eminent scientist, said, "These things that look like mountain ranges and all this are really just frothy kind of foamlike rock and is of no substance. You hit it, and it will just crush all underneath there."

Owen [E.] Maynard and I were designing the lunar module, and I remember saying, "We can't accept that kind of crap. We can call the program off if that's the case. How can you land on something that's nothing but froth and pools of dust that you'll sink down miles?" And we decided it can't be that way. For Christ's sake, we can look up there, and they had telescope pictures of the thing and there's a big mountain range. How in the hell could it be any different than a dry place on Earth? I think we said Arizona. We picked Arizona. And we went ahead and designed the landing gear like it was like Arizona.

I don't know why the program didn't stop. You know, nowadays, if two big-wheels [eminent scientists] like that were to make such a pronouncement about something, my God, NASA would have a hemorrhage. There would be more damned committees formed and all this stuff to try to work this out, it would go on for years and years. Nobody seemed to even pay any attention. I think everyone was just sensible enough to know that, in their own hearts, they knew it wasn't a bunch of pools of dust and all like this. So we went on and designed the landing gear. Sure enough, turned out to be just like Arizona. [Laughter] Without water, absolutely no water. In fact, now they're not even sure there's no water there.

KELLY: What insight you had.

JOHNSON: Well, it was necessity. We couldn't afford to believe the other way. We'd have had to call off the whole damned program. And fortunately, somewhere along about that time, was it Surveyor? What was the spacecraft? Surveyor? You know, Surveyor got pretty close and took some pictures of the thing, and anybody could see these big rocks sitting there, and what the hell, of a rock could sit there, then something else could sit there.

I remember some guys came by one day from—I forget where they were from, and they said, "We're going to survey the moon. What do you think is the best thing could happen? What kind of information do you need in order to land there?" I was in a bad mood that day, for some reason or another, and I said, "The best thing that could happen is for your spacecraft to crash on that moon and bust all to pieces, and then we would know it's strong enough to land on." He was very crestfallen, you know. And I was ashamed of myself for having said that, but I think that was the day we were told we were going to sooner or later move to Houston, and not many people were very enthusiastic about that. Since then, I think it's a fine place. It's a great place.

KELLY: How was the development of Johnson Space Center then? You were there right through the initial stages, and then it was the Manned Spacecraft Center.

JOHNSON: Yes, and before that it was a series of buildings downtown in Houston. They could rent spaces, you know, and what a mess. It was a building over here and a building over there and one of them over here. One of them even was an apartment building, and they knocked all the doors off the different apartments so you could kind of walk between one and the other, you know, and sometimes your office would be in the kitchen. I mean, literally, we'd be in the kitchen. Nobody had an office in the bathrooms, but that was the only thing off limits, but it would be in the damned kitchen.

KELLY: Where was your office?

JOHNSON: First it was in the Houston Petroleum Center, and that was a nice place. It was a new building that had just been built, and we were the only occupants in there, I think. Then we got moved to what we called the Franklin Apartments, which is on I-45, just off of I-45, along about—I can't even think where it is now. Anyway, it was noisy and hard to get to, and I-45 wasn't complete, it was always under construction at the time. It was a mess. But I don't believe your physical surroundings have anything to do with your work. It's only when you become bored and unhappy that suddenly the building isn't suitable to you. You don't pay any attention to it when you're busy. In fact, more often than not, if you find somebody complaining because he don't have a window and somebody else does, or something like that, you might as well get rid of that asshole. All he's going to do is worry about his status in the office or something like that.

KELLY: So were you part of the group that actually helped move from downtown Houston into what is now NASA, in Johnson Space Center?

JOHNSON: I didn't have anything to do with the organization of it. It was just delightful to move to there. Well, I lived in Dickinson, for one thing, and that's only a fifteen-minute drive.

KELLY: Let me go back to the lunar module a little bit and your development of it. I guess the first question I have for you is, you didn't know what the moon was made of, so you decided Arizona. But from there, how did you know how to design it or to develop it?

