

**NASA MSFC Oral History Interview
Steve Johnson Interviews – Apollo/Saturn Program**

Jack Lee

Interviewed by Steve Johnson

Huntsville, Alabama – Unknown, Circa 2012

Steve Johnson: I am talking to Jack Lee, who worked at Marshall Space Flight Center from 1960 to 1995. Prior to that, he worked with the ABMA, the Army Ballistic Missile Agency, from 1958 until Marshall was formed in 1960. Jack, talk about your education and what prepared you to be in the space program.

Jack Lee: How far back do you want to go?

Johnson: We are assuming you graduated from high school. Was there any education in the high school years that prepared you?

Lee: I would say one of the problems I had in my career was the fact that I did not properly prepare myself in high school for college. For some reason, I guess I did not recognize that was necessary. I got through high school okay, was a good student. I really did not think about college until very late in my high school career. I always thought I wanted to be an engineer. I have to admit I was not really sure what an

engineer did. That is how far off I was. I knew a little about civil engineering, but I knew there was mechanical engineering, aeronautical engineering, electrical engineering. I was not sure exactly what an engineer did. I interviewed at the University of Alabama after I graduated from high school, it was in 1953, and got into civil engineering because I understood that a little better.

My roommate, who was also from Birmingham [Alabama], went into aeronautical engineering. He did not know anything more about engineering than I did. To follow along with this, I switched the first year from civil to aeronautical engineering. My interest there was more because of airplanes, not necessarily because of thinking about space or designing airplanes. I always wanted to be a pilot, so I switched to aeronautical engineering. It was not until 1957 when Sputnik was launched that anything was entered into any of my courses that I could relate to space, with an exception of an astronomy course I had taken as an elective out of the physics department. It was my last semester, it was 1957, I graduated in January 1958, it was not until then that any of my engineering classes started talking about space at all. I had no idea about space. I still was thinking I would go to work for some airplane industry.

My roommate in college, who also had been a high school friend, worked at the Army Ballistic Missile Agency up here in the summer of 1957. He was going to graduate the same time as me.

Johnson: He was a co-op student?

Lee: No, he was actually just a student trainee. Back in those days, you could work in the summer as a student trainee. He had worked up here that summer. For that whole semester, all he talked about in our free time was what they were really doing up there, a lot of fun stuff. Again, I had never even heard of [Wernher] von Braun or his team or what they had been doing in the missile business. Actually, it was after I had done a few interviews close to the end of my last semester, my roommate, who actually ended up working for Marshall also, said, "I am going to go up and complete my application. Even though I have been in it for a while, for that one summer, I still have to go up and finalize it. Why not come up with me and talk to them?"

I did it, but I had no intention, no real interest in staying. Once I saw what was happening, and even after I had signed up to work for the government, I really did not plan to stay for long. I always had my idea of going to work for some industry. From that day on until now, every day that I ever worked, with the possible exception of

maybe two or three, I always enjoyed exactly what I was doing. It was always a fun job. My education really did not help me. My education came in the experience I came to recognize in working with some every intelligent, educated people over those thirty-eight years I was with NASA [National Aeronautics and Space Administration].

Johnson: Was all your education, as you put it, from working with people who thought big ideas or did you learn anything from technicians out on the test stands and places like that?

Lee: My first job was in working on modifying Jupiter ground support equipment. I worked more with technicians than I did with engineers. That modification required me to work with the actual technicians. One of the things I did not get a little education about was from an overall missile systems business was ground support equipment. I had to choose a career that would expose me to more and more experience. After a couple of years when Marshall became part of NASA, I went to work with what was then the Light and Medium Vehicles Office. I had been working for Launching and Handling.

Johnson: Before we go on with that, what caused you to change from the Army and move over to Marshall, to NASA?

Lee: I do not think I had a choice.

Johnson: Your lab moved? (Both Laugh)

Lee: One day I was an AROC [Army Requirements Oversight Council] research engineer, the next day I was something else. No, they made the transfer.

Johnson: You were not asked. You moved with the team. Of course, not everybody moved, some people stayed with the Army.

Lee: There were some key people, the Pershing Program was in development at that time. That was also under the von Braun purview. Those people who were directly working with the Pershing, I think they were either encouraged or told you need to stay with the Pershing. That is how that happened.

Johnson: But you were not in that group.

