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EDITED ORAL HISTORY 3 TRANSCRIPT

JOHN B. LEE
INTERVIEWED BY JENNIFER ROSS-NAZZAL
HOUSTON, TEXAS – 17 JANUARY 2008

ROSS-NAZZAL: Today is January 17th, 2008. This oral history with John Lee is being conducted for the Johnson Space Center Oral History Project in Houston, Texas. The interviewer is Jennifer Ross-Nazzal, assisted by Sandra Johnson. Thanks again for joining us for another session this afternoon.

LEE: Glad to have you.

ROSS-NAZZAL: We sure appreciate it. We wanted to go back today and review some of the areas we talked about yesterday and fill out some detail.

LEE: Well, thank you Jennifer for sending the questions to me last night of some of the things that you wanted to review today because we did get off on some tangents yesterday. Today, I think, with your questions and with my presentation material we can keep on point better.

One of the first questions you asked is, "What do you believe to be the most significant contribution while you were working with NACA [National Advisory Committee for Aeronautics]?" I went to my records, and you may have a copy of this.

ROSS-NAZZAL: Oh, I don't.

LEE: This really covers a great bit about what I did with the NACA. It was the promotion for me to get my GS-13 by Carl [A.] Sandahl at the NACA. So I'll just read what this says, because I can't tell it any better. In fact, I think they gilded the lily a little bit:

> Mr. Lee was employed by the NACA as a mechanical engineer, grade P-1 in August 1948, and was assigned to Propulsion and Aerodynamics Branch at Pilotless Aircraft Research Division. …
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> During his employment at PARD, Mr. Lee has gained experience in a wide variety of research programs including both ground and flight test investigations. The major portion of his experience, however, has been with investigations conducted in the Wallops Island Preflight Jet Facility which includes the design and calibration of supersonic nozzles, ram jet engine performance tests, pilot ejection capsule tests, internal store release tests and schemes for surface cooling of blunt noses.
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> During the past two years, [and I think that this is my most significant contribution at the NACA] Mr. Lee had been in charge of all the drop model work in the Preflight Jet. This work has involved original NACA drop studies as well as a close cooperation with outside agencies including the AEC [Atomic Energy Commission], several aircraft companies, the Air Force bombing group at Kirtland Air Force Base [New Mexico], and the Sandia Corporation. Mr. Lee accomplished this work expeditiously despite the fact that the number of principals involved frequently made conditions less than ideal. Because of this work, Mr. Lee has a wide reputation as an authority on store and bomb dropping problems as evidenced by the frequent requests for assistance he received from the Air Force and industry.
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> In the course of the foregoing work, Mr. Lee, has during the past two years, (a) brought to a high state of development the drop model techniques as employed in the Wallops Preflight Jet. This includes the development of lighting and camera equipment and methods for constructing the dynamically scaled models. (b) Demonstrated dangerous deficiencies in the original Mk-7 store proposed for the F-105 airplane. He subsequently developed a store fin configuration which resulted in successful drops. (c) Demonstrated the superior dropping characteristics of bluff store shapes including the flared-cylinder. This work led to the adoption of the internally carried store shape currently in use by the F-105 airplane. (d) Developed the so-called modified light-model simulation method wherein the gravity field deficiency inherent in the basic scaling method is circumvented by accelerating the parent model upward at the store separation. This method was used in drop model tests in the AVCO test vehicle; subsequent full scale drops verified the model tests. (e) Supervised drop model tests of the Ding Dong missile. This work demonstrated for the first time the use of a two leg ejection system capable of imparting pitching as well as variable velocities to an internally carried store to ensure successful ejection.
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> Mr. Lee is currently in charge of tests to determine the drop characteristics of external fuel tanks and stores proposed for the F-104 airplane. He is also in

> charge of a study of a method of externally cooling the surface of blunt shapes. This latter work is underway in the Wallops Preflight High Temperature Jet. In this work Mr. Lee directly supervises several engineering aides. He is a competent supervisor and project engineer. . . .[1]

This was written by Carl Sandahl. Of course it's signed by Maxime A. "Max" Faget, Joseph A. "Joe" Shortal, the PARD Division Chief, and signed off by Robert R. "Bob" Gilruth.

I explained to you yesterday about how a model would come out, and it looked like it would fly back up and hit the airplane. But what it was—the airflow in the bomb bay would impinge on the tail, and it would cause it to tip up. We developed a two-point ejection system so that we could eject it nose down and get it away from the airplane. That was a significant contribution.

I think that pretty well covers what were some of my significant contributions at the NACA—unless you have some other questions you'd like to ask on it.

ROSS-NAZZAL: No, I think that's a great summary.

LEE: I thought that was the way I could bring our previous interviews all back together. Now on to some of your other questions: "Tell us about working at Wallops Island; how you got to the island; how much time did you spend there once you arrived; where you stayed; what were you doing during this free time?" Wallops Island was on what was known as the Eastern Shore of Virginia. That was the peninsula that came down on the other side of the Chesapeake Bay. Sometimes we would drive over to Norfolk, get on a barge, go over to the end of that peninsula, and then drive up to the island. There we had to get on a boat and go across through a marsh in order to get to the island so it wasn't easy.

ROSS-NAZZAL: Doesn't sound like it.

LEE: The Flight Research Division had a seaplane that they called a "Goose" and sometimes they would fly us from Langley [Research Center, Hampton, Virginia] up to the island, land on the water, and then taxi up to the dock. That was the best way to go. We had one pilot who I thought was kind of crazy and not a very good pilot. On one of my trips, he ran up on the dock and knocked the float off of the left wing of the airplane.

When I'd go up to fly test models, I might be up for a day or two, or even three days, getting it launched, getting the data, and then come back to the Center. When I was conducting the drop tests, I would go up for a whole week at a time. I would take my fishing poles, which were surf casting rods. One was the usual surfcasting rod and reel. The other was a new invention at that time with an open-faced spinning reel and spinning rod. On that you would use a lighter line. On the island, just north of the launch facility, there were barracks there that they called a hotel. It was right on the Atlantic Ocean, protected by a sand dune. We would have two bunks in a room, a lower bunk and an upper bunk. It had a kitchen that provided us three meals a day.

I'd get on the airplane with my fishing rods in a tube. People would tease me and ask, "John, what have you got there?" I would tell them, "Those are my calibration rods." Sometimes Caldwell [C.] Johnson and I would go up at the same time, and we would room together. He was an expert model airplane builder. I think you know Caldwell's history. While I was out fishing, he would sit on the floor without any drawings, a picture or anything, and he would build a scale model of an airplane. He did that one week, and that weekend he took it and

won a rubber model airplane contest with it. Those are the kind of things we did for spare time. It wasn't bad.

We had a couple of guys, George and Harvey, who would cook our meals and they were characters and very funny. George would have a lit cigarette in his mouth with ashes on the end while he served the food. One day Caldwell looked at his food and said, "George, there is a fly in my food." George replied, "He doesn't eat much." So we were kind of roughing it. I could get off on that and tell some interesting stories.

