

## ORAL HISTORY 2 TRANSCRIPT

CALDWELL C. JOHNSON  
INTERVIEWED BY MICHELLE KELLY  
DICKINSON, TEXAS – 12 MAY 1998

KELLY: This is an interview with Caldwell C. Johnson on May 12, 1998, in Dickinson, Texas. Interview by Michelle Kelly [assisted by Summer Chick Bergen and Carol Butler] for the Johnson Space Center Oral History Project.

JOHNSON: [Viewing original drawing of Mercury]... flying the other way, and then the G forces are either from his head to his foot or his foot to his head, and they're not very tolerant that way.

KELLY: That's really neat. I mean, such a beautiful drawing.

JOHNSON: I'm amazed I didn't throw it away [original pencil drawing of Mercury].

KELLY: Oh, really?

JOHNSON: Yes. I'm amazed. Those things you throw away because you –

KELLY: Do you know, when we spoke with Mr. [Jerome "Jerry" B.] Hammack a few months ago, he had brought out some of his original photos and everything like that, and he had one of your drawings of Mercury, too. And he said, "Yes. Mr. Johnson gave this to me," and he said he treasured it. So it was really neat to see something like that. It really is.

JOHNSON: We see them [the Hammacks] several times a year at little parties. We get together. That gang, you know, we stick fairly close together.

KELLY: That's nice.

JOHNSON: Unfortunately, some of us are getting along. A few have died, but for the most part, everyone's in good health.

KELLY: That's great.

JOHNSON: Yes.

KELLY: Well, I'd still like you to consider, if you wouldn't mind, if maybe you and Dr. [Maxime A.] Faget and Mr. [Joseph G. "Guy"] Thibodaux, as you had said, might want to think about getting together.

JOHNSON: That would be fun. If they agree, it would certainly suit me.

KELLY: That would be terrific. Well, then, as soon as we contact them, we'll ask them the same and maybe see if we can set up a mutual time if everyone's agreeable.

JOHNSON: Good.

KELLY: That would be great. Well, the other thing I wanted to ask you before we get started here is... [Brief interruption – Subject was Skylab]

JOHNSON: ... at the command service module. They were all working fine. There was hardware left over. So any number of people speculated about things that could be done with this hardware along the lines of space station types of things. There wasn't any point in going back to the moon, and there wasn't any sense in just simply flying Apollo around and around by itself...[Tape interruption] was exhausted. It's a lot easier said than done. In the first place, there's all the residuals that have ... [Tape interruption]

... had to get involved in this, and no one was really comfortable with this business of so-called habitability of spacecraft. Up until that time, you know, there'd only been, at the most, three men on Apollo, two men on Gemini, one on Mercury. They were living in a little space that they could barely move around in. There were no creature comforts whatsoever. It was foremost an exercise in survival, to see if they could somehow keep living through those fourteen days, sitting together this far apart, no place to do anything. We had no idea of mobility and constraint. They had to eat food, whatever they could just grab in bags and eat it, tubes and squish it in their mouth. Hygiene was terrible. There was no such thing as housekeeping. You can get by with that for fourteen days, but you can't get by with it for fourteen months or anything like that, as everybody knows.

But there was not a discipline, an engineering discipline, at the time to look after such things. There were guys that understood structures and guys that understood propulsion, there's guys understood this and that, but there was no one that understood housekeeping, you might

say, and what you have to do for three guys to live for months at a time. For instance, their garments. They had to change their clothing. They had to have waste management facilities. They had to have meals, and they couldn't eat the same thing all the time. Had to keep the place clean. Things had to be stowed someplace. It's just like your home. There was no one in the system that seemed to have any expertise on that. Now, we all lived in houses, and we take the cabinets for granted and the toilets for granted and the beds for granted, and everything has all been worked out for you.

When we started on Skylab, all of a sudden we realized that somebody had to set about designing this place to live in. I was kind of out of work at the time, and I got assigned to be what was called the principal investigator for habitability and crew quarters. Now, the title alone will give you some clue of the thinking. It said "principal investigator" for this, as though habitability and living were going to be an experiment. Now, that gives you some feel for this. It was treated as an experiment. Here's three guys have got to live three months in this thing, and they're calling it an experiment. [Laughter] That may sound good to you, but it probably didn't sound very good to them.

Anyway, I took a look at what had been proposed so far, and it was very stark. Nobody quite seemed to know what to do. The whole interior of the place, in the first place, is metal framework. You know, there's no pleasing carpets, there's no nice walls and no sofas, no beds. In one of the arrangements I saw, it did show some beds, and they were bunks like one would find on shipboard except they were folded up against the wall and they hung down on chains. This is in zero gravity, now. [Laughter] It doesn't make a lot of sense. The place was kind of like living in a barn with no facilities whatsoever, you know, or, worse yet, in a blacksmith's shop. That's more what it looked like.

Anyway, a few guys and myself got together, and we looked around ourselves at our home and said, "We've got to fix this thing. We've got plenty of space." We had twenty-two feet diameter and I forget how long, thirty or forty feet in height, a big cylinder, all the room in the world. There was a weight constraint of some sorts, but it wasn't severe. So we decided that there ought to be compartments to sleep in, there ought to be a waste management compartment, there ought to be a place where people eat their meals and prepare their meals and get together during the day.

Essentially we patterned things after shipboard. For instance, the wardroom, where you get together and people drink coffee and do their thing, there was one great advantage in zero gravity: at least everyone could sleep up against the walls as opposed to sleeping out horizontal, which saved a lot of space, because we didn't really have all that much space. So this little sleep compartment could turn out to be about something like this and you sleep up and down this way, see. There was plenty of head room. So the beds disappeared, and instead of that, there was sort of sleeping bags that zipped all the way up, and one could get in the sleeping bag and zip up.

We found out things that—some of this was just pure reasoning; some of it came about from having watched things in Apollo—that even in this stand-up position—of course, it's weightless, so the crew doesn't feel any weight—but during their sleep, the arms would float like this, and it would bump against something and it would wake them up. So it was soon found out that you've got to put some sort of half restraint on the arms. You don't have that problem when you're lying in a bed; gravity keeps your arms down. But, see, if you didn't have any gravity, your arms do all this kind of thing.

We found from water tank tests that the natural posture of a body in zero gravity is sort of a situation like this, that sitting down is very difficult. It's hard to sit down in zero gravity. You've got to make your knees bend and make the trunk bend to sit down. There's not 160 pounds pushing you down in the chair. But the body also doesn't want to stand up straight. It's hard to actually stand straight. It wants to do like this. So that meant that chairs, in the usual sense, were useless. That desktop, for instance, it would be silly to make the ordinary desk that's twenty-nine inches above the floor, because one can't sit down to a twenty-nine-inch desk. It works out it should be where one would be in this kind of position, like that.

Mobility and restraint of people in zero gravity. The flight crews, they were their own enemy in this regard. They all said, "Nonsense. We do not need any restraint. No problem." They were basing all this upon being in Mercury, Gemini, and Apollo, where you couldn't move ten inches if you wanted to. Everybody was stuffed together. The ceiling was here, the wall was here, the floor was here. You couldn't fall out of the thing. We did have some pictures of several times guys banging their heads, bumping their heads against something that they didn't realize what they were doing. You know, they would float up and do something and their head would boom, boom, boom. I remember seeing a picture of [Walter M.] Schirra [Jr.] once, and his eyes went "dnng!" two eyes went together. [Laughter]

But anyway, we finally convinced people that we would have to put discrete restraint aids in there, that you could not just go floating around. Several things were developed. Some of them were not very good, but various little—you know, instep straps that one would stick the feet under to hold the feet. Some of them were good. Some of them were bad. There was one thing that worked quite well except that it was clumsy. There was a grid floor in this thing, and some of the shoes had essentially kind of cleats on them that could go down through the grid

and if you turned your foot slightly it would lock onto the grid. It was quite effective, but they were heavy and clanky and clumsy. Some of the crew would learn to almost use their toes in this grid to kind of halfway grab it with the toes. And incidentally, they wore out their little booties, the kind of little booties they had. They'd just wear them out in not time with trying to grab hold of the floor.

The business of up and down was very interesting. Everybody says, "Well, zero gravity, there's no such thing as up and down. Might as well be one way as be another." That may be true, except that people for several million years have decided that a good thing to do is to all stand up one way. That is, everybody uses the same up and the same down, and their legs and feet develop to stand on things, their arms develop to do things with. The sun always came from above, so they grew eyebrows to shade their eyes, and they learned to recognize things when they all stood the same way.

Now, it didn't take long to appreciate that things don't work so well if everybody is [in] all kind of funny positions, one to the other. People don't like to look at each other upside down. They don't look the same. For instance, if you're lying on the couch and you're watching TV and you're half bored, it's all right that you're not paying much attention. If something very interesting comes on, people invariably sit up straight and look at the TV. They don't like to watch the TV on their side like this. If you're going to write directions and placards around the wall, it's nonsense to put some this way and some this way and some this way.