Lee: No, I was with Launching and Handling, which later was split up and part of it went to the Kennedy Space Center. We had a thing called the Missile Firing Lab, which is also one of the nine laboratories. That was under Kirk Debus. When we became part

of NASA, then Kennedy became a full-fledge center. Part of the Launching and Handling group went there. The other part became part of the Light and Medium Vehicles Program Office, which was to manage two programs, the Centaur Program and the Agena. I chose to go that way because I felt it would give me some management experience and also to get more involved in understanding the whole system business.

Johnson: You are at Marshall Space Flight Center, maybe not by choice, but it worked out well. (Laughs) What did you do when you first got there, when you first became part of NASA?

Lee: I do not know that I did anything the first day. I think shortly after I was given an opportunity to make a transition to the Light and Medium Vehicles Office.

Johnson: You were essentially supporting launches?

Lee: At that time, this new group was to manage those. The Air Force had been managing them in the past. The director of the laboratory, Hans Hueter, became the head of the Light and Medium Vehicles Office, and his deputy went to the Cape [Canaveral, Florida] with the other group. The next big event was I was given an opportunity to be in residence in San Diego [California]. This was in 1960. I do not

remember what happened a few days after I was transferred, but what I do remember is I agreed to be transferred to San Diego to the General Dynamics plant where they built the Centaur. I had responsibility for that.

Johnson: Define Centaur for me. What was the Centaur?

Lee: The Centaur was an upper stage liquid hydrogen, liquid oxygen vehicle. It was very advanced and sophisticated for its time. It was totally underfunded and did not have the attention from a design standpoint that most other vehicles had. It was the first four gimbal guidance system. It was the first LOX [Liquid Oxygen], hydrogen upper stage. It was the first thin walled pressure vessel, like the Atlas. It was the first restartable engine at altitude and it was the first stage and a half. We threw off some of the insulation on the way up to save weight. We lost the first one for a lot of reasons. It failed. I think Congress and the agency recognized the need for this upper stage, so money was put into it to bring it back up to speed. It turned out to be a very, very good vehicle that we have been flying for over fifty years now.

Johnson: How long did you work on that?

Lee: I was there for two years. During that time period, the Marshall Space Flight Center, or NASA, determined that Marshall should clearly focus on the manned program, and that was the Saturn. The Centaur did not fit into that, so we transferred the Centaur Program from Marshall to the Lewis Research Center. I was out in residence, so I really did not have to move any place. They recognized that. Even though I wanted to stay with Marshall, I got a notice that said, "I, Thomas J. Lee," and there were two blocks there, "I agree to transfer from Marshall to the Lewis Research Center on the Centaur Program" or "I agree to seek employment elsewhere." That is in my 201 file.

Johnson: What did you do?

Lee: I transferred. That was for about eight months and then they contacted me at Marshall and asked me if I would head up the resident office on this Pegasus Program up in Maryland.

Johnson: What was Pegasus?

Lee: It was a micrometeoroid satellite. At one time, they had the model of it in the [U.S.] Space and Rocket Center. It had a ninety-six foot wing span and was about eight feet

tall. It really made a big area. The purpose of that was to orbit Earth and detect micrometeoroids. It was done through what looked like a capacitor arrangement with big plates with different thicknesses. If a small meteoroid hit one of the smaller inner plates, it would get a hit for that. We used that to verify the micrometeoroid model that had been developed by a guy named [Fred Lawrence] Whipple over the years.

Johnson: This Pegasus was basically research we needed to do for once we got human beings into orbit and even went on to have our first space stations like Skylab?

Lee: That is the way we looked at it. Unfortunately, this was kind of a twist here, there were eight Saturn I launch vehicles. Pegasus was identified as a secondary payload, by the way. It was not even the primary mission for the last three. Once we got through six launches, we were already in the process of developing the Pegasus, in the process of qualification and design. We recognized all the objectives for the Saturn I launch vehicle design had been verified through the first six launches. The next day, after some criticism from outside NASA, we redefined the Pegasus as a primary mission. Then we went ahead and launched the last three, all successful.

Johnson: You said these were launched aboard the Saturn I?

Lee: Saturn I. After some twenty years or so, we turned them all off. They lasted much longer than we ever anticipated.

Johnson: The Pegasus satellites were giving us data for twenty years. Did we learn things that made it safer to be on orbit?

Lee: I cannot say that for sure. It did maybe give us some confidence because it did verify the models that had been used within the limits that had been identified. It did not cause us to change anything in design of any manned or human spacecraft.

Johnson: But it reaffirmed we were on the right track?

Lee: It was a confidence builder, yes.

Johnson: You ended up going to Kennedy after that, am I correct?