When I first started fishing, I asked George, "Where's a good place to fish?" He said, "Just right out there." It turned out that he did not really know so I went right out there just over the sand dune. Sure enough, I started catching speckled trout and things like that. In the spring on the full Moon in May, the redfish would come up the coast going north. In the fall, they'd come down the coast on the full moon in October.

I was out there one night fishing in October—this was before anybody had known that the redfish were there—and I hung on to a great big redfish. I hadn't done much surf fishing for large fish before. I was there all by myself. I was afraid that he was going to pull me in the water. I kept backing up and backing up, and I finally fell down backwards on a sand dune. Then I looked, and I saw this silver fish shining in the Moonlight close to shore. I was really excited. I went down and picked up this great big redfish. I started running to the hotel with it, but it was so heavy that I had to stop and put down the fish. I started to run again, and I had to put the fish down a second time. Finally I got to the hotel, and I threw that fish on the living room floor. He weighed 42 pounds!

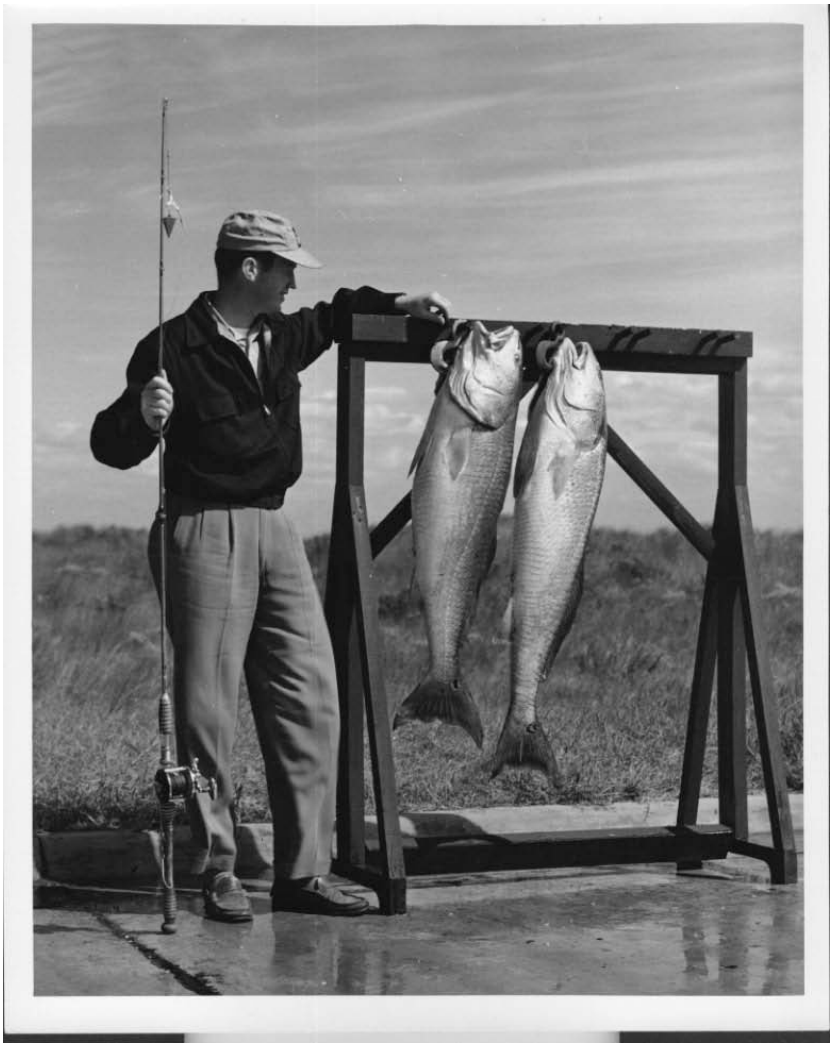
There were about a half-dozen people there. There was a young engineer from the Grumman Aircraft Company from Long Island, New York. I was running tests for their airplane

and stores in the preflight jet. He went back out with me. Some of the other people came running out to fish and to watch. Part of fishing is patience. They finally got tired and went back in. The engineer from Grumman had never seen a fish that large before. He was very excited and he stayed with me. He said, "Catch another fish, John, catch another fish!"

I would use a piece of cut-up mullet, which included his head, and this particular time I had the head of a mullet on a large hook. Redfish are bottom feeders, and they have a very hard mouth that they could crush shells with it. You could not set a hook in his hard mouth. What he does is he "mouths" the bait, and then he runs a ways before he swallows it. That's when you set the hook.

There was a full Moon behind the clouds, and there was a break in the clouds. When I saw this I said, "Now do you see that break in those clouds? When that Moon comes out from behind that cloud, I'm going to catch another redfish." So sure enough when the Moon came out from behind the clouds, I felt one on my line, and I said slowly, "There he is! There he is!" He said, real excited, "Catch him John, catch him!" I said, "No, no, I have to let him run first." So I let him run. When I finally set the hook, I had caught a 36-pound redfish.

Joe Shortal, the PARD Division Chief, wrote a book on the NACA History of Wallops Island. That is a precious book. It has a picture of me the next day, with those two big redfish hanging on the rack with my fishing pole. [next page] That is a part of that history book. I tell people that my claim to fame at Wallops Island was catching those two big redfish.[2] Later on, Gene Schult who had been my roommate came up and caught two redfish so his picture is in the book along with mine.



When the people on the mainland found out that the redfish were there, the next night they came down and went on the south end of the island where there was a great big gut coming out of this marshland from behind us. They went down there with larger poles and heavier lines than what I had. Or they would use a great big hook on a piece of rope, tie it around a log, and throw it out in the surf. That night *great big* redfish came through that gut. I was told that the redfish tore up every piece of tackle that they had. I was so tired that night that I couldn't get out of the chair and go down with them so I missed that. But I had a ball. Anyway, you asked the question so I answered.

The next night they evacuated us because Hurricane Hazel was coming in. That night as we left in the Goose, I looked out of the window at a big beautiful full Moon. I could not believe that a hurricane was coming in. The next morning we had to go to work then they let us go home at the height of the hurricane with winds at 95 mph, but that is another story.

ROSS-NAZZAL: It sounds like summer camp.

LEE: It wasn't all bad. You took advantage of the situation.

ROSS-NAZZAL: Sounds like fun.

LEE: Of course, as I said yesterday, I got there right after [Chuck] Yeager had broken the sonic barrier in the Bell X-1 Rocket Airplane and flew faster than the speed of sound. We were beginning to fly airplanes and rocket airplanes at subsonic, sonic [Mach number 1], and supersonic speeds of Mach number 2.

I did some testing at Mach number 2, and I wrote a TM [Technical Memorandum] on the results of one of these tests. In my title was, "High Mach Number." When you wrote a TM, you had to go through an editorial review board. The chairman wouldn't let me put "High Mach Number" in the title. I asked him, "Why not? It is twice the speed of sound." He said, "Yes, but do you know how high a Mach number you can get?" I said, "No." Nine years later we were flying at Mach number 15. Going from subsonic speeds to Mach number 15 and putting atomic warheads into outer space and reentering them to develop the heat shields for safe reentry was on-the-job training. That era was so exciting and challenging for us "crazy NACA nuts."