JOHNSON: Well, that Arizona business came sometime later, but first off, there was a great controversy about whether or not to fly directly to the moon or to the so-called lunar orbit rendezvous, and most people intuitively rejected the rendezvous. It just seemed absolutely out of the question to get up there and separate these craft and one go down and one somehow launch again and meet up with the first one. It just seemed—you know, so many things.

But after a while, the guys that were analyzing the situation, they presented a very convincing argument that it was not only plausible, but by far the simplest way to do it, and from an energy standpoint, there was no question about it. There's no point in landing a big heavy thing on the moon if you don't have to, and leave the heavy thing in orbit where it doesn't cost a whole lot to leave it there. But the original contract with North American did not specify that mode. It was rather vague, and so North American was charging ahead as though in some manner there would be a direct landing, and I think—and they fought that for a long while, and I believe they fought the rendezvous because they knew that someone like Grumman or somebody else would get the lunar module, and they flat didn't want to share

any of this with anybody, and they fought it like mad, till finally it was just obvious that they were not going to win. In the course of twenty-four hours, they went from full over this way to full over that way. They found out which side of the bread the butter was on, and they decided they'd better do it this way. But that helped prolong the argument for a long time. If Rockwell—well, it was North American at the time, if they had really gotten behind it, it would not have prolonged the thing so.

The miracle, in my mind, is how in the world did we manage to change the mode so drastically and still salvage the whole system. The command module and service module had to be changed a little, but not much, and somehow they managed to accommodate the lunar module in the whole launch system. It had not been planned at all, and ordinarily you could not make such a big mistake and then somehow salvage the thing midway through the thing, and it did, almost without a glitch. I'm going to tell you, it's a miracle, a real miracle. I don't know how it happened. So there had to be a great deal of luck throughout this whole business. I don't mean just luck from a safety standpoint, but it just had to be a lot of damned things went right, no question about that.

KELLY: Can you tell me a little bit about your input into the design of the command module?

JOHNSON: Yes. We had a contract with Convair—two aerospace companies; I forget who the other one was [General Electric]—and we were doing an in-house design at the same time, and those guys were independently doing—General Electric, I believe it was. They kind of went their way, each one of them took a separate approach to it, and we went our way. Finally we got to a place where we had to reconcile these three different concepts. Well, whatever the technical merits, and I guess people could argue for years what it was, since we were the ones that were making the choice, we picked our way. [Laughter] I'm oversimplifying it, but when it got right down to it, all the people at General Electric said that

was best, all the people at Convair said theirs was the best, we said ours was the best. We were running the show, so we picked ours. Simple as that. Well, at least it worked. I don't know whether the others would have worked or not.

For instance, General Electric—there was a big thing going on then of the radiation environment of space, going through the Van Allen Belt and such things as that, and General Electric had designed in kind of what you'd call "a safe haven." It was a big—not a big, but it was a chamber that the crew could get into in times of high radiation levels and protect themselves.

JOHNSON: It weighed a lot, took a lot of space, so it had a down side. But there were big differences like that. Now, I have a drawing that one of the guys in my group made, his name was Will Taub, a excellent draftsman and designer, of which these three concepts are side by side, all to the same scale, and you can see them. I don't know that anybody's ever seen that thing. I've got a copy of that thing. But that was very interesting.

But the command module itself, Will and I did a lot of work on that in configuring the general arrangement, particularly positions of the crew. There were three men, and at one time it was thought that they would run a sixteen-hour shift, overlapping shifts, so that one could sleep while the other two were there and take their turn. So it started out being arranged from the basis of that going on, one guy had a place to sleep while the others were up. They would rotate. Later on it turned out that all three were going to sleep at the same time and all three were going to be awake at the same time. It turned out it really didn't make a lot of difference, but it did have some effect on the initial position of the crew. I remember some of the sketches show a sleeping place beneath the couches, the two of them, where a guy could sleep down there.