Lee: The way I got to Kennedy was I was the resident manager for the Pegasus. Because the Kennedy people were all tied up in trying to get the manned system going too, which was a change. They said, "Why not bring your team down and launch the thing too?" For those three launches, I was resident manager there, and then I went to the

Cape during the launch where I was a test conductor for the launches of the last three. I ran the countdown for the last ten minutes of those three launches. I was there and my then supervisor, Lee James, who was the project manager for the Saturn said, "I want you to be down there." I said, "I do not really know too much about launch operations." He said, "You will learn." It was a good move and I did learn a lot about launch operations. I stayed there until after we launched Apollo 11 and then I came back to Huntsville.

Johnson: A quick interjection here. You are doing pretty well for a guy who did not feel like high school prepared him to be an engineer. You had a lot of different jobs. After Apollo 11, you came back to Marshall and you became a technical assistant for the center director.

Lee: That happened to be the title. By the way, I became much more knowledgeable in the technical aspects of launch. Things like the tour out in San Diego, at the time, I had only been here for two years and I thought all the knowledge in the world about launch vehicles resided in the von Braun team. I was still young. When I got out to San Diego, I got to know one of the young managers and engineers with astronautics, and they recognized I was probably biased in my opinion about everything. They were patient with me and ended up teaching me things that were different about the Atlas vehicle,

where things were. You did not always have to design it this particular way. I learned a lot about the systems. I did not get any more intelligent on an analytical standpoint. I did not learn any new formulas or that sort of thing. It was more about the system education I got there.

Johnson: You come back as a technical assistant to the center director. This was Eberhard Rees. Tell me about what a technical assistant did post Apollo 11.

Lee: That position had been filled by at least three people before me. The way I looked at it, the way Lee James looked at it, and the way I think Eberhard Rees looked at it is you can do whatever I ask you to do. You are here to learn again. I was on the tenth floor. I had lunch with the von Braun group every day. I attended all the meetings. In the past, that position had been used to educate, to elevate you to a higher responsibility position. Jack Balch had had that job and he ended up to be the director down at Stennis [Space Center]. Lee James had had that position and he became the program manager. I forget who I followed. That was the plan. The job description did not detail you had to do specific tasks. The intent that was unwritten was that you were really there to learn. Let us see if you are good enough to elevate you to a more responsible position.

Johnson: Before we get away too far from Saturn, doing the different jobs you did and the different places you were located, did you have much occasion to interact with Dr. von Braun?

Lee: On the Centaur, I was too low a grade. He did visit once and gave us a little speech. When I came to the Pegasus, we had some controversy within the project office and the way we were designing and developing it. It was a much more conservative design than Marshall had been used to. We got a lot of criticism. They did not pay much attention when it was a secondary mission. When it became a primary mission, then the center labs got asked to look into it. They gave us a real black eye. The Marshall team said, "You guys are really off and it will never fly." In fact, one of the key guys, who is still around, made a prediction that the power system would fail after the first orbit. Like I said, we turned it off after twenty years.

That brought me in contact with von Braun because now we had to make a decision between the program office and his technical guys. In that case, we made presentations to him, exactly what we knew, what we were doing. As far as I know, he never flinched about it. He went with our approach and it turned out to be quite successful. I do not know whether this would have driven it or not, but we were looking at additional delays in schedule and a lot more money to do what the guys out here wanted to do.

That is another area of education I got about there being more than one way to do things.

Johnson: Von Braun, it seems in listening to many people talk that, for a guy with some distinctly personal ideas about how we should do things, he was very flexible.

Lee: Yes. Flexibility would be one way to put it for sure. He had a good understanding of what it took to accomplish an objective. I think he knew there was more than one way to do it, even though some of his team believed we had to do it a certain way. He was an objective individual.

Johnson: In the different tasks you worked on from 1960 to 1969, before you became technical assistant for the center director, did you run into the long work hours, extra shifts, six days a week work? In your various jobs, was it like that for you?

Lee: Yes, it started out that way. There are two things that happened, one when I went with ABMA. They had a standard fifty-eight hour work week. That was it. All of a sudden, you never had an opportunity to work only eight hours a day and be off on the weekends. The other thing that got drilled into me because I worked with these people for so many years, I think it was a German mentality, it was that the job is there and it

has to be done. In some cases, it is the most important thing you can be doing in your life. They never said that.

Johnson: Did you feel that it was?