We would design, develop, test, and fly the models, and we'd write the final reports. We took projects from birth to grave. Now during this period of time while I was doing my work in the preflight jet, which I thought was very important, the branch under Max Faget was flying models up to Mach number 15. As I told you earlier, he had found out that we could not get an airplane to go much faster than Mach number 6, and that we would have to go in a new direction to be able to put something into outer space. When we started flying these nose cones and ballistic missiles into outer space, which were models of atomic warheads, Max came up with the idea that we could put a man in space using a blunt-shaped reentry vehicle. I think I talked to you about that, but I didn't tell you the significance of it—that you could not get an airplane to go that fast.

I remember seeing Max in his office with his feet on his desk running the slide rule. At the time I did not know what he was doing. He was running calculations to see how he could put his rocket-boosted spacecraft into orbit around the Earth. My ex-wife [Dottie Lee] used the Friedan calculator to do the calculations for the heating on these reentry vehicles. I ask people today the question, "How many of you can believe that the manned spaceflight program was started on a slide rule and a Friedan calculator?" Doesn't that send chills through your spine?

ROSS-NAZZAL: Absolutely, I'm not even sure people use slide rules anymore.

LEE: Then I went through how Bob Gilruth and Max Faget had sold the idea to the President of the United States and to Congress.

You also asked if I was active in any social groups, athletic teams, or charitable organizations at Langley. I'm not sure I can say too much about social groups. We were

working so very hard, but we had intramural baseball and basketball teams and I played on both of these. We also had a duck pin bowling league that I was also on. I do not know of any duck pin bowling alleys today. We had a gymnasium where they carried out a number of activities. That was near the end of the Big Band Era, and Louie Prima with Kelly Smith and several other big name bands came there.

On the Langley Air Force Base, there was an Officer's Club which we were able to go to. They had slot machines and some of the best food—especially prime rib. There were times when I was able to pay for my meal out of the slot machines. So that was very pleasant. They also had music for dancing. Shirley Schult, [Max Faget's secretary and Gene Schult's wife], sang for one of the orchestras.

At PARD we grew up in the design, development, and testing world and writing the final reports. We took a project from birth to grave, and we were always expanding the envelope. We were doing things that people had never done before. So by going from the NACA to NASA, we were the people who had grown up in the field and knew how to design and take a project from birth to grave. By this time we knew what the Mercury spacecraft design was going to be like.

We had essentially designed the Mercury spacecraft when we turned it over to the contractors. That is why they were able to answer our RFP [Request for Proposal] within a month; in two weeks, we had evaluated the proposal and had rewarded a contract. In six weeks we had let a contract on Mercury to the McDonnell Aircraft Corporation. This is a feat that has never been duplicated before or since. That's how the NACA experience helped us.

In the questions you sent, you asked about my memories of Sputnik. The answer to that was that it was a shock, like it was to everybody else. What the NACA had done, and my division [PARD] under Bob Gilruth, Max Faget, [Joseph] Guy Thibodaux, and Paul [E.] Purser

had done was to start the manned spaceflight program. We were ready for the challenge. What I'd like to point out here is that when we designed the Mercury spacecraft, it was a great paradigm shift. We went from flying a man in a winged vehicle to a man lying in a seat in a blunt-shaped vehicle. This was something that had never been done before. *PARD was the "eye of the storm" for the manned spaceflight program.* Sputnik gave the nation the *incentive to start the Mercury Program so we were ready for the challenge when it arrived.* That's what was so great about Bob Gilruth, Max Faget, Guy Thibodaux, Paul Purser and others—they already knew what we could do, what had to be done, and how to do it.

I was excited and elated to be accepting challenges for things that had never been done before. I always loved a challenge. In Mercury I started picking up responsibilities, and instead of putting me under the Aerodynamics Group, I was made the head of the Mechanical Systems Section. My section had the responsibility for: 1) the propulsion systems, 2) the reaction controls, 3) the parachutes, and 4) the pyrotechnics. Most of these things I knew very little about.

The propulsion systems included the escape rocket motor that was to pull the capsule off of the booster in case of a booster malfunction, and the posigrade motor, which was attached to the launch escape tower that would pull the tower from the capsule on a successful launch. The reaction control system would control the attitude of the spacecraft in orbit and orient it so that it could reenter the atmosphere. The retro-rockets would bring the spacecraft back in from outer space. The spacecraft did not change orbits. The ring-sail drogue would pull the main ring-sail parachutes out of its canister that would open for landing. I was responsible for the development of these two parachutes with Radioplane in California. This ring-sail parachute design has been used on all of our spacecraft programs since then. The pyrotechnics on the Mormon clamps for

the escape rocket motor and for the retro-rocket package had to work for a safe landing in a rough sea if necessary.

Our subsystems had to work from the time of ignition at launch until the time the spacecraft landed safely in the water. So on the first launch of the Mercury spacecraft test vehicle, I was really sweating bullets.

I was busy trying to handle all of these things all by myself with the help of other experts around the Center. All of a sudden Max Faget added about seven people to my section. He brought in six young college graduates. They were Phil [Philip M.] Deans, Walt [Witalij] Karakulco, [James] Kirby Hinson, Robert Rollins II, Jim Saunders, and David Winterhalter, Sr. For some reason, Robert Rollins soon left. I put them on the parachute program because we were having problems at that time.

Dick [Richard B.] Ferguson was transferred in from another part of the Center. I gave him the job of working on the hydrogen peroxide reentry control system. I didn't know that he didn't know anything about them. A few years ago I asked him, "Dick, did you know anything about hydrogen peroxide rockets when you took over that?" He said, "No." He did an excellent job on it. As I said, it was on-the-job training for all of us.

I didn't know anything about propulsion either. Max brought in Charles [W.] Yodzis, who had experience in propulsion, and so I gave him the assignment of working with Guy Thibodaux on the rocket motors. He finally left me and went to work for Guy, but I was still able to draw on Guy's support. Guy was still in PARD and had not joined the Space Task Group at that time. When we moved down here to Houston and started designing the engines and the rocket motors for Apollo, Guy came down from Langley and became the chief of the Propulsion Division at the Space Center for Max Faget. Charles Yodzis was still with him.

ROSS-NAZZAL: Can I ask you a question? You had said that you didn't know a lot about propulsion, and you had assigned Dick Ferguson to work on the RCS [Reaction Control System] jets. How do you account for the fact that guys who didn't know how to do any of this ended up succeeding?

LEE: As I said earlier, we would go to people with experience in those areas. They were always willing to help. And we would pick their brains. When we were working with contractors, they knew a lot about some of those specific areas, but in many cases we were giving them challenges that they had never seen before. In many cases, we were ahead of them. We had a contract with Bell for the hydrogen peroxide reaction control subsystem, which was highly classified, which I think was for the Air Force. It was hard to work with them on the program to find out what they were doing. They were reluctant to give us information.