So, it turns out that using an up and down in a spacecraft is very, very important. That way you can put all the lights in the ceiling where they're supposed to be, you can put things you've got to do around the side, you can put things that you've got to walk on and grab with for your feet down here. So you end up just like it is on Earth. Besides that, the body, if you ever

notice, if you stand up, you can...[twist] the trunk and the head almost 180 degrees and reach all these things around you, but you cannot...[bend forward and backward] very far. It's very difficult to do things this way. So all of this reinforced the idea of maintaining an up and down in the system.

Now, the way Skylab ended up, though, the thing called the workshop, this is where the guys did their work and where they lived and all this, everything that was up and down everywhere, but the moment that one went through the hatch into the next section—and now I forget the name of the next module; I should remember, but I don't—everything was every which way. Every way. There was no up and down, and everything was just scattered. Some things were written this way, some this way. Here you go from a world that's organized up and down, and then you go into chaos, and nothing is where it ought to be. Then you go to the next module, and it may be chaos in a different direction. [Laughter]

Anyway, it was a mess, but the principal compartment, that is, that workshop area, we did maintain the up and down convention, and little things came about. In the wardroom there was a pedestal we devised that one could mount food trays. These food trays had heaters in them and had recesses that one could put cans of prepared food, and it would heat the cans of food with a timer so it could be set ahead of time and the meal would be ready when you come in.

It was very crowded in this little compartment, and you would have thought that when three guys were in there and that one wanted to go around the side, instead of kind of slithering around, he would say, why didn't he just go across the top? No gravity. They would never do it. They would never do it. And it occurred to us that people just don't like the idea of crossing the table. Their manners were better. In any case, they never did it. So there are certain things

that even though you've got the zero gravity, I don't think you can take advantage of those things.

The garments, an interesting problem. Before that, all the astronauts were pilots, so they all wore flight garments. That was their favorite. That was their uniform. They had pockets down the side [of the legs], all kinds of things here. They don't have pockets here [at the side of the waist] because you can't get your hands in pockets when you're sitting down, but they could get their hands in pockets on their [legs]. We reasoned that that may have been good for sitting down, but that's a poor arrangement in zero gravity, for two reasons. Number one, it's not all that easy to bend down and reach your feet in zero gravity. In the second place, it put more bulk on the lower legs, which, when one moves around in zero gravity, become unmanageable.

We had many instances where the crew, in moving about, kind of floating, you might say, would bump their legs against a switch. They wouldn't even know it. They would be doing something and they would inadvertently flip a switch. Most of the switches were protected with guards. I think you may have seen them, you know, the switches in between two little things that it's difficult to just bump into, but nevertheless a toe or something could get in there and move that.

Oftentimes a spacecraft would—something would start to happen, and the ground would say, "What's going on here?" and everybody would say, "I don't know. I didn't do nothing," and it turned out that the guy's toes had done something and he didn't even know it. Some of these switches were right along a passageway, right where you'd go through something. There's a lesson to be learned there: don't put these things near a passageway. You're going to bump them. So there were all kinds of very interesting little things that came out of this workshop area.

KELLY: How were the clothes then designed?

JOHNSON: The clothes? Oh, yes. I was talking about the flight garments. So we ended up finally convincing them that they should wear pants and they should wear shirts and they had undershirts and underpants and socks, just exactly like you wear every day on Earth. Somehow or another it's very difficult to get people to want to do things in space like they do it on Earth. They seem to feel obliged that we should reinvent the things, even though people are the same, their body is exactly the same, but somehow they want to reinvent it.

Besides that Skylab, they were going to have three crews, and virtually everything for all three crews had to be put aboard on the first flight. No one knew who the crewmen were going to be. They're not all the same size, so how could you give them all these single-piece garments? Some of them would be too big and some would be tight, and I can't imagine staying there three months with a jumpsuit that's not long enough between the crotch and the shoulders. You know, you'd have long days with that. So we finally convinced them to use the separate shirt and pants and all, like everybody else does.

And also, why we're about it, we got some—I think a man name Fred Toerge, he designed the outer garments just from the point of how they looked and all. First place, of course, they were blue, NASA blue, but they had a white stripe up their sleeve up to their shoulder and a stripe down the side and around down the leg, and not only did it look kind of nice, but it allowed, then, when photographs were taken, that you could quite readily distinguish the position of the body because you'd have that white stripe that you could see.

Well, it wasn't long, though, before the crew members completely messed that up. Everyone of them had to sew his name and rank and serial number and his old outfit in the Army and Navy and Air Corps and Marines. They had patches all over them, and first thing you know, you could hardly tell the things were blue, they had so many patches on them. But that was really a small matter.

We accumulated a great deal of data in the course of these missions. There was a thing called Channel B. It was not the channel that operations used, flight operations used ordinarily, and it was not a channel that the press—it was just day-to-day chit chat. Late at night the guys would kind of like data dump things that they had thought of during the day. They would come down at one or two o'clock in the morning when everybody else was asleep. But we logged it all and went back and looked at it. It was very interesting, because a lot of the things that the crew would say after they got home was not what they had said on the spur of the moment at night. I don't mean there was a lot of contradictions, but there was a different flavor of things. Later, when they would get home, they would tend to kind of get their stories straight, and all three crewmen would kind of tell you the same story, even though in the course of the mission they had quite violent disagreements over something.

Some of the stuff we put aboard was absolutely useless. We misjudged it. I remember we had some little beanie hats sort of things. The idea was that it would protect their heads from being bumped, because we had seen evidence of guys bumping their heads. They never wore them, they never seemed to bump their heads, and the [beanies] weren't any good. Some of the material, I think, in some undershirts, whatever it was, it didn't absorb perspiration and it apparently just smelled awful. It was some sort of synthetic something or another. That was a big mistake.

We rigged a thing called a fireman's pole from the bottom—I'll call this the bottom now because I will use the up/down thing, but from the floor all the way, [maybe] up forty feet to the ceiling, with the idea it went down the center of the place and that you could just grab this pole and kind of go scooting along like a fireman's pole, and guide yourself. They hardly ever used the thing. It was speculated that you could—in fact, I think a couple of crews didn't even rig it. After they got there, they didn't even put it in. They found it was useless.

But for the most part, things worked pretty well. The waste management system worked. It seemed to work a lot better than the present ones do on shuttle. And yet I think one of the reasons the things worked, part of the whole business was that urine and feces had to be collected, freeze-dried, and all because of medical reasons to bring back. So the crew was more conscious of—and they're kind of trained what to do and that, but there seemed to be fewer complaints about it on Skylab than there turned out to be on shuttle later on. I really don't know why. I don't know that much about the one on shuttle.

KELLY: That's interesting.

JOHNSON: And it's rather strange. There must be some reason why shuttle didn't just simply use the one on Skylab, but everybody likes to invent something new. [Laughter]

KELLY: [Laughter] There you go. Now, how about their food? Was that any different from Apollo or Mercury or Gemini?

JOHNSON: Yes. We finally convinced everyone that there's was nothing wrong with eating the same food that you eat on Earth. We had knives and forks and spoons and plates, these little cans. When [we] first mentioned knives and forks and spoons, everybody said, "Not in zero gravity." It didn't take long, though, to show almost anyone that you can take 90 percent of the foods you eat, if they're in the can, they've got enough sticky stuff on them, for one reason or the other, that you can turn the can up like this and half of them won't fall out of the can. In fact, half the time, if you'll notice, you've got to bang the devil out of the can to get anything out of it. So we finally convinced everybody that—except for a few things. Canned green peas wouldn't work; they'd all come floating out of that. But for the most part, the food was just more or less like you get except there was great pains taken to make sure it was proper food.

The crew complained about the food though, that it all tasted—I think the word they used was "bland." And we never could quite figure why it was. Now, if you remember, Skylab was overheated at the beginning because [the solar protection shield was lost]. There was some speculation that everything just simply got too warm and it kind of destroyed some of the taste, but they would say things like it wasn't salty enough or it didn't have enough pepper in it, just everything was so bland. I don't know if anyone ever did really figure what was going on. Now, it may have been that the people that made up the diet purposely went easy on salt and pepper and such things. It could be that way.

But I thought it was a very, very satisfactory mission, and it's just a shame that we let it fall into Australia. You know, we had a great space station going, and it wouldn't have taken a hell of a lot of thought to have kept that thing up there. Near the end, maybe within about three months of its demise, there was a panic, "Oh, we've got to do something to save Skylab." Well, it was too damned late then, but it could easily have been done. But I don't think anybody

wanted to save it at first. You know, let the good times roll. Man, we were doing one thing right after another, and the last thing anybody wanted to do was mess around with some old clunker spacecraft still sitting up there. You know, "Let's do something new. Let's build a shuttle." And I think that had a lot to do with just kind of letting it go, except there was some concern after a while as to where it was going to hit.

KELLY: Were you involved in that decision?