Lee: I did not think of it that way. I just said this is the way that it is. There is a job to be done and you ought to stay with it until you get it done. Plus, most engineers probably would not admit this, but we inherently underestimate what it is going to take to do a job. When you do that, you are already setting yourself up to have to work. I do not remember ever spending just eight hours a day. I was not the sharpest guy in the class, so I had to spend more time doing my job than a lot of other people would have. That is just a truth. I already recognized it was going to take me more time to get my task or job done. I never thought there was any other way. What also gets you in a bad habit, and it stayed with me my whole career, even today, is you never leave the work. When you are not thinking of a specific task you are doing here, I am thinking about the work.

Johnson: You would go home and you would still be thinking about it?

Lee: If you really like your job, in your spare time, you are thinking about that. There is no time.

Johnson: With all these extra hours of thinking about work when you were at home, was the work environment good? Were the men and women excited to be there?

Lee: I never had that problem. I hear that morale may be low out at Marshall now, but then I talk to some of the younger people and they say we had it during the good times. The good times for them are right now, so I get different inputs on that.

Johnson: You were busy spending long hours developing spacecraft and all the support systems and everything that goes with putting men into space. It sounds like you were having fun doing it.

Lee: No question about it.

Johnson: When you were working all these various jobs, did money come up? Did controlling costs become part of the equation?

Lee: Up through Apollo, I do not remember that ever being a driver. We had three things to concern ourselves with, performance, schedule, and cost. Performance was the key thing. Performance over all else. Schedule was next, and then the cost. Through the Apollo Program in any of my jobs, I did not recognize we were not doing something

because of cost. In the case of the shuttle, it got a little more tight because we were back into a different mode for NASA after the cold War and after Apollo. Today, they have even gone to what we call full-cost accounting. During the early days, Apollo and Shuttle, the center's had some flexibility to handle their institutional capability, civil servants, their facilities, that sort of thing. Today, they tie all that to particular program costs. I think it is causing the agency and program managers to recognize it is very difficult to do that when you have to start trading off those, especially when you are looking at trying to control costs and save money.

Johnson: After 1969 when you were technical assistant, were you working on the shuttle at that point?

Lee: No, at that time while I was Rees' technical assistant, it was mostly Skylab at that time. I did not have a direct management role in that. I kind of followed Rees around and did things for him, made speeches, that sort of thing. From that, I became the program manager for the Spacelab. The Spacelab was a separate program from Shuttle.

Johnson: Those were scientific labs carried in the bay of the shuttle.

Lee: I recognized we had to fly in the shuttle, but the shuttle was developed over here and we were developing with a corporation of ten European countries, ESA [European Space Agency]. We were developing the Spacelab knowing it had to go in the shuttle. The closest I got to the shuttle at that time was interface between making sure we were going to be compatible with the shuttle, whether it was weight, CG [Center of Gravity], environmental control, avionics, or what have you.

Johnson: Was this something that required a lot of testing? Was it the kind of thing where testing had been done for Skylab that you followed on work that had already been done?

Lee: It was all new. The shuttle presented an interface that we had not seen before. I think it worked better than I anticipated when we first got into it. Like I said, you were developing the shuttle at the same time you were developing the Spacelab and you had changes on both sides which effected the other side. We got that well-defined, got good cooperation out of other Europeans and the shuttle people. I think we had a minimal amount of integration problems with the shuttle.

Johnson: While you were working on Spacelab, how many different shuttle missions was it a part of?

Lee: It was 1980 when I became deputy director. It was not until April of 1981 that we launched the first shuttle.

Johnson: Concurrently with shuttle development, you were working on Spacelab.

Lee: It was in full scale development. We built engineering models, but we were still away from launching at that point.

Johnson: When did the first Spacelab fly?

Lee: I think it was in 1982.

Johnson: After you flew the first one, did you have to adjust, change designs or any of that?

Lee: No, the Spacelab was very versatile. We had pallets for outside experiments and then inside experiments. We did not make any major changes to the Spacelab through the whole program. We made some adjustments in what we got from the orbiter and we made some adjustments in the experiment designs a little bit, but the basic Spacelab, I thought it would leak, if I were quite honest with you.

Johnson: Leak oxygen?

Lee: They had a particular designed seal that did not look like it would hold pressure to me. It passed all the tests.

Johnson: You still did not believe it would work?

Lee: I thought surely we might have a problem after we go through the launch environment of the thing, but we never had any problems.

Johnson: I think what you are saying is that Spacelab, once it was designed and ready to go, it did what it was supposed to do. Let us jump ahead to 1986. We have the *Challenger* disaster. What happened to you after the *Challenger* disaster?

Lee: First off, prior to the *Challenger* accident, I was at Harvard [University] in my last semester in 1985.