One of your questions was about who made the decision to include solid propellants for launch escape systems, and why was this preferred over liquid propellants. This is a very interesting question. We had a lot of experience in using solid fuel rocket motors in our flight test programs off of Wallops Island. The solid fuel is self-contained, more reliable, safer, and easier to work with than liquid fuel and its chemicals. So the solid fuel rockets had a great many things that made it far superior to use than liquid fuel rocket motors for what we were doing. Our tests of these rocket motors were in free flight or on test stands outside of a facility. These decisions were made by Gilruth, Max, and Thibodaux.

The aerodynamics for scaled models were run in some of the NACA wind tunnels. The preflight tunnel was the only wind tunnel on the Wallops Island and that was not used for testing

the spacecraft. Max had tests run on different heat shield configurations in a high temperature jet facility at Langley Field. I was not too familiar with them, but he told me that from these tests they had found the circumference of the heat shield so that it would have even-heat distribution over its entire surface. They also found the angle of the side walls of the spacecraft so that it would have equal distribution of heat over its surface. As I mentioned earlier, he had also tested the spacecraft reentering with the heat shield still on the spacecraft that was successful. Those times were interesting and exciting. This was the type of information that was given to the contractor to show them how the spacecraft was to be designed and built.

Before I was put in charge of the escape rocket motors, while we were still at the NACA, Max had already come up with a configuration of what the capsule would look like. He had built a full-scale model of the spacecraft with the escape rocket motor on it. He had it launched off of Wallops Island. The launch facility was about a quarter mile south of our living quarters. Woody [Willard S.] Blanchard was the project engineer for the test at that time.

There are three nozzles on the escape rocket motor. On launch, when that rocket motor was ignited, one of the inserts in one of the jet nozzles came out. The spacecraft, with its rocket motor still firing, started tumbling and was coming straight up the coast. There were about twenty of us standing on the sand dune at the hotel watching it. When I grew up playing baseball my father had told me, "Now, when a foul ball is hit and you don't know where it is, don't go running around because you might run into it. Stand, watch, and find out where it is." So I watched the configuration come tumbling by us with its rockets still firing. This was quite a spectacular sight. It landed in the water pretty close to where we were standing, just a few feet off of the shore. Abe [Abraham D.] Spinak was one of the engineers that ran the preflight jet. When I looked around, he and I were the only two still standing on that sand dune. Everybody

else had scooted! The problem of the inserts in the escape rocket motor was solved before it became my responsibility. That was very interesting and exciting.

ROSS-NAZZAL: I can imagine. Something that sticks in your memory. Tell us about some of the major challenges you faced on the launch escape system.

LEE: Redstone Rockets in California had the contract for the escape and posigrade rocket motors. Static tests of the escape rocket motor showed that when it was ignited, it would start, stop, and then it would catch and fire. The timing had to be exactly right. You couldn't have it not igniting immediately.

I got hold of Guy Thibodaux. He said, "Well John, get me the records from the contractor." So I got the records, and I showed them to him. Guy said, "Oh, you have got a hang fire." That is, the igniter was not immediately igniting the solid fuel. Guy and I got on the plane, and we went out to Redstone, California, to see the contractor.

The next morning at breakfast I asked him, "Guy, how are we going to play this thing today?" He said, "We'll sit and wait to see what they have to say, and then we will tell them what's wrong." We go in the meeting, and we were sitting around a table and here came these two young engineers running in saying, "We know what happened; we know what happened." Guy said, "You can't tell me what happened. I know what happened. You had a hang fire." Their mouths dropped open and said that that was also their conclusion. I could hardly keep from rolling in the aisle laughing. You have probably talked to Guy Thibodaux. You know nobody's going to get ahead of him. That was the funniest thing.

Dick Ferguson worked for Guy after Guy left PARD in Virginia and came here to Houston to head up the Propulsion and Power Division for Dr. Faget. A couple of years ago I told Dick that story. He went and told Guy what I had told him. I said "Dick, I didn't mean for you to tell Guy." He said that he couldn't help telling Guy because he thought it was so funny. He knew Guy probably better than I did because he became Guy's deputy and the Division Chief after Guy had retired. That was typical of Guy. We had fun.

The drogue parachutes opened at 10,000 feet and landed on the water. Radioplane had won the contract for the parachutes on the Mercury Program. It included the main parachutes and a drogue parachute. The drogue chute would pull the main parachute from its canister so that it could be deployed. It was a little more complicated than that. When we started with the parachutes for the Mercury Program with Radioplane, they brought in their parachute which was a regular, standard-type parachute. We made a drop test with this parachute on a full-scale model of the Mercury spacecraft, and the parachute failed to open. We could not have a parachute that might fail.

Radioplane came back with their brand new design known as the ring-sail parachute. It was a composite of horizontal rings of strips of cloth that were separated from the rings above. It had very positive opening characteristics, and so we developed a 90-foot one for the Mercury spacecraft, and it proved to be perfectly safe. The drogue parachute was made the same way. One of the requirements at that time was that the drogue parachute would be deployed at supersonic speeds so I had the task of developing that drogue chute at supersonic speeds. Dr. Gilruth sent me down to Eglin Air Force Base in Florida because the Air Force had developed a two-stage rocket test vehicle which would give us the Mach number 1.4 that we needed. The Air

Force had developed the booster to use to test the Steinthal drogue parachute for the Air Force under contract to Cook Electronics.

I took our drogue parachute down there and put in their two-stage launch system. This was their first flight using this new launch system. When the first stage fired, the second stage also fired so the test was a failure. We pulled out all of the drawings trying to find out what went wrong. I was not an electrical engineer, but I could follow a wiring diagram. I found out that they had used a switch that had two leaf springs in it. One was to fire the first stage, and the second one would fire the second stage. I took a look at the thing, and I asked, "Well, if they both closed at the same time, they would ignite the boosters at the same time, wouldn't they?" They said, "Yes."

At this time on the Mercury Project, we were going through all the boosters that we were going to use with a fine-tooth comb and getting rid of all of the single-point failures. We wanted to make certain that we wouldn't have any single-point failures on the launches with the astronauts. We didn't want to lose any of the astronauts. One of things that I had to admire about the astronauts was that they would go to the Cape [Canaveral, Florida] and watch the Air Force launch their rockets: the Atlas, the Deltas, and other rockets, and they would watch them blow up on launch. They were having about 50 percent or 60 percent failures on these boosters, and they were still willing to fly the spacecraft.

I asked them what they had done to check the switch to see if this would happen. The colonel heading the project (and he may have been the commander of the flight test facility) was standing there. He asked, "What are you talking about?" I asked, "Have you run vibration tests or anything like that to see if this could happen?" He asked, "What do you want us to do—tear it

apart under vibration?" I said, "No, but this could possibly happen from the vibration of the booster."

The next morning when I came in, two of the young engineers came running in and said, "John, John, you were right, you were right." The colonel was nowhere to be seen. I told them, "Well, we've been flying these rockets for years. You should get the information from us on how to wire your boosters." Cook Electronics were the people that designed this system for them. They were to use this launch vehicle to test their supersonic drogue parachute. As well as I can remember, Cook had bought the Steinthal Parachute Company [M. Steinthal & Company, Inc.]