JOHNSON: Only in a very roundabout way. We were making some studies of how to control it coming in, and finally Marshall [Space Flight Center] worked out ways of changing its attitude such that it changed its drag coefficient, and so they could somewhat adjust, after watching it for a hundred orbits, you could tell just about what to do. They missed the Indian Ocean a little bit, but it hit just the western part of Australia. But that was pretty good.

Incidentally, I've seen some of the debris that was picked up in Australia, and everybody says, "Well, you don't have to worry about things. They'll all burn up and it won't hit the Earth." I'll be damned if that's so. There's some big old tanks that are left that are half as big as this room and must weigh a half a ton, and they are sitting there kind of charred and busted up, but if they hit the top of your house, you'd know it, I'll tell you that. So this business of everything burning up is not quite so.

KELLY: How did they go about their everyday maintenance activities or personal hygiene and just everyday cleaning?

JOHNSON: They were overworked. They were overworked. In spite of trying to fix up this place to lighten their everyday burden, they were spending a great deal more time than you and I do on personal grooming and fixing meals and cleaning up. It was taking a good portion of their day. So the work that they were supposed to do had presumed that they were free all day to do these things. It was like you go to the office and somebody else cleans up the kitchen after you go to the office. Somebody else cleans up the house. They didn't realize that these guys were doing two jobs. So the guys were just working all the damned time.

We put some entertainment stuff on board, but, in the first place, they didn't have much time for it. In the second place, they found out that looking out of the window, for instance, was something they'd spend a fair amount of time doing. It was different, relaxing, looking out the window. They avoided any of the games, the competitive games. I think now, in retrospect, that any psychologist could tell you that they'd want to avoid those, because three men for three months, probably the worst thing they could do was to get involved in competitive games, see who can beat whom. That might just aggravate some situation. And I think they intuitively recognized that that's not the thing to do, so they didn't play cards, they played music, and they looked out of the window. And they liked to exercise. They used the old bicycle. They'd get on that thing and just buzz away.

Incidentally, they would get overheated. Now, Skylab had a nice air-conditioning system, well ventilated, but it turns out that in zero gravity, when the body gets hot and all this hot air develops around you, it doesn't rise like it does through the gravity, you see, the light air. So you're working, and you're working in a little bubble of hot air that you're making, and that little bubble of hot air just clings around you, and you just get hotter than a firecracker. That's another lesson that many of us learned.

KELLY: Absolutely.

JOHNSON: Well, one guy didn't like to sleep right up against the wall. He said it was because of ventilation problems. We suspected he just couldn't—you know, he went to sleep knowing he was standing up, and that just ain't the way to do it. [Laughter] He would rig his sleeping bag things on the floor outside. But maybe that's all.

KELLY: It's amazing what we take for granted living on Earth.

JOHNSON: Yes, that's right. You get mighty accustomed to—the thought in some area of your subconscious that "I'm going to wake up and fall off the wall or something," you know. [Laughter] It was very interesting.

Very few people paid any attention to Skylab. The people at Johnson Space Center almost didn't know it was going on, except the operations types there and the crew and those of us there doing...[Experiment 487]. It was probably because it was not Johnson's mission. It belonged to Marshall, and, you know, it couldn't be any good if it belonged to Marshall and didn't belong to Johnson, so nobody paid any attention to it. But I thought it was a very interesting thing.

KELLY: To your knowledge, was Skylab ever designed to hold any more than three crews?

JOHNSON: I don't think so, because we just had the three sleep stations there, and the wardroom would only hold three people. So I don't think so, but I don't think anyone ever envisioned that there would be somebody there for three months. You know, the medics would say—they started out to say, "You might be able to take this weightlessness for maybe a half hour," and after that was done, they'd say, "Well, okay, you can get by with a half hour, but a couple of hours will do you in." You'd go a couple of hours, and say, "Well, you'll never make it more than for four or five days." I think they finally gave up after a couple of months and nobody--

KELLY: You had brought up another interesting point about the window on Skylab. Can you tell me a little bit about that design?

JOHNSON: Yes. We reasoned that, you know, it didn't have any windows. How were these guys going to live there and they didn't have any window? Now, they could go up to the observatory. It's a solar observatory, and you could go inside, and there was windows there, but just in the normal course of the day, and especially there in the wardroom, it would seem only natural that one should have a window that you could see out. My God, what a view! What a view and not to have a window. So we said, "We ought to have a window."

Poor Marshall Space Flight Center, they were behind schedule, over budget. Everybody was on them, and here we say, "Let's cut a hole in the side and put in a window." That's like cutting a hole through your roof after the house is all finished, practically, and saying, "We want a big skylight in there." Well, it was just terrible! I can feel for those guys, but on the other hand, the whole idea of this thing was to put men up there and see how they're doing. It needed a window.

Well, there was an impasse. So finally George Mueller, Dr. George [E.] Mueller, who was the director of manned space flight, called a big conflagration at his headquarters in Washington, and we all went up there and we gave our reasons to do it, and Marshall gave their reasons not to, and he had to make a decision. He had hired a man named Raymond [F.] Loewy, a very famous French industrial designer. He redesigned the Studebaker years ago. He changed the refrigerators from having the big old units up on top to putting it all inside. He changed—do you remember Lucky Strike [cigarettes] went to war, the green and white? He changed the color of the Lucky Strike package. The U.S. Postal Service thing, he did that. He did Exxon. He invented the name "Exxon."

Anyway, he [Mueller] had hired him to give some advice on the decor and the design features of the thing, colors and things like that. Right in the middle—I mean, after all this was over, this big discussion, and nobody knew quite what to do, Mueller turned to Raymond Loewy, and he said, "What do you think, Mr. Loewy?"

And Raymond Loewy said, "I can't imagine *not* having a window."

And George Mueller turned to poor Leland [F.] Belew of Marshall, and he said, "Put in a window." And that was that. [Laughter]

KELLY: That's pretty interesting.

JOHNSON: Incidentally, Mr. Loewy visited Johnson Space Center once, and it was a very foggy, foggy morning. You couldn't see your hand in front of your face. He came to my office, and I was supposed to show him around. While we were walking around, I said, "What do you think of this place, Mr. Loewy?"

He said, "Well, if the outside is as grim as the inside, I don't think much of it."  
[Laughter] He hadn't seen the outside because it was so foggy. But it was. You know what it's like in that place, these dull beiges and these grays. You know, it's absolutely sterile. It's an awful-looking thing.

KELLY: It must be something different from a designer [unclear].

JOHNSON: Yes. It was just horrible. Everything is this way and [unclear].

KELLY: You also mentioned, that brings up another thing to me, a little bit ago about the design and the patterns of paint colors. Could you tell me about that? [Subject: Skylab.]

JOHNSON: Oh, yes. That was one of the things. You know, we all think we're great at colors. Now, I can at least take myself out of that category, because I'm red/green blind and I'm very poor at colors. So I hesitate to say anything. But anyway, most everyone has their idea of what makes good colors, and especially women. Well, every guy that had anything to do with the interior of Skylab, that might have anything to do with painting the inside, has a wife, and every one of the wives had their idea of what the color scheme should be inside. I'll bet that thing was painted over half a dozen times, depending upon the rank of the person whose wife had last said what color it should be. And when they finally got down to painting it, in the good old government way, all these paints got identified by some great number that's in the wavelengths of light, the emissions from this down the thing, and the specs went out with all these complicated things. No way you could just go down to Sherwin Williams and buy a color. It

had to be to this government spec. And the funny part about it, it had taken a year with everybody—with every color of the rainbow, and then when you finally get through, it's got to be within a match of exactly [unclear]. It was hard to disguise it anyway, because it's mostly made out of aluminum alloys and structural members, and it looked kind of crummy anyway.

KELLY: What colors did they end up with, do you remember?

JOHNSON: You know, I don't even know, but the one in the [National] Air and Space Museum is painted, probably. I don't even remember what it was now. It's fairly neutral colors, I think. No chartreuses and lavenders.

KELLY: No interior decorators.

JOHNSON: No.

KELLY: I know when Skylab was first launched, one of the solar array panels had broken, and I know there was a big effort to help repair that. Were you involved in all that?

JOHNSON: Oh, yes. Well, everyone was involved. That was priority number A, number one. Something had to be done. We figured we had maybe ten or twelve days to do something at the rate the temperature was rising. What happened, there was a thermal shield outside to shield the structure from the sun, and it would re-radiate back, and in doing a launch, that thing got torn off. Big pieces of it got torn off. And in the process, it messed up the solar arrays so that

one of them would not unfold. So there was Skylab sitting up there with no solar arrays, no way to get power other than batteries, and it was getting hot inside because the sun was shining on this thing and it had no protection. And at the rate the temperature was increasing, it was kind of figured that a dozen days or so and that thing would be so hot, we'd have to give up everything.