Johnson: You were at Harvard. Were you getting an advanced degree?

Lee: It was advanced management. As a result of that, ordinarily I would have been involved in the flight readiness reviews and all the details, but I did not finish that until January. As [William] Lucas' deputy, I was not involved in any of the decisions, flight readiness reviews. Ordinarily I would have been at the Cape for the launch. Because of this, I stayed in the HOSC [Huntsville Operations Support Center] during that launch.

Johnson: The operating center.

Lee: Yes, because I had not been involved in any of it. After the accident directly, as I mentioned earlier, we had these contingency plans. I had been in the blockhouse during the Apollo fire. That was not near as well organized from a contingency standpoint. I recognized what you needed to do.

Johnson: Immediately in the Huntsville Operations Center, you started work.

Lee: First thing I did was stop all the phones going in and out. We did not need any of them. Then we impounded all the data right now and I called all the leaders of these contingency plans together. They knew what to do, I did not have to tell them to get started. They started this process.

Johnson: Let us stop a second to say the Operations Center is getting all the propulsion data and External Tank data from the launch at Cape Canaveral. That is the data you impounded, all the data up until the disaster.

Lee: That is right, as far as from a launch processing standpoint.

Johnson: You started the contingency groups. What happens next?

Lee: Those guys go off and start doing their thing. They bring their groups together, they start looking at the data available. From that time, I started to bring in contractors to give me inputs on what they saw, what they were finding. I think we probably worked close to twelve, fifteen hours a day from that time, nobody took off any time in that group that was reviewing this until April.

Johnson: That was from January to?

Lee: January to April. No weekends were taken off. Everybody was focused on evaluating the data.

Johnson: Before we talk about the process of evaluating the data, everybody is directed to find out what happened, I know, but it makes sense that there would be a little depression, that everybody would not be real happy. Was it tough to work through that?

Lee: The tough part came from outside criticism later. One of the tough things that I found myself in was these people who were doing the work, they were not sharing it with their families. We had about 3,500 people then, this was a small group of people. The rest of Marshall Space Flight Center employees, they were not getting any information at all other than what they got through the press. What they were getting through the press was something I objected to then and would object to today. The team that was put together on the Rogers Commission that evaluate this, they seemed to have freedom to go talk to the press, give their opinions, and most of it made Marshall look really bad.

In our case, we had been taught that you do not deal with the press. I always felt I was exempt from it. You do not talk to the press about this. That is the convening authority's job. [William] himself did not control that, his team. What was coming out of the press really made Marshall look bad. That really exacerbated the problem of the people in the Center not knowing what was going on. Somebody finally got the nerve to tell me that.

At that point, I started regular meetings, at least internally, to be able to tell people where we were going and try to mitigate some of the accusations that made Marshall look so bad.

Johnson: You started right after the disaster and you went up until April. Were you still figuring out what happened at that point?

Lee: I think we had pretty well isolated it. I testified before the Rogers Commission two or three times. The actions that were given to us were to come up with what you think happened. Wayne Little was my deputy at that time, and we collectively put down what we call a red light chart saying this is a possibility, yellow is a possibility, but green is clean, red is bad. We had come to the conclusion for probably where the accident really happened.

Johnson: You had figured out there was a problem with the seal?

Lee: Yes. We found also that there was potentially more than just a cold seal. That might have been part of it, but there were other areas that could have caused that seal to fail other than the fact that it was frozen. We did not know which those were because the evidence was not there. There were at least four or five different areas that could

have caused the thing, everything from water in there that frozen and lifted the seal to other things, not being properly captured or not understanding how the joint actually expanded.

What we did was we established a design team at Marshall, this was after the Rogers Commission. We took a group of design people, knowing what you know, and design me a seal that will satisfy any of those requirements. They went through everything from a heater to a capture feature. At the same time, Thiokol was doing the same thing. We kept these two groups completely independent. Let us see what these guys are doing, see what these guys did. They converged to a pretty much new design. That is kind of the way we went with it.

Johnson: You mentioned the media reports and the things that were being said by the Rogers Commission that made Marshall look bad. Looking back on the investigation and knowing what caused the disaster, had Marshall made mistakes?