When I got back to Langley, I went down to Caldwell Johnson's branch. His people did all of this kind of work for Guy Thibodaux on firing his multiple-stage rockets. I asked for them to give me the drawings of how they did it so that I could send them to Cook. Russell [E.] Clickner asked me if I was talking about Cook Electronics, and I told him, "Yes." He said, "They have already been in our office, and we showed them how to do it." So Cook Electronics, in their great wisdom in electronics, had done it their way instead of our way. But I sent the information to them, and as far as I know, they ended up having a successful launch of the boosters, but they were not able to develop a successful supersonic drogue parachute.

Bob Gilruth then sent me out to the NACA Flight Test Facility at the Edwards Air Force Base at Muroc, California, to have it dropped in a test vehicle from an F-104 Airplane at Mach number 1.4. Neil [A.] Armstrong, who was a test pilot there, flew the F-104 airplane for us on these tests. We had a failure on the first drop test. The camera showed that the drogue parachute opened and closed at a very high rate of speed and tore itself up. The parachute had a 30-foot-long nylon riser that had high elasticity. We found out that we had to change from a nylon riser

to a Dacron™ riser that had much less elasticity. That was successful. I think I told you about seeing Neil Armstrong later here at Houston to receive the Rotary NASA award that we, the Space Center Rotary, presented to him. Did I tell you that story?

ROSS-NAZZAL: No I don't think you told us that story.

LEE: That's an interesting story. I am a member of the Space Center Rotary Club. Every year the Space Center Rotary Club gives what they call the NASA/Rotary Award to the outstanding person in aviation and/or space. It was started about eighteen years ago. Owen [G.] Morris, who had worked for NACA and NASA and is a member of Rotary, came up with the idea. He and Charles Hartman were two of the people who implemented this award from Rotary. Dr. Max Faget was the first recipient of the award. Since then, some of the astronauts, congressmen, aircraft executives, and others have received it. They had been trying to give it to Neil Armstrong for many years. Neil, who is a quiet, private kind of person, had kept turning it down. Finally, about three years ago, he came down and accepted the award. The award banquet is held at the Hyatt Regency hotel in downtown Houston. There are at least 700 to 800 people in attendance at the ceremony every year.

When I got there, the first two people that I ran into were Bob [Robert F.] Thompson and his wife Dorothy. When I went up to say hello, Bob introduced me to Neil. It was Neil Armstrong. It was the first time that I had ever met him. I shook Neil's hand, and I asked him, "Neil, do you remember those drop tests on the Mercury drogue parachute at Edwards?" He said, "I sure do." And he went through this spiel. He recounted some of the problems that he had to face on flying these missions. When he dropped the test vehicle with its drogue parachute

from the F-104 airplane, he said that if the parachute worked, they knew where it was going to land. If it did not open, it would keep on going flying at Mach number 1.4. They had to be certain that it would land somewhere in the desert and not on someone. What was interesting about this was that when I talked to Neil Armstrong about it, he went through all this and he had remembered everything. Here was a man who had been a test pilot, had become an astronaut, flew in Gemini, and was the first man to land and step on the Moon. He had done all those great things, and he still remembered that specific test program. I was so impressed with him.

It turned out that the first one failed, and it kept on going and landed out in the desert somewhere. They were able to find it and get the camera out of it. We found out that when the parachute was deployed, it opened and closed at such a high rate of speed that it tore itself apart. The riser on the parachute was 30 feet long and made out of nylon which was very elastic. When I reported this to Max, he put Phil Deans on the problem. He ran the calculations that showed that the dynamics of the nylon riser was what was causing it. Well, he worked out the dynamics of it. We put it on a Dacron riser, which was not near as elastic, and it worked. I did not know this at the time, but when Phil was assigned to my section, I assigned him to help me on the parachutes. He had gone to Max and told him that he did not want to work on parachutes because his degree was in aeronautics. Max explained to him that parachutes were aeronautics. I was certainly glad that I had him. Phil became a highly rated and a very successful engineer at the Center.

An interesting antidote to that is that when I went out for the second drop test, I carried a Steinthal drogue parachute under my arm. My purpose was to get Radioplane to solve the problem, which they did, with us and Phil Deans working with them. They certainly were not about to let me test the Steinthal parachute. I could have done it too because I was responsible

for developing the drogue parachute. We were held responsible for the success or failure of our programs. At that time, we did not have to go through review boards and all of those kinds of things every time we wanted to try something new. We were in a race against the Russians to put a man in space.

I now know that Cook Electronics and the Air Force did have a failure, and they did not develop a successful Steinthal parachute at supersonic airspeeds. We at NASA and Radioplane ended up developing the first successful supersonic drogue parachute.

It turned out later that when John [H.] Glenn was reentering the atmosphere at transonic speeds, he thought that the capsule was oscillating too much. He said that he thought that he had better push the button and eject the drogue parachute. He said that he reached for the button, but that the parachute came out before he touched it. All of this was happening while the capsule was oscillating, and he had his spacesuit and gloves on. The drogue chute came out, and it survived. I still wonder to this day if John Glenn would have survived if the drogue had not been designed for supersonic speeds.

Later on in the Apollo Program, we were going to test the deployment of the triple parachute system with a boilerplate capsule of the Apollo spacecraft out over the Galveston Bay. "Shorty" [John A.] Powers was the first person who was the head of our Public Affairs Office [PAO]. He had one of the best jobs at the Center as head of public relations, which included the astronauts, and he blew it. When Shorty found out about the test, he got a hold of the press and invited them out to observe the test drop the next day. He had not talked to us about it. We were using the same parachutes that we had on the Mercury Program.

The following day we were going to fly John Glenn. I told Max about it. I was concerned that they might stop John Glenn's flight if we had any kind of failure with those

parachutes. Max checked it out and found out that we really were not ready to go, and he stopped the drop test. Shorty Powers went in and accused Max of stopping tests because of him and the press. Max told him no, we still had some problems to work out. The next day, after John Glenn had been launched on our first orbital mission, we dropped the capsule, and the test system failed. The parachutes were not deployed. The next day, the headlines in the *Houston Post* newspaper was, "The Apollo Spacecraft was Stuck in the Mud in Galveston Bay." That pretty well takes us through developing the drogue parachute.

ROSS-NAZZAL: Tell us about your work on the contract evaluation committee for the Mercury Project.

LEE: On the Mercury Project, I represented the Mechanical Systems which included the parachutes, the rockets, the pyrotechnics, the hydrogen peroxide jets, and they all had to work. The evaluation board asked me how I would rate the evaluations of all of the propulsion systems on the spacecraft. I said that it should be about 60 percent of the criteria because they were such a very important part of the whole system. They lowered the evaluation of the propulsion systems to 40 percent of the total criteria. You can see that that was a very important area in the design of the spacecraft.

Bill [William] Petynia and I helped Bob [Robert O.] Piland to pull together the results of all of the committee reports for the board's final review. We knew what findings went on to the board for their final evaluation.