So there was a panicked effort to design something to put a sunshade over that thing, send it up on an Apollo command service module, rig a sunshade. There were two principal concepts, one devised by Jack [A.] Kinzler, who was head of all the shops at the time. He proposed an umbrella type of affair that would be in a canister that can be taken inside. There was an airlock, fortunately, right exactly over the spot that you would need to rig this sunshade, and it was for scientific purposes, to stick things outside without the air all rushing...[out] and everything. So he devised this concept that you'd put it up through this airlock and when it got out, it would unfold as an umbrella with a big aluminized screen over it.

Everyone agreed that that was a workable idea, and they went to work. I had proposed, as an alternate back-up solution, to pull an awning, stretch an awning from what would be the solar telescope structure towards the back of the system and drag this awning over the top from the outside. But to do this, a crewman would have to stand up in the open hatch of the Apollo command module and, with some hooks and all, hook these ropes and pulleys, and then they would pull this thing apart. That was deemed more risky than the other one, and it was. It was more risky. But it was a back-up in case...[the first] didn't work. So we worked on them both and we developed them both, and we stowed them both aboard the command module to take them up there so if one of them hadn't worked.

Fortunately, the very first try, they rigged the umbrella up from inside, and immediately Skylab started cooling down. They then were able to get out an EVA [Extravehicular Activity] to pry loose the solar array, and they got one of them out, so the old craft had to get along the rest of its days with just one solar array and with this jury-rigged thing on it.

A lot of times people remark of how well Mir has done with patching up itself. Well, they seem to forget that Skylab did quite a bit of patching itself on that thing. But it was a frantic effort. It was no sleep, an hour at a time and everybody working, and no expenses spared. Everybody did everything they could do. It was a great thing. Looking back on it, it was a frantic effort, but it was fun in the sense that I think everyone likes to do something that must be done and do it in a hurry and you don't have time for little petty bickerings and all this stuff. Everybody just does everything.

I think I may have said something once before that we needed a gallon of a certain kind of paint to coat this...shade with. It was manufactured either in Durham or Raleigh, North Carolina, on or the other, somewhere around there. We needed it, we had to have it by the next morning. An astronaut got in a T-38 and flew to Raleigh-Durham Airport. In the meantime, the paint manufacturer had delivered the paint there, and it was ready, and he put the thing, and turned around, and got back, and we were painting it on at six o'clock in the morning and he had left at midnight. I don't know what that gallon of paint cost, but it was a fair amount of money.

KELLY: An expensive gallon.

JOHNSON: That's right, but it shows you what it can do when you have to do it.

KELLY: You just spoke of Mir. In retrospect, looking at the space station that's being designed now, what do you think were the most important lessons that the program learned that you were involved in from Skylab and from its design?

JOHNSON: I don't know. I really don't know. The space station is such a complex thing. I can never quite get a feel for it. One thing that they didn't learn—I don't think they learned—is how difficult it is to do things in orbit as opposed to doing it ahead of time on the ground. Now, I know they had no alternative but to assemble this thing in orbit, because it's out of the question to launch that whole thing. I'm rather surprised, though, that it became so complex so soon. It would seem like it would have been much better to design a very simple, self-sustaining station first, something that you can grow upon it, but not have to wait until there are multiple launches before it becomes operational.

Also, the thing suffered—or it suffers, in my opinion—it doesn't have any boss. It doesn't have any designer. It's designed completely by committee and countries. Everybody has to agree, and that means you're going to end up with the root mean square. There's no way any genius can be active there because it's going to average what the thousand people want, and if you average what the thousand people want, it's, by definition, mediocre. That's the definition of mediocre. So that's what the space station is going to be: mediocre. It's inevitable, but it's the only thing we've got at the moment.

Why in the—well, I do know why we abandoned some of the things we had, because everybody wants to do something new, but we had that wonderful launch vehicle, the Saturn 5. Wonderful vehicle. We just abandoned it! I can't imagine why we did such a thing, in retrospect, except I do know why. It's because we got tired of messing with something that

works so well. Who wants to work on something that works so well? You want to work on something that don't work so well. [Laughter] And shuttle offered a whole lot of challenges, and I guess there's no argument with the principle of shuttle. Of course, having it reusable is better than having to build a new one every time, throw it away, but that didn't mean we had to abandon the other one just simply because we started a new one. But somehow we did. Somehow we did. And now we couldn't build another Saturn if we wanted to. Even if you could find the drawings and the specs, everyone would say, "Oh, I know how to do it a lot better than that now." So everything would be built different anyway.

KELLY: That's a really interesting perspective.

JOHNSON: I guess that's why shuttle was started: people were kind of getting bored.

KELLY: I'd like to get to that in just a moment, but would you like to take a break right now?

JOHNSON: Yes, I guess so.

KELLY: Okay. [Tape recorder turned off.]

As far as approaching shuttle, I was hoping to ask you a little bit about what you did when you first began working on the idea of using a reusable spacecraft, and then moving into actually designing the spacecraft itself. Was that an idea that you had circulated around for a long time with using a reusable spacecraft, or how did that idea come about?

JOHNSON: Well, everyone, of course, recognized that we should have reusable spacecraft, and, as a matter of fact, at first Apollo was going to be reusable. It turned out it really wasn't a very practical idea. It was cheaper to build several of them than to try to repair one of them that had already been on a mission. It really wasn't designed for that anyway. But everyone in the aerospace business was busily designing some version of a reusable spacecraft, you know, the big companies, the Boeings and the Rockwells and various people, McDonnell Douglas. Everyone had some ideas about doing it.

We had finished up doing everything else, and, like I said a while ago, kind of bored, so really wanted to do this. Max was kind of spearheading it, as far as we were concerned. I don't think Marshall was really doing very much. I think Marshall realized that whatever was done, they would end up probably building the big booster systems, propulsion systems of the thing. I don't know that Langley got terribly interested in it. I really don't know. I think somewhere along about that time, Langley was trying to get back into the research business. That was really their strong suit, was research and development, as opposed to developing a project itself, to present some particular project. Johnson Space Center obviously was project oriented and mission oriented.

I don't know exactly how it started. I do know that long before there was an effort of consequences, Max had been thinking about it, and I remember it got to the place where he and I decided to build a model of the configuration. The spacecraft itself was virtually an airplane in its configuration, a straight-winged aircraft. It was modified somewhat to take care of the reentry situation, heating. The booster at that time was a twin booster, and the spacecraft was nestled in between the booster. The booster would fly back, re-enter [unclear].

We built a model, a balsa wood [unclear] model. Max built the spacecraft. I built the boosters. We could hook them together and just glide them around and then glide the spacecraft by itself. They didn't really perform too well. I remember we were showing it to Dr. [Robert R.] Gilruth at one time and explaining some of the difficulties with the aerodynamics, and he kind of chided both of us, as I recall, that we'd made schoolboy mistakes. [Laughter] He didn't mince words. And, of course, the moment he pointed out the problem, we recognized it and both of us agreed that it was rather schoolboy mistakes that we had made on the thing.

The configuration was altogether different than shuttle turned out to be, altogether different. In the first place, it was a straight-winged aircraft with a conventional horizontal tail, perfectly satisfactory for what we thought was going to be the mission, but the mission started changing. It turned out that the program—now, I'm about to say some things that I probably don't know very much about. But the program was too big for NASA, and the Air Force got involved, and the Air Force had ideas of something that they wanted to use a shuttle for, this overall concept, for military reasons.

The deal was that they would support this thing and not fight it, but it had to incorporate some characteristics that were desired by the Air Force. One of them was that it had to take care of a payload that was better than...[fifteen] feet in diameter and I forget how—sixty feet long, a monstrous big payload, big cylinder. Well, the thing that we'd started out with was nowhere near that capability, nowhere near that. It was principally a manned type of thing, as opposed to a big cargo-carrying type of thing.

The Air Force also wanted to be able to return from orbit at any given time in one orbit, return immediately for military reasons, to get the hell back down on the ground. Well, we had never envisioned having to do such a thing. Now, to do that, it means that the craft has got to

be able to fly very well hypersonically during entry. That is, it's got to make great cross-range changes to its orbit in order to get back down on the ground in the right place at the right time, no matter where you are. That made a great deal of difference in the configuration. We didn't like it, but that was the deal. Otherwise, the Air Force would have protested and tried to seek money of their own, and there would have been some competition, and probably then neither one of us would have done anything. So somewhere along the line, someone agreed to whatever.

It turned out, of course, when all was said and done, the Air Force never used the thing for that at all, never used it, but it got set that way, and so we were saddled with that great monstrous cargo bay on there. It turns out to be somewhat convenient to space station, but space station doesn't really use that thing. It's more weight-limited than space-limited.

Within the engineering development directorate, we all kind of got to work on that. My outfit dealt with the configuration, you might say the shape, what it kind of looked like on the outside. Various other people dealt with propulsion systems. Marshall went to work on things that had to do with big boosters, that sort of thing. I remember—I'm not sure this number's right, but a friend of mine who did a lot of the drafting on the configuration, I think he told me not too long ago that he can recall fifty-four different configurations, fifty-four evolutions of it, separate drawings of something new and different, and change this, change that, move this, move that. Fifty-four of them. I think that's the number he said. He name was Jessie Phillips. He now lives in Hampton, Virginia. I suspect Jessie has a copy of each one of those, and if he has, I would bet you anything that they're the only copies in existence, because I'm sure that the system did not keep all those things. But Jessie might just have, because he personally drew them all.