Lee: Let me give you a fact from my impression and then you can draw your conclusion. One of the things that Marshall was primarily expert in is liquid rocket propulsion. If you look at our organization back in those days, the whole organization was set up in making darn sure that we understood everything we needed to know

about design and problems with liquid propulsion systems. On the other hand, when we decided to go with the solid rocket motors, we said to our self the Air Force has been launching these things, the DoD [Department of Defense] has been launching this pretty much this same design. We will depend on that expertise and that capability to give us assurance. We set up a capability at Marshall to be able to assist these things and review designs and so forth. We did not set up an organization to understand enough about solid rocket motors even near what we knew about the liquid propulsion systems. That today would be a mistake.

Johnson: But you did not know it was a mistake.

Lee: We did not know it was a mistake at the time. That, I would say, was a shortcoming of our system. We did not pay the same attention because we did not think we had to to the solid side as we did to the liquid side. Just after the *Challenger* accident, Marshall had the best capability in the world in solid rocket motors. I assume they still have some of that. We changed that. That was one of the organizational changes we made to compensate. We inherently did not have the detailed knowledge, the breadth and depth of penetration into the design of solid rocket motors that we inherently had in all our other programs.

Johnson: You are saying the investigation, the figuring out what happened, the redesign, that helped bring Marshall up to speed, so to speak?

Lee: Absolutely. That was too late then, but it helped us in deciding whether to go with the Advanced Solid Rocket Motor or what we are doing in solid rocket motors today.

Johnson: Being part of the group that worked to figure this out, did it give you a different appreciation of just how hard human spaceflight is? You had been around the Saturn V, so you knew it was complex. Did this change the way you looked at it all?

Lee: No, not really. We had had a lot of failures in propulsion systems. We spread engines all over Hancock County down in Mississippi, but we always came back and got a team together, recognized where the problem was, worked with the contractor, and solved the problem. It was a joint thing. I do not know if this is going to answer your question directly or not, but what I did find was after *Challenger*, in the way the Rogers Commission conducted that and the way the country looked at it, somebody had to be responsible. In fact, I remember President [Ronald] Reagan's Chief of Staff, I remember him being interviewed when I was in Utah. His comment, "We are going to find out the problem and find out who is responsible." We never worked that way in the past. It was we are going to find out what the problem is and we are going to fix it.

What happened was contractors would bring lawyers, if you are going to start blaming someone. We never indicated or said if there is some individual responsible that we will deal with that, but the intent was not to start out looking for that. It was to start looking for the solution. That changed my mind about the whole process of manned systems.

Johnson: You were not even at NASA when the *Columbia* disaster happened, but you were there for *Challenger*. With *Columbia*, it was the same sort of thing. Somebody made a mistake. From what you know, is it the wrong thing to think about individuals and maybe the right thing is to think about systems that we maybe did not understand, that we needed to know more?

Lee: I do not have a problem with the process. If you find the individual or group who were responsible, I do not have a problem identifying that. In *Columbia*, you cannot find one of the details, but during the *Challenger*, there were management decisions and individuals.

Johnson: Flight rules were violated, am I correct?

Lee: I do not know.

Johnson: They launched colder than.

Lee: I do not think we had flight rules. There were individuals who made decisions that got that tied to “we have to find someone responsible,” not someone individual, but a group. In *Columbia*, there was no way to find that. This could have happened anytime, anywhere. It was not that some guy did not inspect that piece of foam that came off. We knew foam would come off. We did not know that much and that it would do that kind of damage. All the previous information had been it would not do any damage. They were a little bit different in that respect.

Johnson: In both instances, whether direct link was assigned or not, people lost their jobs. Do you think, as a man who had a broad experience in the space program, in manned spaceflight, that was right? Should people have been blamed for those two accidents?

Lee: Not in my opinion. I know the process they went through. I know the individuals who made the decisions. We had gone through a similar kind of rationale, a process, for other decisions, not necessarily leading to launch or to tests. There was nothing malicious about this. It goes all the way back to our real lack of knowledge on Solid Rocket Motors, knowledge that if we had known better, had more detail or knowledge,

the decision probably would have been made differently. You cannot blame that on what you do not know, too many things. We addressed problems of unknowns, but then there is a thing called unknown unknowns.

Johnson: You do not know it, but you do not know you do not know it.

Lee: That is right. That was one of those unknown unknowns.

Johnson: In the not too distant future, you would become center director at Marshall Space Flight Center, a whole new way of being a part of the space program, I would imagine.

Lee: Yes.

Johnson: Talk about that. What was it like after being a part of programs and working on programs and suddenly you are in charge of a big chunk of the program?

Lee: One thing you learn, I first started my experience with Rees and working on the ninth floor, is you are going to have a lot of decisions to make and it is going to be a

technical decision. Like I said, I was not the smartest guy in the technical area, but Wayne Little was my deputy, and I picked him in particular.