KELLY: Did you adopt a lot of your design from the Mercury capsule?

JOHNSON: Not a bit. It turned out, by the time one put three men in, and the whole shape of the thing was quite a bit different, it just—almost everything turned out to be different. See, the Apollo can fly a bit, the command module, in the sense that it can develop a fair amount of lift so that as it comes back into the Earth, it can move itself around some as it comes in. And that was thought very necessary because the guidance system was such that it wasn't sure you could hit the right spot, and this gave an opportunity to correct things. As you got into the air, you could correct it.

Initially, it was thought that the amount of lift should be some value—the term L over D [L/D], I think it was 0.35. It's a ratio of how much lift it has to how much drag it's got. Later on it turned out that we could not achieve that high a lift for several different reasons. But fortunately, it also turned out that the navigation guidance and control and all was much better than thought, and so it did not require to have such—it could get by with much less, and that was some of the things that Gemini explored. Gemini was used to check out some of those things.

KELLY: That's very interesting. Talking about the lunar excursion module and the command service module, did you develop the docking mechanism for those two as well?

JOHNSON: No. I was kind of on the outside of it at the time and doing something else, and I protested it. I got criticized that I didn't think it was a very good idea, but I was not directly involved in it at the time, and I'd left the Apollo Program at that time.

I have difficulty lasting through a program. [Laughter] I either do something I shouldn't, or I just get bored with it, something like that. But anyway, I didn't like it, but I didn't really have anything to do with it, so that was that on the thing. It [the docking system] works reasonably well, but the problem with it was that it occupies the very passageway that

you want to open. This mechanism is in the middle of the passageway, and it should not be that way, because all kinds of things can go wrong. If you can't get it out of there properly, then it's no use to even have docked it. You still couldn't get through. And it's like having everything in the doorway. Even after you connect, you can't open the doors because you've got all this stuff in the way. Later on, we changed that in the Apollo-Soyuz, we changed the whole thing, and, incidentally, that's what they use today on the Space Station and Mir, the Apollo-Soyuz type of thing.

KELLY: I'd like to ask you a little bit about that, too. How did you get started in developing the docking mechanism in ASTP [Apollo Soyuz Test Project]?

JOHNSON: Well, I ended up in what was called the Spacecraft Design Division at JSC [Johnson Space Center], and we had a kind of a license to explore technology and design, what future designs might be, and the evolution of things. A couple of guys and myself got interested in this docking business again, and we didn't like the thing on Apollo. In the first place, Skylab, see, was coming along and we still had to do docking on Skylab. We didn't like this thing, and it was kind of hopeless to change the command module. We thought, well, if we ever do something further on, we ought to have a different docking.

First place, we wanted something that did not block the passageway. Second place, it should be—we used the term "androgynous," that is, no sex, no male, no female type of thing, which, see, the old probe and drogue was. So you couldn't have two male spacecraft or two female spacecraft docked. So we wanted something that was neuter, either one. And so we devised this thing of—it's a hole with things around it that would get together this way instead of something going this way. We worked that thing. A fellow named Jim [James C.] Jones, who died some years ago, and Bill [William K.] Creasy was still around, works for

Johnson Engineering now, and I and probably some other guys helped, but we went as far as building some mock-ups and calculating performance and that.

Along about that time, the Russians made some overtures at a high level of the country to discuss future space business, and the word came down to Johnson Space Center to be prepared to discuss future spacecraft with the Russians. Dr. Gilruth picked Glynn [S.] Lunney and me and a guy from Marshall named George [B.] Hardy to think about this, and we were invited to go to Russia to talk to them. This was in 1970.

We got together and we said, "What are we going to talk about? We don't have any program in the United States. There's nothing planned to do other than some vague way or space stations one of these days." And we thought, "Should we talk about guidance control, rendezvous type of things, docking?" I told Dr. Gilruth then, I said, "Well, we have been doing work on docking systems, a different kind of docking system." So he wanted to know about that. He said, "Okay. That's something we could talk about. We could offer that." [Glynn S.] Lunney and the operations guys had developed some techniques that looked like reasonable things to do, so he said, "Put that on the agenda as possibilities."