I couldn't tell you what all fifty-four of them were like now, what all the evolutions were, but it probably would be very interesting to look at from the start to finish and trace the changes in thoughts and ideas and how it came about. I suspect that even the last one is considerably different than what it really turns out to be by the time Rockwell started working on it and introduced things that they had to do for certain other reasons. You know, that's the way spacecraft goes. That's the way everything goes. You know, Mercury resembles that drawing. You look at that and look at that picture on the wall over there, and they're similar, but they're not the same by any means. There's a lot of things going on on that.

KELLY: What time frame did you initially start talking about this project in working with the Air Force?

JOHNSON: I can't remember when it was.

KELLY: Was that during Apollo?

JOHNSON: Yes.

KELLY: Okay. So, sometime during the sixties or seventies.

JOHNSON: Yes. Yes, all of these programs, you know, have a great overlap. There's a tendency to think that you do one and then you start the next one and do the next one. You know, Apollo was under way before the first Mercury flew. That's a good illustration of the way this system

overlaps; that is, different people do different things. The concept designers are way out ahead, and then the preliminary design people are a little bit behind them, and then the real-world people that are really doing engineering development, then they come along, and so that concept stage is way out here when something else is following along behind. It's kind of risky, because you're betting on success.

JOHNSON: See, you're betting that what you had done before is going to work, and you're so damned convinced that it's going to work, that you're going on ahead. And so far that's turned out to be the case. [Laughter] But it could be that, you know, once in a while you may make just a catastrophic mistake, and then the whole house of cards comes tumbling down. You know, your chain gets broken in the middle of the chain.

We came awful close to that in Apollo, making a terrible mistake. I think I may have mentioned that before, that we completely changed the Apollo concept in the middle of the game and somehow got away with it. It's amazing. It's amazing.

KELLY: What did you and Dr. Faget initially propose the shuttle design to be able to do? Was it simply for experimental use? Was it to [unclear]?

JOHNSON: I don't really remember, to tell you the truth. It had cargo space in it, that's for sure, but it just did not have that raw capability that the shuttle has now. Now, the shuttle suffered by doing some of these things the Air Force wanted to do. It's not a very good flying machine, but it's good enough. There are a lot of people that badmouth the shuttle, its aerodynamic characteristics, and it's not the best thing in the world, but it does work. I'm rather surprised that

since it worked so well, or well enough, and it's so well documented and understood that by now we know everything about that thing, how it works and all of its weaknesses and its good points, I do not understand why the present system, in, let's say, making craft to go back and forth on the space station, particularly the so-called escape or emergency vehicle, why they're not just simply little shuttles, something that will land on a runway, essentially as a flying machine. We know all about the thing.

Instead of that, NASA is building a kind of a hybrid thing that's half flying machine, half not, got parachutes or paragliders. It's taken all the bad features of everything and put them into one instead of taking the good features, and it's not made to land on a runway. Now, I can't imagine not landing on a runway. All over the world are runways with all the infrastructure that goes, you know, the communication system, the weather reporting, everything. You could just as well land on it. But somehow or another, it's almost like the Saturn V: it works good, so let's don't play with that anymore, let's get something that don't work so good. [Laughter]

KELLY: Right. Back to your point.

JOHNSON: Now they throw the shuttle away and they do something else. But anyway, there were a lot of people working on the shuttle, but there was so much money involved in it, it was clear there can't be but one shuttle.

KELLY: So after you started working on your initial design, after you'd shown Dr. Gilruth your initial prototype, where did you go from there?

JOHNSON: Let me see what happened. There was a little—they often call them task groups. You grab people and put them all together and put them in one room. Jim [James A.] Chamberlin—you will run across that name quite often, James Chamberlin, was put in charge of that, and I kind of lost track of it then. Jim had a way of pulling everything together, and it would always be off in some little room somewhere, and it was very difficult to penetrate, see what was going on. Only Jim knew what was going on. You know, people kind of [unclear].

Now, sooner or later it got to be so big that it got beyond that so-called task group of things and then got divided up all over the place, with the landing-gear people and the wing people and the propulsion people and all this kind of thing. But I don't remember how long that little task group stuck together; perhaps six months or something like that. I don't really remember.

KELLY: Were you part of that space task group?

JOHNSON: Yes, at first I was, but I'm not sure quite what happened. I think that somehow or another the way Chamberlin was running it, working it, and the way I worked and all didn't fit together right. Besides, I think at that time I had a division to run, too, and I probably had my hands full with other things. But I really don't remember too much about that.

KELLY: I did read that you and Dr. Faget had conducted a feasibility study for your design.

CALDWELL: Yes.

KELLY: Can you tell me a little bit about the type of things that you looked at?

JOHNSON: No, but I do remember that there was one concept that we employed Rockwell with to do a study of a particular thing that we were going to salvage. We were going to salvage the first stage of Saturn. It was a two-stage situation, and we rigged up a vehicle to utilize Saturn—it certainly used the Saturn engines. It went its course, but it would not satisfy that Air Force requirement. It just simply wasn't large enough. So it fell by the wayside. We must have postulated some design requirements to start with. You know, nobody's just going to start off designing something without having some specifications, even if you made up your specifications yourself. You've got to sit down and decide what you're trying to do before you're going to do it, because otherwise it's kind of dumb to think of something and then try to find a reason to use it. You ought to have a reason first. But strangely enough, somehow or another I don't recall. There were a lot of other things going on. You see, the other things were flying and business was going on at that time.

KELLY: Do you recall some of the specifications that you had come up with, some of the initial ones?

JOHNSON: No, I surely don't. I dare say that between Max and some operations people, they probably generated most of the specifications, but I can tell you this, that they would fall far short of what the Air Force wanted. I do know that much. I'm not sure where it went from there, too, because obviously, once it became an overall NASA program, it had to be pulled together by many, many, many people. I've got a notion that Robert Thompson was the first

guy to take that thing over as total director, program manager for the whole shuttle program. I think Robert Thompson, who, incidentally, you ought to talk to him if you ever get around to it.

KELLY: Okay. Terrific.

JOHNSON: I think he lived in the Woodlands area for a while, but I believed he's living back somewhere in the NASA area. I think. It wouldn't be hard to find out.

KELLY: Were there any other individuals that you recall had a significant contribution?

JOHNSON: Oh, yes, but there's so many, I don't even know where to start. The operations people played a great part in this thing, too. Usually the engineering people and the operations people, the design people and the operations people, are kind of like this. [Demonstrates] We're really not, because, just like my hand, they're both connected to the same hand. They have opposite points of view of things. The operations people, you know, complain that the engineering design people, if they had any sense, they would make the damned thing so it would be easier to fly, not so much trouble, and, of course, the design people say if the operations people had any damned sense, they wouldn't need all these things that they have, they practically ruin everything after they get their hands on it. [Laughter] But the fact is, it takes both parties to do the thing right. After a few years go by, you kind of forget that you were mortal enemies for a while. It takes both sides.

KELLY: What in particular was your significant contribution to the shuttle design?

JOHNSON: Probably not nearly so much as to Mercury and Apollo. The thing had gotten too big. It just was too big for any person to make an impact on the thing, and so I decided at the time, like I said...[there] was a division to run and we were turning out these configurations, the fifty-four different configurations, not any one of them worth a damn. But I guess somehow along the line they ended up absorbing the inputs of many, many, many people, and that's why there were fifty-four, because so many different inputs would keep coming in and changing things. And some of what were thought to be good ideas didn't turn out to be so good when you really got down to it.

KELLY: Was that as a result of the engineering and operations people working together?

JOHNSON: Yes. It may be that from a design standpoint you think you've got a great idea and something's great, and then after some consultation with the operations people, they point out that this is not going to work at all, that X days out of the year you're not going to be able to fly it because the wind's too high and whatever the [unclear] might be.

And then I'll say again, there was that constant input from the Air Force. The difficulty with working with the Air Force, there's no way to argue with them. You can argue with yourself and negotiate internally, but you can't negotiate with an independent agency like that. All you'd know is that you'd just get an edict from the Air Force that would say, "It's got to be like this." Not why. [Brief interruption; readjusting the microphone.]

And then there was no way to negotiate anything, and it would have taken a level so high up in the government that the kind of subtle engineering points could not be made. I'm not

trying to imply the Air Force was unreasonable. It's just that the system is clumsy when you get that high up. There's just no simple mechanism to sit down and talk one on one. There has to be great letters written and the Secretary of Defense has got to talk to the head man at NASA.