The Redstone boosters that we used for the suborbital flights with Alan [B.] Shepard and Virgil [I. "Gus"] Grissom had been developed by Wernher von Braun and his team for the Air

Force at the Army Ballistic Missile Agency at Huntsville, Alabama. I found out just a few years ago that in WWII, von Braun had on the drawing board a man in a capsule for a one-way trip to New York City, New York. We could have had a 9/11 [September 11, 2001 attack on the World Trade Center] in World War II if he'd been able to do that. Does that send chills up and down your spine?

ROSS-NAZZAL: That's frightening.

LEE: Then I became the head of Mechanical Systems Section. I was in a small group of people who were in the Space Task Group that welcomed the first seven astronauts that came on board. I briefed them on the parachute systems. I told you about Ham [the first chimp in space] and his flight. I talked about the astronauts being willing to risk their lives even after going down to the Cape and watching all those boosters blowing up on the pad. Thank God we never had any of that happen. I talked to you about how Chris [Christopher C.] Kraft was running the launches at the Cape.

Before Alan Shepard's flight, Max called me into the office and asked me to manage one of the three parallel studies of sending man to the Moon so that's when I left Mercury. It was about the time of the first boilerplate capsule test, but I still watched that with great interest.

From those studies we started the Apollo Program. President [John F.] Kennedy was able to say that the United States would go to the Moon in this decade. We hadn't even put a man in orbit around the Earth when he said that, but the Apollo Program to land a man on the Moon had already been started.

That was about the time we moved down here. You probably know this, but what was so interesting was that the site that we built the Center on acreage that [Humble Oil] Exxon had donated to Rice University. Rice was then able to donate it to the government. Exxon couldn't do it because it might be considered a bribe, but an educational institution could do it. After we moved down here the government bought additional acreage from Exxon for the Manned Spacecraft Center. Then the Friendswood Development Company, an Exxon subsidiary, built a whole new city, Clear Lake City, around the facility, which is now part of Houston, Texas. Did you know that story?

ROSS-NAZZAL: Yes.

LEE: What was so interesting about that was that I was on the Board of Directors of the Citizens State Bank in Dickinson for fourteen years that was owned by Walter Hall. He was a state banker, and he owned five banks around the state. He owned the bank that was the Webster State Bank. What is interesting about this is that when Walter Hall offered me the position, I read the Texas State Manual listing the responsibilities of a director. At that time, when we accepted the responsibilities of an outside business, we had to get approval from the Personnel Office. They would determine if it would be a conflict of interest with my government job. I could not see where that would be a conflict of interest so I sent a memo to the head of personnel who at that time was Stu [Stuart H.] Clarke.

He sent me a two-page memo of disapproval. I said to myself, "If I am not able to solve this, Walter probably will not want me on his board." So I set up a meeting with Stu Clarke and Dr. Gilruth. When Stu handed the memo to Dr. Gilruth, he laid it down on his desk without

looking at it. Gilruth asked if he had checked with NASA Headquarters [Washington, DC] on the subject, which he had not done. So Dr. Gilruth had asked him to do so, which he did. Stu Clarke came back with an approval. What he and I did not know was that Dr. Gilruth had already cleared it with NASA Headquarters so that Walter Hall could nominate me for the position. This opened it up so that others at NASA became directors of banks. Joe [Joseph F.] Shea became a director at the La Porte State Bank, and Alan Shepard became a director of a bank in Baytown. These are two who I know of.

Walter told me the story that the people in Clear Lake came to him and told him, "We're going to be annexed by Houston. What can we do to stop it?" He told them, "You need to get together about $250,000." They told him, "No, we don't have $250,000." What a big mistake that was. Clear Lake City was annexed by Houston. Then the Clear Lake area spent millions of dollars later trying to be de-annexed, and they were never successful. If they had listened to him, Clear Lake might have been another city, just like Nassau Bay. Of course, Houston wanted the Space Center to be in Houston and that was a big combination that was hard to beat. That's a very interesting sidelight I think in the development of the area.

When we moved down here from Virginia, we had three different projects going on at the same time: 1) Mercury had flown its suborbital flights, 2) we were cutting the hardware for the two-man Gemini spacecraft, and 3) we had signed a contract for Apollo Command and Service Module [CSM], and we *still* had to get a contractor for the Lunar Excursion Module [later known as the Lunar Module or LM].

Max had said, "I'm going to be down in Houston on the 1st of January. I want you to be down there the 1st of February." So I was here. I came down here six months before my family moved down. I stayed in the temporary barracks here at Ellington Field that were built in WWI!

In addition to flying the flights and all, we still had to build the test facilities, including the Mission Control Center and the Environmental Test Chamber [Space Environment Simulation Laboratory]. That chamber was the largest in the world that could simulate space environment at that time. As far as I know it probably still is. The Apollo contract for the Command and Service Module was the largest contract that the U.S. government had ever written. It was larger than the one for the atom bomb in World War II.

When we organized down here, of course Dr. Gilruth became the Director of the Manned Spacecraft Center. Max Faget was made Director of E&D [Engineering and Development Directorate]. Chris Kraft was made Director of FOD [Flight Operations Directorate]. Astronaut Deke [Donald K.] Slayton was made head of the astronauts and Flight Crew Operations [Directorate]. Deke had been diagnosed with a heart condition so he had been taken off of flight status.

I think that it was amazing what Dr. Gilruth and his people accomplished during this period of time. We were working 10 to 12 hours a day, sometimes 6 or 7 days a week, and traveling all over the country. We were in a race to beat the Russians to the Moon. It took us awhile to catch up with them.

Now you may know this from your other interviews, but in order to go to the Moon, we had to develop the capability to change orbits in space, rendezvous, and dock with other orbiting space vehicles. Our studies on the Apollo showed us that we had to have that capability. During this time the Mission Control Center had been completed in Houston, Texas. Gemini IV was the first flight controlled from the Control Center. I didn't have anything particular to do with Gemini. It was on Gemini IV when we flew Ed [Edward H.] White.

Another anecdote here is that on the first docking of the Gemini spacecraft with the Agena rocket motor, the combination went into a violent uncontrolled spin. They thought it was due to cross-couplings of the two vehicle control systems. Neil Armstrong was the pilot. He undocked from the Agena, but the spacecraft continued to spin at such a high rate of speed. Both of the crew members were about to black out. Neil turned off the RCS [Reaction Control System], and that stopped the capsule from spinning. One of the RCS jets had stuck open. So this saved their lives. That was very close.

ROSS-NAZZAL: I imagine people on the ground were holding their breath.

LEE: Yes they were. As I have said, I was not working on the Gemini Program. Dr. Faget had made me his technical assistant, the head of the Apollo Project Office for E&D. When Dr. Gilruth started the Center, he brought on board Jim [James C.] Elms in 1963 as his Deputy Director who was an outstanding organizer and manager. He helped Dr. Gilruth to organize the Center. Jim Elms came up with the idea of assigning subsystem managers to the subsystems on the spacecraft. Bob Piland lead a team, which I was part of, which identified the 36 subsystem managers from E&D that were assigned to the Apollo spacecraft. They were later increased to 42. They worked for their divisions and got their instructions and support from the divisions, but I was responsible to Dr. Faget for these subsystem managers. Later, I was made the manager of the Program Support Office.[3] An updated outline of my duties is shown NASA's position record.[4]

I kept Dr. Faget abreast of the subsystem managers' progress. I would sit on the many review boards that they had to go before while getting ready for flight. What was so interesting

about this was that in those days, the subsystem manager had to show that their subsystem was ready to fly. That was part of my job. The division chiefs were also responsible for the technical support that was required.