Well, we prepared ourselves for those different things, and when we went to Russia, lo and behold, we had hit the nail right on the head. We had lucked out and had prepared ourselves for the very thing that they wanted to talk about when they got to it. Well, at the time nobody had mentioned Apollo-Soyuz. It was just some future activities. They were interested in docking types of things, but they were still hanging in there with their Soyuz docking mechanism. Apparently we scored a big hit with them on that, and when they came back here to the United States several months later, out of a clear blue sky they said, "Why don't we have a mission, Apollo-Soyuz." What they always said was Soyuz-Apollo, which is understandable.

Incidentally, one time there was a bunch of—you know the little buttons of Apollo-Soyuz, the pretty little red and blue things on there? The guy manufacturing those made a

whole batch of them, or at least a number of them, with the red and the blue backwards. The Apollo side was the red, and the blue side was—and those things are worth their weight in gold if you can find those. It's like a stamp that's printed upside down.

But anyway, the Russians proposed this program, and we were completely stunned. We had no idea this thing would move so fast. They were talking about doing it two years later, just like that, boom, do this thing. Well, we can't do anything that damned fast. They couldn't have either, for that matter, but that's what they said. But the first thing you know, we had to get down to brass tacks as to what to do. It was all approved up and down the line, so that was the chance to introduce this whole new docking system concept.

When I remember, there was a group of guys headed over there, his name is Vladimir [Sergeyevich] Syromyatnikov, and he and I have become good friends over the years. In fact, just two weeks ago he was here and I was talking to him. He and I were heads of the committees to do something about this docking system, and theirs was different from ours. They agreed to this androgynous system that we proposed. They agreed that was a good concept and that's what we should do. So they had designed one real quick-like. They had put one together, a particular design, and we had a particular design, both the overall concept. He and I were supposed to get together with our guys and thrash out what the hell we were going to do about this. We couldn't have two different ones. Whatever it was, it had to be the same. Other things might be different, but, by God, that damned interface has got to be the same.

Anyway, it turned out that the mechanism that they had had, had three fingers. Like this, you know. They had three and ours had four. Well, we either had to go to three or they had to go to four. We had to decide. Their system worked kind of mechanically. Our worked hydraulically. It was no problem with us to make all four right together. It would have been very difficult for them, with their mechanical systems, to go to four and still have a mechanical system. It would become a nightmare.

Right on the spot, that morning, I said, "Okay. We'll change to three like you want." It was all the same to us, three or four. They could not make the four, we could make the three, so I said, "Okay. We'll do three." Well, they didn't know quite what to do. They had gotten exactly what they wanted, but now they didn't know what to do. In the first place, they didn't expect anybody to agree. They were not prepared. In the first place, they didn't exactly trust me. They kind of thought to themselves, "Who is this guy? Who's he to say that the United States is going to change to three?" And they were very wary of this thing, and they hummed and hawed, and they said, "All right. We'll go back and talk to our management about this kind of thing."

I said, "What's to talk about? We agreed. Let's get on with it."

Well, no, no. Well, they went back, and that night they must have had a big—and, of course, I told Gilruth. I told him what I'd done. He said, "Well, is it okay?"

I said, "Yes. It's all right with us."

He said, "Well, whatever you say."

So the next morning when they got in, they said, "We've decided it's a good idea for you to do it our way." [Laughter] And apparently they had checked all up and down the line, and they must have checked with Gilruth, and he had endorsed whatever I'd said, and now they felt comfortable with it. But it was very interesting, to have somebody ask you to do something, and when you say okay, then they don't know what the hell to do. They wanted to fight, I guess. But we got along fine. It was a very cooperative group of people.

KELLY: Was it difficult in the beginning because of the culture difference?