Incidentally, this is in the same vein, but a different subject. During Apollo-Soyuz, one would have thought that that would happen in space there between a country like Russia and a country like the United States, who at that time were not at all on good terms, but it was the other way around. It was very, very personal relationships between the thing, and somewhere along the line, President [Richard M.] Nixon and whoever was head of the Russian state at that time had simply agreed that it was going to be on a person-to-person level, that as long as there was no political overtones involved in this thing, it was going to be engineer to engineer, and that's the way it turned out. It's hard to believe. It's hard to believe.

KELLY: Interesting. So at the time of the early design of shuttle, then you were also working on ASTP [Apollo-Soyuz Test Project] as well as Skylab, which we're just mentioning there.

JOHNSON: Yes. That was quite a diversion.

KELLY: Absolutely. Now then, after the ASTP mission, did you become more involved in the shuttle Program, or were you working on the program?

JOHNSON: No, because I had left NASA by then. In fact, ASTP was flown about a year after I retired. Besides, the shuttle Program had gotten down to the hard working part then, the grinding it out, that kind of thing. The people that did the grinding out, if they hear me say

something like that, they would say, "That's typical of those [unclear]," using the term "grinding it out" as though that's just dog work, which is unfair of me to say, because I didn't mean to demean that part of it.

KELLY: I understand.

JOHNSON: But it had gotten down to a place where there was a lot of people doing a lot of detailed things, all of them important, but, you know, somebody's got to do the brakes on the landing gear.

KELLY: Right. Absolutely.

JOHNSON: And somebody's got to do the worrying about every damned little thing that goes on there.

KELLY: Absolutely. Have you ever had the opportunity to watch a launch or a landing of the shuttle?

JOHNSON: No, I never have.

KELLY: Really?

JOHNSON: No, never have. In fact, I only saw one launch of Apollo, the last one, and I made a point. I said, "By God, you'd better get yourself down to [John F.] Kennedy [Space Center], or the first thing you know, there won't be any more." Of course, it was very impressive, very impressive. I remember that launch. There was an old black man there that had been invited because he was like 101 or something like that, you know, and he had been invited. He probably had said something to the effect that he really didn't believe all of this stuff going on, you know, which, of course, a lot of people didn't. And after it was all over with and he saw the thing go up, I heard later that somebody asked him, "Do you believe it now?" and he said something to the effect of, "I didn't see nothing go to the moon. All I saw was a big cloud of smoke." [Laughter]

My mother, as a matter of fact, I believe she died not believing that really man had gone to the moon, and I'd said, "Well, Mama, they did."

She said, "Well, how do you know?"

I said, "Well, I just know they did, Mama."

She said, "How do you know that somebody didn't just tell you this and show you all of these things?" She said, "I see things on television every night that don't really happen." And every now and then I'll get wondering if my mother was right, that it was all just a big television show. [Laughter]

KELLY: Oh, how funny. You could have told her they were just trying to make you feel better and that your work was really moving into something.

JOHNSON: Well, she had a point. I don't really know.

KELLY: Nobody does.

JOHNSON: Except the guys that were there.

KELLY: Yes, that's true. And they'll tell you otherwise. They'll tell you otherwise.

JOHNSON: That's right.

KELLY: What types of projects did you work on then after you had retired from NASA?

JOHNSON: For a year or so, I just played golf, I fished, fixed up the house, you know, did all the things you say you're going to do when you retire. I did some consulting work. It was very dissatisfying, frustrating. I found out that people didn't—they wouldn't hire me for—they didn't really want to know what I—they didn't want my advice. All they really wanted to do was to write my name on their proposal, to say that I was a member of the team. They didn't actually say, "Here's your check. Now go home and play golf, and when we get all through, sign this document." It didn't come quite to that, but it was almost to that. And so I quit doing that. That was horrible. I'd rather do nothing than somebody give me money to just sign my name.

But fortunately, Max and a couple of guys from the University of Houston decided that we ought to build a space station, a personally financed space station. First thing you know, I started back working on that, and we went to Washington [DC] and convinced NASA to use the shuttle to take the thing up. It was a man-tended spacecraft, and it was called the Industrial

Space Facility. It was Earth orbital, unmanned. It would just be visited by the shuttle and the crew. As long as the shuttle was there, the crew would go aboard and retune it and collect the specimens, the work that had been done automatically on board the thing, and go on back home. Then several months, three or four months later, come back.

It was operational on the first launch. It didn't take fifteen launches to get it going. The very first time, it was ready to go. You could take a second one up and join it with it, and now you've got twice as much. We talked about a third and a fourth one, but in reality, probably two of them is as much as you could handle. It could survive two and a half years without a revisit. In case there was some problem with the shuttle, you could go two and a half years.

Incidentally, during that period, that's when the shuttle had its problems, the *Challenger* had its problems. So we had a real situation to which we had been designing of standing down for two and a half years.

We finally ended up going into partnership with Westinghouse. We really didn't have the muscle to carry this thing off. Westinghouse had the muscle. They didn't have any experience in the spacecraft business, but we had that part of it and they had the muscle, and we were doing fine. We had gotten to the place where we were starting to build hardware. We were scheduled ourselves to launch in 1981. I didn't say '91; I said '81. We'd only been working on this thing six years, had it going.

In my opinion, what happened was that NASA began to realize that here was a real threat to the space station. The space station wasn't getting along worth a damn. Here we had something that, all of a sudden, how are you going to get the Congress to spring for billions of dollars when all they had to do is spend one billion and you've got this small space station? It's still a space station, and it could have been the forerunner. And the first thing you know,

NASA got cooler and cooler and cooler and then got cold, pretty soon just wouldn't even talk about it, and they hustled the congressmen and bad mouthed everything, and Westinghouse management got cold feet in view of this turnabout by NASA, and they said, "We're just not going to put any more money in that," and we closed down. And we were that close.

And, you know, we told NASA, we said, "Paint the damned thing blue. Write 'NASA' across the thing. Get you a space station. You will have gotten things started, you will have a presence in space. Russia's the only guy that's got anybody up there now, and now we'll have something, too." But the people that had great vested interest in that space station fought that tooth and nail. There's nothing they dislike more than the idea of a two-bit one-billion-dollar space station up there. Now we're looking at what, forty billion or something? I don't know what it is.

KELLY: Something astronomical.

JOHNSON: Every week it's a few billion more, and it ain't there yet, either.

KELLY: No, it's not.

JOHNSON: Anyway, obviously that's a personal opinion.

KELLY: Sure. That's what I'm asking you now.

JOHNSON: You know, this whole business worked, in my opinion—you know, everybody wants to know who is the guy that does all this? Well, of course, everybody says it's not any one guy, and it truly isn't. It's more than a person. Everything came together right. The country was prosperous. We had a cold war going on, not a shooting war, but a cold war going on with a great rival that we needed to do something against. We had a president who said, "We're going to go to the moon, get a man on the moon and back before this decade is out," committed to do that. There was a group of people that had developed the expertise to do this kind of thing. We didn't have terrible entitlement programs that were eating our budget, the United State's budget, alive. We had the money to spend. It all came together at one time—boom—all these things. That's why it worked.

It wasn't any one person. It was [President John F.] Kennedy, the economy, the Russians, and we had a bunch of Germans that had come over from World War II that knew about lots of things. We had things like the Langley Research Laboratory that was doing [unclear] aircraft rocket research. We had aircraft companies with expert people in them. Boy, you know, it just came together. And right now, you see, they're not coming together right now. People are dissatisfied. There doesn't seem to be any particular reason to put up a space station. You know, they say, "Aw, so what," and there's dissention in the ranks. They're worried about Medicare and Social Security. Was there Medicare then in the Mercury days? I guess there was. I don't even remember when it was. It must have been.

KELLY: Around the sixties is when it came about.

JOHNSON: Yes, it must have been. It must have been. But anyway, it wasn't a big thing like it is now. There were no HMOs or that kind of stuff.

KELLY: I would like to ask you one question, and that is, what do you feel has been your most significant contribution to the space program?

JOHNSON: There's a word in the dictionary that I only know because I ran across it by accident once. It's "consintnity." It's hard to pronounce. It means [a] kind of an artful assembly of things. That's probably what I did, was artfully assembly things that other people had done into a combination that was pleasing. I didn't invent any new aerodynamic principles, no new propulsion systems, none of these things, no new structures. It was just a matter of taking the ideas that other people had and putting them together in a way that everybody could look at and say, "Yes, that's what we want."

That's what this poor space station does not have. It has never had anyone to take all these things and put them into a pleasing arrangement. It looks like crap, you know. [Laughter] And it's all just for the wont of just somebody to do it. Now, it's possible that in this day of computer graphics—I'm not sure you can do it with computer graphics. You can make awful pretty pictures and you can show the thing in every different direction that you want to, and you can shade it and roll it over and look at it backwards and forward, but it's always coming out not looking very good. Anyway, that's what I did, and I could not have thought of doing that without people that had the ideas for all these separate pieces. But there's a place for everybody.