Johnson: You had a good technical assistant.

Lee: I had a good technical deputy, so I did not have to worry about that. In addition to that, a technical problem comes up, and you are going to find a lot of different inputs. The one thing you are going to find is you have 3,500 scientists and engineers out there and you have a pretty good probability of at least having one of the best proposals given to you and you have to select that. In the personnel area, I never had any problem in the personnel area as center director. I found there were some people who liked to change certain things. I am probably famous for the first thing I did. We used to have a staff luncheon on the ninth floor that was the center director and all the lab directors and program managers. I had heard enough coming up through the system that people looked at that as we were having gourmet meals and it was this exceptional situation to be in, which it really was not. The food came out of the cafeteria like it did for everyone else. Probably my most famous decision was I cut out the staff luncheon and caused all the managers and lab directors to go eat with the people. Some people liked that.

Johnson: You basically sent the managers back down to a little bit lower level. You came up under the von Braun team where even the directors were engineers at heart and they spent a lot of time talking to the people below them. Was that kind of going back to that a little bit?

Lee: A little bit. This staff luncheon thing was misunderstood. If it bothered people, it was easy to change.

Johnson: Was that part of your method, to get the higherups going back and talking to their people?

Lee: In any organization, you have your formal organization, you have your informal organization, and you do not ever have to reveal where the informal organization comes up. There are people below you, first line is maybe one or two levels down, who you have a lot of confidence in. You get a lot of input on what needs to be done organizationally from that. I never considered myself a leader, a manager. I think managers can learn how to be managers, but I think leaders have to be leaders and managers. Von Braun was clearly a leader. I would say one of the things I contribute my own success to in the programs I was responsible in starting was Spacelab. I surrounded myself with the very best people that I could get. That was not always the

philosophy in a lot of the organizations at Marshall. If you had a good person, you wanted to keep him forever. My philosophy was that you first surround yourself with the very best people you can get. The second thing you do is you encourage and support their advancement. That does two things for you. First off, you lose that good guy, but I never had a problem replacing one of those good people with another good person. People would be happy to work for you if they knew you were going to help them. That was one of my best attributes, that I surround myself with very good people.

Johnson: It was shuttle from basically the beginning of your center directorship until you quit doing it. The Shuttle Program, did it proceed, and we had to come back from the *Challenger* disaster, would you describe it as problem-free during your directorship?

Lee: There were always problems and concerns that you had. That is the reason we continued detailed flight readiness reviews. One of the things that happened that I think was chastised at NASA was the flight readiness reviews, which were not supposed to be getting all your people together and making sure you are satisfied that you are ready to launch. Those got to be video telecons and they would set them up for an hour, a lot of people would not show up. As a result, you were not sure you got the best inputs. That happened because we had launched so many times and people decided they did not need to go to this. We reintroduced that you had to be involved,

you had to sign off on the thing. That caused people to identify concerns early that got fixed.

One of the biggest concerns I had was on the Shuttle Main Engine. We went to a silicon nitrite bearing in the turbomachinery. That is a piece of glass.

Johnson: That replaced a piece of what, steel?

Lee: Yes. I carried one of those in my pocket as long as I was center director. Pratt & Whitney proved that is was good. It was a very good thing, but that bothered me for a long time. We never had any problems with the Shuttle Main Engines in flight.

Johnson: I do not know if you call yourself lowest of the low, but you were not high up when you started at Marshall and you ascended to center directorship, so you had a broad career doing a lot of things. When you look back on your career, what jumps out at you that you think, wow, I am glad I was a part of that?

Lee: The most fun I had all around was on the Pegasus.

Johnson: The satellite some people thought was a waste of time.

Lee: I was in residence and we reviewed and approved the sign changes, we approved them from a contract standpoint, we did the building of the avionics in the same building. I could see the work order go and get the PC [Printed Circuit] board fixed. Then that went to another area for superstructure. I was able to follow that. I took it up to GE [General Electric] and put it in the vacuum chamber and then I followed it to the Cape. I was the launch test conductor. I got the full gamut of what it was like.

Johnson: It was your baby.

Lee: That was the most fun, the most rewarding. I would say probably the Spacelab was the most rewarding, mainly because it was new and different. We started from scratch. We had a little task team at Marshall called the Sordid Task Team. I headed that up. We looked at the preliminary design and then worked with the Europeans on the agreement and made sure we had an understanding. I had a good working relationship with the project people in Europe. We brought that thing to the point where I think we pretty well solved all the development problems when I became deputy director.