JOHNSON: The only difficulty that I ran across was with our people, with our embassy people and people like that, which was horrible. You know, they acted like we were in a shooting war or something and we ought not to even talk to one another, or that we should tell them

and let them go tell the Russian Embassy, and then the Russian Embassy would tell their people. You know, all that crap. And from the very beginning, President [Richard M.] Nixon had said that NASA was going to do this and the engineers were going to do this, and that was that. It was not going to be the CIA. The CIA had briefed us, and the Army intelligence had briefed us, and the FBI, and everybody and his brother, "Oh, don't drink a vodka with them. Don't even wink at one of the woman. Don't walk around the streets by yourself," and all this kind of stuff. That was a bunch of crap. Nothing like that went on. It was all fine. But I could see their cloak and dagger guys and their cloak and our dagger guys hang around in the background, you know. It looked like a movie. And they all wore trench coats, just like in the damned movies, and a fedora. You wouldn't believe it.

The Russian team was first rate. They were crackerjack engineers. The main difference was their back-up. They didn't have much back-up. You know, we could be ten deep if we wanted to be. For every position you filled, we could have put ten guys there. They just had one or two. But they were really good, crackerjack guys. We got along fine.

KELLY: That's terrific.

JOHNSON: There were interesting incidents that would occur, though. One time we made a trip to Leningrad while we were there over a weekend. When we all came back, we all have dysentery. Oh man, some guys just damned near died, you know, and we protested like mad all about this, and they said, "Nonsense. Nothing wrong with the water in Leningrad. You just brought this [problem] with you." So that was that.

Well, it was not long after that that they rented some rooms in a little motel in Webster, and they were kind of living there, and they were walking around barefoot and taking showers in the stalls, and they all came down with absolutely the worst cases of athlete's foot you've ever seen. We've got a whole bunch of little viruses that the Russians

don't have any protection against, and they may not bother you and me, but it just ate their feet up alive. And they protested like mad, and we said, "Nonsense. You brought it with you." [Laughter] The doctors at JSC developed some sort of ointment for them, and it apparently was fairly effective, but the trouble is, it just smelled awful, and you could tell those guys a mile away. [Laughter] But it was a very interesting and nice.

KELLY: That's good. Well, I don't want to keep Mr. Faget waiting for you too long, so we can stop it here if you like.

JOHNSON: Okay.

KELLY: I would like, at some point, to maybe talk to you again and see if we can briefly cover some of these things and then go back and research a little bit more on what we've talked about so we can—

JOHNSON: We should get involved with Skylab somewhere along the line.

KELLY: Absolutely. I'd like to do that.

JOHNSON: Because Skylab had some very interesting things that went on. For the most part, JSC does not know much about Skylab, because JSC didn't participate much in Skylab. There were just a few of us in the Skylab.

KELLY: I'd like to do Skylab and also shuttle as well. Shuttle is very important. So at some point, if you don't mind, I'd like to maybe arrange another time, if that's okay with you.

JOHNSON: Okay.

KELLY: And we don't have to do it now.

JOHNSON: Let's do it later. We're going to have to leave this building in a week or so. Otherwise, this is a very convenient place. So if we can do something in a week or so, this would be a good place to do it.

KELLY: Great. And if it's convenient for you, we can do it over at NASA and do it in our offices, whatever works best for you. You're really helping us out, and we want to make it as accommodating as possible. I really appreciate it.

JOHNSON: Okay. What do you want to do about such things as these documents and sketches and things like that?

KELLY: I don't know. I mean, I would love to look through them, but I don't know how you are with them. Obviously I wouldn't want to take them.

JOHNSON: I would be reluctant to just have them all disappear.

KELLY: Oh, no. Absolutely. Those are treasures.

JOHNSON: Okay. Maybe we can figure some way to copy them or something.

KELLY: Exactly. I'd really like that. But I'll investigate that as well, because it looks like some of those documents are kind of older as well.

[End of Interview]