In fact, I'm just about to cave in about the computer, because if you look around, you see a little two-bit calculator on my desk, and in my office I never had any computer equipment. It

really wasn't needed because everybody else had stuff. But I didn't learn to think with a computer, but I'm about to cave in. I'm finding out now I can't keep my records straight. My handwriting is getting so poor, I can't write letters anymore, and so I may have to give up.

KELLY: It's a big thing to give into.

JOHNSON: Yes.

KELLY: You mentioned some of the people that you worked with, and can I ask you who, in your opinion, were your favorite people to work with, and who do you think contributed the most to the program?

JOHNSON: Faget. No question about it. I didn't particularly like to work with him. But don't get me wrong. He's very opinionated and so am I, and so naturally—you know, people have written many times how well we get along together, and we do, in fact, but neither of us like it. [Laughter] It's a marriage of convenience, you might say. I'm useful to him, and he's useful to me, and we know how to communicate. We don't have to write great messages and sit down and talk a lot. I can understand.

His reputation is such that some people may be somewhat fearful of criticizing him or getting into arguments with him, but I've long since gotten over that. [Laughter] I'm two years his senior, so I can always claim seniority. But I don't see much of him anymore. Maybe a year or so ago, there was a private outfit that was promoting a reusable launch vehicle, and they hired, as consultants, both Max and me to do some work on the thing. Well, almost

immediately, I was disenchanted with the whole idea. It didn't seem very good. I didn't put any time on it and didn't take any money for it. Max did, because I think he was hoping to correct the faults in the thing, but I'm not sure of the present status, but I think he finally kind of gave up on it. It just wasn't coming together right. I think now it may have been something that's happened since then, but everybody wants to make a reusable launch vehicle, too, and now that we've got a reusable spacecraft, but so far no one has managed to do it.

He and I had a little go at a thing called a fly-back booster, and we were going to salvage some whole existing Thor—there used to be a military rocket called a Thor, and we got pretty hot on that. It would do its thing and then turn around and glide on back to the launch site. But there were not many fours. There only about a dozen of them left, and nobody seemed to be terrible interested in putting up the money to do it. It kind of died on the vine.

Max was very interested in a balloon launch. You launch first and get yourself to high altitude with a hot-air balloon, a helium balloon, and then launch from that. It's a great benefit, getting to, say, 70,000 or 80,000 feet to start out, because you've gotten out of most of the air. You don't have to go charging through the air. That's a big benefit. But there's not much money nowadays. Probably twenty years ago it would have been a cinch to get several million dollars to do those things, but now money's kind of tight. Can't do it. But since space industries is now a thing of the past, I'll have to decide what we're going to do next.

KELLY: Can I ask you, looking into the future, what would you like to see happening with the human space flight program itself, whether it be with NASA or private industry?

JOHNSON: I don't know. I know damned good and well that we've got to do things in space, if for no other reason than like the man asked why he climbed Everest, first place because it's there. But mainly we're getting too big for this Earth. Sooner or later, sooner or later, unless human beings want to just give up and stop being, which I don't think people are going to do, the only place to go is to go down into the Earth, and that doesn't seem like too good an idea. The oceans might help for a while, but sooner or later we've just flat got to go somewhere else, and the only way I know how to do it is you plug along, you know, do one thing at a time.

I do wish the manned people and the unmanned people would quit bickering so much though, fighting each other when there's a—for instance, this last business with Mars. It would have been out of the question to put a man there right now, and yet there was no reason not to send an unmanned thing to Mars. Probes that are going out to Venus and the other planets, it's just a matter of time. It is regretful that you can't stay around long enough to see all these things happen, but even if you wait, if you could stick around until things got to the moon and to Venus or Saturn or wherever, then there's somewhere else to go. [Laughter]

KELLY: Exactly. Exactly.

JOHNSON: I hear kids all the time talking, saying, "There's nothing left to do. You know, Bill Gates has invented all the damned computer stuff, and the space station is going up, and what are we going to do?" Isn't that silly?

KELLY: It is.

JOHNSON: In the first place, Bill Gates wasn't even born when this space business started. He'd probably say that himself, you know, "What's there to do? Everything's been done. Bell's already invented the telephone."

KELLY: Is there anything else that you would like to talk about or like to add, any stories, whether it be from Mercury, Gemini, Apollo, Skylab?

JOHNSON: Oh, I'd probably think of a million some other time, but I can't right now.

KELLY: Okay. Well, maybe if we can pick up some other time.

JOHNSON: Most of them, they tend to get to be things that are dealing with personalities, and most stories that are funny, they're not funny to everybody.

KELLY: That's right.

JOHNSON: You and I may think they're funny, but the guy that we're talking about, it don't seem so damned funny to him.

KELLY: That's right. I understand that.

JOHNSON: So they're probably better not said, except when you're drunk. Then you'll say anything. [Laughter]

I've found one thing, though, that the friends that have been developed in the course of all this, sometimes I don't think they would have been friends if we had not had something in common. That is, their personalities are not necessarily so congenial, but the fact that you worked on a common goal for a long time and you recognized that the guys did their part and did a good, honest job at it, it becomes more important than whether some little personality thing. You know, you develop a kind of a—it's more than a professional respect. It's just a simple respect for the person being a solid kind of guy that's smart and works hard and is dependable, you know, that kind of thing. Now, there have been some guys that have been the other way around. They've turned out to be not worth a damn. They didn't do their job. They failed when they should have hung in there, and they let everybody else down.

The move here to Houston from Langley, see, most of us worked at Langley first, for the most part. It kind of, in a way, separated the men from the boys. We all settled in Newport News and Hampton, Virginia, all had homes, all our kids were going to school there, all settled down, good job, no sweat, and to pull up stakes and go flying off to Houston for some goddamned, god-forsaken, pie-in-the-sky sort of thing, all of a sudden there was a certain group of people who did that and there was a certain group of people that said, "No, I'd better not do that." And that separated the men from the boys. Now, I'm not saying which were the men and which were the boys, but it separated the people that were exploring, you might say, from the people that were more content to stay where they were. Now that it's all over with, I say, "Well, maybe I should have stayed." And I dare say a lot of-- [Tape interruption]

... everything was just in a great place. My wife didn't like it, though, but her family's all on the East Coast.

KELLY: That's right. I'm sure it's very different.

JOHNSON: I think I told you about the \$5,000 cure that the English people had. Did I tell you about that?

KELLY: I don't know. Why don't you tell me again.

JOHNSON: The people that came from Canada were just great people, and a lot of them were English, and they were homesick, especially when they came here. It was bad enough being in Canada, but you come to Texas-- [Laughter]

KELLY: I know. [Laughter]

JOHNSON: And they were homesick, and their wives were all upset, you know, and the husbands weren't bothered because they were working, they had something to do. But we called it the \$5,000 cure. They all had to take \$5,000 and visit England, go back home for a month or so on vacation, and then when they came back, their wives were cured. They found out that the plumbing here was so much better and the supermarkets were so much nicer and the automobiles were better. They decided that Texas wasn't all that bad. [Laughter] But it cost \$5,000 to fly them home.

KELLY: Was there a large Canadian contingent that moved from [unclear] here?

JOHNSON: Yes. There were thirty-some of them, I think. They were hand-picked when the aviation company AVRO went bankrupt. The chief aerodynamicist, I think, was Jim Chamberlin, James Chamberlin, and he hand picked these fellows. NASA had made it clear that they would hire these guys if they chose to come here. And they were topnotch people. A couple of them turned out to be no good at all, but most of them were really topnotch, and there was no way that the program would have made it without them, I don't believe. Certainly Mercury would have had a hard time. They all went on to do good things, have responsible jobs. They turned out to be good people. And so the same thing probably happened at Marshall, but in that case it was the German people that came over. Takes a lot of people.

KELLY: That's right. I know you didn't work at Marshall per se, but did you spend a lot of time there?

JOHNSON: Not a lot, but a fair amount of time. They're nice guys, too. We used to get crossways with them a lot. They were more disciplined than we were. We were inclined to be more flitting around and do thing at the spur of the moment. They were more solid. It's almost as though they were German, you might say. It may be a good thing to have those sort of rivalries. Some people say, well, that's bad, but maybe it spurs you on, and you try to do better than the other guy.

Well, I've talked too much.

KELLY: No, you haven't. No, no, no. I was wondering if you wouldn't mind showing us some of your pictures here as well. Maybe if you want to start with this one right up above you, I'd like to take a look at that.

JOHNSON: That was a pencil drawing that I made in 1958, and we were putting together a report on the proposal for the Mercury spacecraft. I'm not even sure it was called Mercury then. That was one of the figures that was in the report. There were five figures, and I'm not certain what happened to one, two, three, and four. That's figure five. But they not have ever turned into the report. And I'm kind of happy I kept it. I don't even know why I kept it, to tell you the truth. I thought I might have—usually I throw things away.