For the Apollo Program, NASA built a new rocket test facility on Merritt Island, later named Cape Kennedy [now Cape Canaveral], Florida, after our late President John F. Kennedy. Now one thing I have never written about was the fire at the Cape. I didn't want to talk about it. People always wanted to be around the astronauts. They wanted to be seen with them and photographed with them. I could understand that. Based on my World War II experiences, I tried not to get too close to the astronauts because if anything happened to any of them, I knew that it would be hard to handle.

But I did have some good friends in the Astronaut Office. I considered Deke Slayton and Alan Shepard good friends. The astronauts were assigned to follow specific subsystems. Alan Shepard was assigned to the parachutes and Gus Grissom to the propulsion systems. Alan called me up one day and said, "Hey John, I'm going out to the Rag Factory." That is, he was going out to see the parachutes at Radioplane. I think it was PR [public relations] for the company to have an astronaut to come to see them. If I had said, "Okay Al, I'll go with you," I probably could have gotten in on some of the first-class treatments that the first seven astronauts were given, but I did not. I was too busy.

I did not get close to the astronauts other than in my work. I had not even met Neil Armstrong, and he'd done the drop tests for me. But Neil Armstrong was the one who gave me the [Silver] Snoopy Award. Word must have gotten out to him some way of my responsibilities on Apollo. Needless to say I was very proud of that.

Joe Shea was the first Apollo Spacecraft Program Manager. He was responsible for the spacecraft being built by the contractors. His office assigned spacecraft managers that took care of having the spacecraft built at that contractor and shipped to Merritt Island by the contractor. The subsystem managers were held responsible for their subsystems in each spacecraft. Dr. Faget and Joe Shea set up a series of meetings to review the status of the subsystems with his spacecraft managers who worked with the contractors. Dr. Faget and Joe Shea co-chaired those meetings.

I was assigned to be secretary of those meetings. We came up with a list of action items that E&D had to do, and those that the Apollo Spacecraft Program Office had to do. I would write those items in the minutes. I also made up a chart to follow these action items so when we would have the next review, I would go over the checklist of each of these items. There was one person from the program office, a Dr. Lee by the way, who never completed his action items. Finally one day at a meeting he asked, "What is it that I have to do to get off that list?" I responded, "You have to solve the problems." It wasn't long after that, that he left the Center. I guess he wasn't used to what he thought was some peon questioning what a doctor should do. That was of the things that I was assigned to do.

When I first moved to Houston, I was in an office with Dr. Gilruth and Dr. Faget and some of their staff in the Farnsworth Chambers Building off of Telephone Road. Dr. Gilruth set up Joe Shea with his people in a motel on the Gulf Freeway. I forget what the name of that motel was. Max had a bunch of his engineers in the Rich Building on Telephone Road.

I came down here six months before my family did. That was when we were having our house built that my wife and I had designed for the lot that we had bought. I was rooming at Ellington Field with Owen [E.] Maynard from the Apollo Spacecraft Program Office. Dr.

Gilruth had hired Jim [James A.] Chamberlin from Canada. He had been working at the AVRO Aircraft Company in Canada that had been dissolved. He came on board with the Space Task Group while we were still at Langley and he brought with him about a dozen of their best engineers. Jim Chamberlin was a top engineer. Owen Maynard was in this group of very good engineers.

At that time we did not even know what the Moon was made of. Owen would bring drawings of the LEM [Lunar Excursion Model] home [the barracks] with him at night. At that time we were trying to decide how to design the lunar landing system on the LEM. Should it have four legs or three? Whether or not it should have spikes that would go down into the ground or whether it should have pads on the bottom, and those kinds of things. One night Owen Maynard put his pencil down, and he said, "Damn, just think, the decisions we're making today can affect the astronauts' lives ten years from now." Wasn't that a scary thought?

I think you asked about the fire at the Cape, and I had never put that in my memoirs or my presentations. I think I did talk to you yesterday about Dr. Faget and Phil Deans investigating it at the Cape, and that I sat on the review board here with Aaron Cohen on the questions that were being sent to the Center from the Cape. Then after the fire at the Cape, Joe Shea was relieved by George [M.] Low, who at that time was Dr. Gilruth's Assistant Director. Low stepped down from that position to take over the Apollo Program. George Low did a magnificent job.

We talked about the Apollo 8 [Frank] Borman crew, and that I was the lead engineer from E&D on the team that helped determine the status of the subsystems and the upgrades that would be needed, if any, so that we could go to the Moon.

I was taking care of the subsystem managers for both contractors. The job became so large that I had Dr. Faget assign Phil Deans to take care of the LEM at the Grumman Aircraft Company. Later, I brought Bob [Robert P.] Burt onboard to monitor the North American contract. With their help, I would coordinate the subsystem managers' progress for both contractors.

On the Apollo Program, instead of supporting the engineering part of it, I was put on the management committee representing E&D. That was my part on the evaluation committee for the Apollo CSM contract. Bill Petynia and I also helped Bob Piland pull together the committee reports to be sent to the board. So I got to see all aspects of the engineering sides of the evaluation.

I was not involved in any of the work on the engineering facilities or the Mission Control Center. With the help of Jim Chamberlin, I helped set up the E&D part of the Mission Evaluation Room.

I have told you about my mixed emotions when I was first with von Braun and his staff at the MSFC. Later on in the Apollo Program, Dr. Gilruth had George Low host Dr. von Braun and his staff from MSFC along with KSC [Kennedy Space Center, Florida] and NASA Headquarters on a tour of the MSC facilities. I was put in charge of the E&D divisions' presentations to MSFC. After the tour, I was commended in front of our guests by George Low for a job well done, which I thought was very nice of him, but the divisions were the ones that deserved the credit. I also received a letter from Dr. Gilruth.[5]

I have to say this. There were a number occasions where we had to change von Braun's ideas around. When we flew the Skylab Program, I was working on a design for a Space Station. von Braun had proposed a Space Station design as a big wheel in space to simulate artificial

gravity because they thought that the astronauts would have problems in zero gravity. In the Skylab, we found out that we didn't have to have artificial gravity.

Dr. von Braun proposed going all the way to the Moon with one booster rocket and to bring the spacecraft back from the Moon. That would have been a monster. It wouldn't have worked. Because of the work that we had done at Wallops Island on staging of the booster rockets, Max Faget convinced him that staging was the way to go. I saw the history of von Braun on TV, and they gave him credit for staging in going to the Moon. I know that he had a little help there.