Johnson: In your career, I am sure you worked with contractors on a regular basis. Was the contractor experience good? Did contractors do what you wanted them to do? Was it a good exchange of ideas?

Lee: On which program?

Johnson: Just in general.

Lee: Not all of them were as good as others. Probably the best contractor I ever worked with, and I really did not have any direct control or responsibility, was on the Jupiter Program. That was Chrysler Corporation. They were very good to work with, some of the locals.

Johnson: Some of the locals were not so good?

Lee: No, some of the local guys were all really good that I worked with. We always came to an agreement, but we had to give one major contractor almost a zero for an incentive award in one period because they were not doing the job. What they did was they chose not to accept any fee in the period, so it did not go into record. I would say in general, I cannot complain. I do not know how other programs are, how the DoD sees things, but I would say I always had a good working relationship with the contractors.

Johnson: Did you notice rivalry among NASA's various centers? Certainly you probably did when you were director.

Lee: I have been asked that before and I think it probably was not as bad as it worked out. There were some individuals who worked with individuals at other centers that were almost combative. They were rivals. You could see that in every center. That is individuals. From a center standpoint, the organization that did the Apollo, you had at least three of the strongest center directors that you have ever had, von Braun here, [Robert] Gilruth at JSC [Johnson Space Center], and [Dr. Kurt] Debus at the Cape. All of them were really big thinkers, looked after their system, their design, and their approaches. You had George Miller and Sam Phillips at Headquarters who were able to bring those guys together. It was not exactly rivalry as much as you had different opinions. I think the reason they got the reputation of being rivals is because some individuals were. I can give you some names of people who were just hard to get along with. You just did not like them.

Johnson: From time to time, people would butt heads at various centers.

Lee: Yes, they just disagreed in concept, they disagreed in position. Clearly, there was that rivalry. It worked itself out in Skylab, but that created part of these different opinions.

Johnson: Skylab, of course that was between the Apollo folks here and down and Houston where they probably had different visions.

Lee: That had been a role that JSC had had before, a laboratory like that with all the human aspects of it. Because we had completed all the launch vehicles for Apollo here, JSC tied up most of their center with operation for the future. Ordinarily, that role would have gone to JSC if everything else had been equal, I think, but it came to Marshall because we were running out of business. That created a lot of this dissention between some individuals.

The other rivalry that was with JSC would become a little obvious. After Apollo, we had to diversify at Marshall. We got into the optics business, which was not our role at all. We were new in this. We did the HEAO [High Energy Astrophysics Observatory] Program and then we were assigned the Hubble [Space Telescope] and then Chandra. That really got some people at Goddard's nose out of joint.

Johnson: Marshall is now working on telescopes, moving from propulsion to telescopes.

Lee: That is like you guys took over part of our role in missions. And we did. From an agency standpoint, it was a good move to retain Marshall Space Flight Center's capability.

Johnson: Did Headquarters help or hinder? When you look back over your career, did Headquarters do what it was supposed to do?

Lee: I was really impressed with the management at Headquarters during the Apollo Program. Again, we had a national objective to get a man on the Moon. You had some really good people. I mentioned George Miller and Sharpe [First Name/Spelling?], good manager, and then Sam Phillips was on loan from the Air Force. [He was] an exceptional manager and had the right attitude. I would say those two guys had a lot to do with bringing the whole thing together. The centers probably did not give Headquarters the respect that they deserved in a lot of areas. We were down here, we were doing the hardware, we were managers with a lot of technical capabilities. Then you have these guys sitting up in Washington [District of Columbia] that do not do anything but go to parties.

Johnson: That was the sort of feeling, yes.

Lee: I spent my last year at Headquarters. I got a real respect for the people in Headquarters. They were sharp people. They did not have the hardware, hands-on experience we did, but very intelligent people, very ambitious, had the agency's interest at heart. I think a little bit of that not having the respect for their role may have created a little bit of a problem between us and Headquarters at times too.

Johnson: When you look back on your career from the time you worked on the Saturn Program to Spacelab, the shuttle, did you have a sense during all those years you were part of making history?

Lee: No, and I am a little bit sorry I did not. I remember when we launched Apollo 11. There were a number of reporters in the blockhouse, in the launch facility, that were clearly looking for some profound, great statements. Some of our guys apparently thought ahead.

Johnson: They were ready. [Laughs]

Lee: They were ready. Heck, I was standing there, the Moon, this is great. No I did not. I thought about that a few times, why did you not think ahead a little bit and prepare yourself to enter into history with some of these other guys?