KELLY: It's a beautiful drawing, though. Does that show the astronaut actually trying to [unclear], or--

JOHNSON: Well, that gives some idea of the reach, what the reach would be to the [unclear]. That gives you the impression it was quite spacious in there, but by the time that thing got all the junk in there, there was no place to reach that far. It's very naive in many respects, but it was 1958.

KELLY: You can only say that in retrospect, too. Once it's done, you can say that.

JOHNSON: That's right. That's the flag that went to the moon that, when I retired, I was given that plaque, with the [unclear].

This one right here, I was fortunate enough I was awarded [a] spacecraft design [award] in 1976 by the American Institute of Aeronautics and Astronautics.

KELLY: For that specifically?

JOHNSON: Well, just for the general—I had retired then, just for the general contribution.

KELLY: Well, I wouldn't call it general.

JOHNSON: They couldn't think of just one thing, so they called it spacecraft design.

KELLY: I wouldn't call it a general contribution, though.

JOHNSON: This is mostly Apollo-Soyuz things. Now, that was the flag that was on Apollo-Soyuz. And these are some of my Russian colleagues.

This very grim-looking picture here was the day after we first arrived in Moscow in 1970 for the initial discussion, and that was at Star City. It looks rather grim, these guys in these great coats, [unclear]. It was kind of cold and dreary in the middle of Russia.

In 1970, you know, things were not too red hot then. I remember coming into the city from the airport. There were great billboards, and they showed this picture of Uncle Sam, and Uncle Sam had big canine teeth sticking out, and blood was running out of his mouth, and he's got a Vietnamese baby in one hand, killing the baby, and he's stomping on the baby's mother. This was when the Vietnam War was going on, and the Russians were pretty opposed to that.

And to be driving into Moscow with billboards like that, being an American, that was not very comforting. But we were treated just fine.

KELLY: That's great. That was your first trip to Moscow?

JOHNSON: Yes, and just nobody had been there before. This picture, we signed. This was the group of us. There's myself, George [B.] Hardy from Marshall. That black-haired man with black glasses was named Crimer. He was an official interpreter. And a man from Washington headquarters, Arnold Frutken, and Dr. Gilruth. You can barely see him on the side. We were signing a Memorandum of Understanding to begin discussions of no particular activity, but just general discussions for space activities, and that led to Apollo-Soyuz. It turns out that they had that in mind all the time, but we did not know [unclear].

This is my good friend Vladimir Smermetnikov [phonetic]. He's a chief mechanical designer on the thing, and he and I were kind of counterparts.

KELLY: How interesting. Does he make it back to Houston every once in a while?

JOHNSON: Yes. Yes. He's still active on the Mir docking situation, so every time there's a joint mission, he's here as their representative for the docking in case something kind of goes wrong. He's at Mission Control here, so he's still quite active.

KELLY: I'm wondering if he might even be willing to talk to us about his work as well, or maybe the two of you together.

JOHNSON: I wouldn't be surprised. Right at the moment he's in Washington, because he just called me a couple of days ago. When is the next--

KELLY: The next mission, I believe, is the beginning of June or the very end of May. I think it's tentatively scheduled for the 28th of May.

JOHNSON: Does that visit Mir?

KELLY: It does.

JOHNSON: Okay. Well, he will almost certainly be here.

KELLY: Okay. Great.

JOHNSON: He would probably be delighted, and he speaks English well enough that--

KELLY: Terrific. We're also working with the Shuttle-Mir Program, and they have lent us some of their interpreters, so perhaps they might be willing to lend us one of their interpreters to help us, and I'm sure, even with his terrific English--

JOHNSON: He will disdain--

KELLY: [Laughter] Okay. Well, just to give him the opportunity to say whatever he likes without having any sort of imposition or--

JOHNSON: I'll tell you a story about Vladimir. During the ASTP, we would get together maybe once a month to discuss things and agree on certain features [unclear], and then we would write the minutes of the thing and get the minutes signed, and then we would either come home or, if they were here, they would go home. One time they were here, and he would insist on rewriting things that the translator had written. He didn't like the way—as a matter of fact, he would do a better job because he really understood what he was writing, but he would insist on doing it himself. It would make us a little bit nervous, because we were not quite sure what the hell he was writing. [Laughter]

But I remember once it was a Friday and it was getting down to a deadline. They had to leave on the airplane that afternoon, and when lunchtime came, we were still scribbling away at the minutes, but we went to lunch, and I could see that we were not going to finish in time. So I went to our head of ASTP, a man named Glynn [S.] Lunney, who is—he should be in this picture, but I don't see him. Here he is, right there. I said, "We're not going to make it. Vladimir is holding up the works, and you'd better say something to Professor Bushuyev [phonetic]," who was Vladimir's boss.

So we went to lunch. I happened to walk over to lunch with one of our interpreters, and on the way back from the lunchroom, it turned out that just by chance, Vladimir and his boss were walking together ahead of us just as far as from here to the wall, and they were in deep conversation, and the boss was kind of doing like this [shaking his finger at Vladimir] to

Vladimir, you know, and Vladimir was [unclear] walking along. My Russian wasn't good enough to follow things like that, so I asked the interpreter, "What are they saying?"

He said, "He's telling Vladimir that if he didn't just sign those minutes the way they were, that he would find somebody else in the delegation to sign them." [Laughter]

KELLY: Oh, no. That's so funny. [Laughter]

JOHNSON: Now, I didn't let on that I knew what was going on, and when we got back in the meeting room, I said, "Vladimir," I said, "are you ready to sign those minutes yet?"

He said, "Yes." He said, "I've been thinking about it over lunch, and I believe I'm ready to sign them." [Laughter]

KELLY: How funny. [Laughter]

JOHNSON: I never did tell him that I had heard what had gone on.

KELLY: What are these medals up here?

JOHNSON: That was signed by the crews of Apollo and Soyuz, and these are the little medallions, and that's Apollo-Soyuz.

KELLY: That's really neat. And they call it, of course, Soyuz-Apollo.

JOHNSON: Soyuz-Apollo, that's right. Or Apollone. Apollo is Apollone.

Now, these things have nothing to do with NASA. When I was a younger fellow, I used to fly my airplane. That was a couple of records that I held since the fifties [unclear].

KELLY: Wow. Look at that.

JOHNSON: When I was a young fellow. You can tell how old they are. The paper's getting old.

KELLY: That's so terrific. And I see here you have an NACA [National Advisory Committee for Aeronautics] Award, too, a plaque.

JOHNSON: Yes. They gave me that when I retired. I've got a lot of little trifle things around, but I just chose to put these up.

KELLY: And how about, perhaps, over here. You might want to show that.

JOHNSON: Oh, yes. That's a cobblestone from Red Square. Bill Creasy [phonetic] and some other guys, there was some construction work going on while they were there, and they slipped over there one night and stole a couple of cobblestones, and they had this one mounted and gave it to me when I retired, and they've got a little spot marked there on Red Square where it came from. Now, those guys were stupid to do that. They could have put those guys under the jail and we'd never hear of them again. [Laughter]

KELLY: They're right near to the Kremlin, too. [Laughter]

JOHNSON: That's right. That's St. Basil's Cathedral. And this is what we call the "Goon Department Store." And this was some sort of big old apartment building. I forget what it was. But I came back one night, it was snowing. I'd been to the Bolshoi Theater, and I was walking back, had come back up this way here. The snow was coming down, and it was cold, and that great red flag over the Kremlin was flying in the breeze, the spotlight on it, and the soldier guard was standing there, and I thought, "What in the world am I doing here in Red Square, in the middle of the night, in the snow, and that flag sitting up there and the Kremlin over there?" And I sure felt a lot better when I got to the hotel and [unclear].

KELLY: Were there any accounts of anyone listening to you while you were in your room?

JOHNSON: Oh, yes. It was mostly a matter that they were looking out for us. They just flat didn't want [unclear]. I remember the first time I went over there, Dr. Gilruth had a bag that the lock was faulty on it, and so he didn't lock it because he couldn't get it unlocked when he locked it because it wouldn't unlock. So he kept it unlocked. Well, while we were out once, when we came back, his bag was locked. [Laughter]

KELLY: Ah-oh. [Laughter]

JOHNSON: Somebody had been through it, you know, and then they just automatically locked it. They didn't know it.

KELLY: Wow. How funny.

JOHNSON: But there were no incidents that I know of. One fellow, though, insisted on trying to sneak some photographs of things with his camera someplace. We'd been to Star City. They'd asked us not to do it, so most everybody respected that. No use causing trouble over a damned photograph.

KELLY: Sure.

JOHNSON: But he tried to do it anyway. And when he got back home, he found out that all his film was completely fogged. He didn't know when and where, but it was all fogged. And it wasn't going through the airport thing, because they don't have enough power on those things to [unclear]. But that roll of film was completely fogged. [Laughter]

KELLY: Wow. Very interesting.

JOHNSON: He was foolish to have done that. It was kind of silly.

KELLY: Well, he took his chances.

JOHNSON: Yes.

Well, I don't know as there's anything more I have to say.

[End of Interview]