The other was that later on, after Apollo, we ran two competing studies between the two Centers on the design of the Space Station. The study at our Center was managed by Rene [A.] Berglund. I was his deputy and the chief engineer from E&D. We would meet with MSFC staff on each of these studies. The studies had two different approaches. We proposed solar arrays for our power supply in Earth orbit, but MSFC went with atomic energy for their power supply. It was determined that solar arrays were best for Earth orbit. Atomic energy could be used for flights outside of Earth orbit so it turned out that we beat them on that.[6]

When I would work with my counterpart over there, we would come to an agreement on what we should do. I'd come back and present it to Dr. Gilruth and Dr. Faget, and they would agree with it. The manager at MSFC would present it to von Braun and his staff. Then I would find out that no, Marshall had changed or knocked out certain things. They were very hard to work with. You couldn't seem to get agreements with them, but we ended up beating them on every turn.

I think that they knew liquid propulsion, and I won't argue with that because I don't know too much about it. They were not experts on solid fuel rocket motors. For some reason,

they were given the responsibility on the solid rocket motors on the Shuttle. I think it was a political decision. This was proven when they had the O-ring problem on a Shuttle flight [STS 51-L, Space Shuttle *Challenger* accident]. Guy Thibodaux is a world-wide expert in both solid fuel rocket and in liquid propulsion. I firmly believe that Guy and his people would have recognized the problem, and the *Challenger* explosion would not have happened.

Those were some of my experiences with Marshall. Those were some that come to mind right away. It was hard to work with Marshall. I think if you talked to Caldwell Johnson, he would tell you how hard it was because he worked with them more than I did.

When we heard that NASA planned to go to the Moon after the first manned flight of the program [Apollo 7], thoughts were, that was great! It was a real bold idea. We jumped right in and went to work on the upgrades. I don't remember specifically from subsystem to subsystem what some of the upgrades were that we had to make. I passed the action items from Aaron Cohen on to the subsystem managers and they, with their divisions, took care of them.

I will discuss some people that I was personally involved in. Jim Chamberlin was an outstanding engineer. He was the Gemini program manager, and he got the Spacecraft built at the contractor. When the spacecraft became operational, Chuck [Charles W.] Mathews was made the program manager. So, for a while, Jim was free-ranging around the Center. He was writing Gilruth all these memos about the problems that he thought there were on the Apollo spacecraft, so Dr. Faget talked Dr. Gilruth into putting Jim Chamberlin under him because what Jim was talking about were Dr. Faget's responsibilities. Max walked into my office one day and said, "John, I'm bringing Jim Chamberlin on board. You're to take care of him for me." I said, "Well thanks a lot."

I knew that Jim had a reputation of being hard to work with. I found out that he was a very brilliant man. He had a personality where he would get under people's skin. My first experience with him was on the Mercury Program. He got it set up so that we could go out to McDonnell in St. Louis [Missouri] and work with our counterparts on Mercury. These were the days before the subsystem managers. My counterparts were Jim Mazzonie on the propulsion systems and Johnnie Whitecamp on the parachute systems. One day I got a call from Jim Mazzonie, and he told me that Jim Chamberlin had been out there and had changed one of our agreements. I went immediately into Jim Chamberlin's office and asked him why he had done that. He had a sheepish grin and said that he was checking to see how well and fast the system would work. He seemed pleased how fast it had worked with me. The next time that we were at McDonnell for a big staff review, Jim Mazzonie told the staff that I had never steered him wrong. I thought that was a very nice compliment.

Jim Chamberlin had the ability to get to the meat of the problem. He would get two people in a room, and they would be discussing the same problem, but they had different ways of doing it. He would ask one what he wanted to do, and then ask the second person what he wanted to do. If one guy seemed to be winning, he would work with the other person and help build him up a little bit more. Then the other person would say something that he really did not want to say about what his problems were. The real problems that a person did not want to talk about would somehow sift out onto the table. That was one of the ways that he worked with people.

He made me a co-chairman on his ad hoc committee. We were investigating problems that we were having with hardware and software that were going to the Moon. I wrote the minutes for these meetings, and I would chair the meetings when he was not there. Those

minutes would go to Dr. Gilruth, Dr. Faget, and Flight Operations so they all knew what we were doing.

In some cases E&D was designing things without knowing what the actual criteria were, such as operations, and for the proper Moon environment, and those kinds of things. We found out that the Crew Systems Division had taken the responsibility for the VOX [voice operated transmitter] Communications System, [it was voice-activated] because it was in the astronauts' helmet. We turned VOX Systems responsibility over to Ralph [S.] Sawyers' Electronics Systems Division responsible for electronics.

The Crew Systems Division also did not know what the criteria were for designing the astronauts' helmet to be used on the Moon's surface. We made certain that the right people had the right responsibilities and the right design criteria. Oh, and by the way, one of the people who was on the committee representing the astronauts was Ken [Thomas K.] Mattingly, so I got to know him pretty well.

When Frank Borman and his crew came out from behind the Moon for the first time, you could hear them just like they were in the next room. I was elated. It was a beautiful sound. Jim's committee helped us to solve those kinds of problems. As far as I know, the astronauts did not have any trouble with their helmets from the Moon's environment. Those were some of the things that we did. I also received a letter of appreciation from Lt. General Sam Phillips on my contributions to the Apollo 8 mission.[7]

As well as I can remember, I was in the viewing room at the Mission Control Center when [the Apollo 8 crew spoke to the American people]. It was just a great thrill, and it sounded like they were in the next room.

We were always continuing to get ready for the next. We were also having reviews of the subsystems and the writing of the post launch reports on Apollo 8. I guess this is the place to review some of the things that we have already talked about. George Low, who was then the head of the Apollo Spacecraft Program Office, set up what was called the Mission Evaluation Room [MER] in Building 45. It was headed up by the Apollo Spacecraft Program Office. It included the Apollo Spacecraft Program Office's lead engineer and the engineers from the contractors as well as E&D with their 36 subsystem managers and their contractor counterparts. I was the lead engineer from E&D for the subsystem managers and their support. There were about 100 people around the clock. I would head up one shift for eight hours and Phil Deans and Bob Burt would run the other two eight-hour shifts. That was carried out through all of the Apollo flights. When the explosion happened in the Apollo 13 Service Module, we [E&D], within eight hours, told Flight Control what had happened to the spacecraft, and how they could use the LM as a life boat to save the crew and the spacecraft.

[Before the Apollo 11 launch,] I had received the [Silver] Snoopy award from Neil Armstrong which was a big thrill. I hadn't even met the man. Dr. Faget had picked Aleck [C.] Bond and me for the Manned Flight Awareness Award which included a trip to Cape Kennedy for the Apollo 11 launch. I had grown up flying rocket models off of Wallops Island, observing the test of the Little Joe boiler plate rocket model at White Sands, and the Big Joe boiler plate at the Cape. Even I was not ready for the Apollo 11 launch. I saw grown men crying when that baby took off. Of course when it landed on the Moon, I was also very elated. You know how close that they were of running out of fuel. Everyone was elated when Neil Armstrong said, "Houston, Tranquility Base here. The *Eagle* has landed." When Neil Armstrong landed on the Moon my father called me. He was very proud that his son worked on the space program.

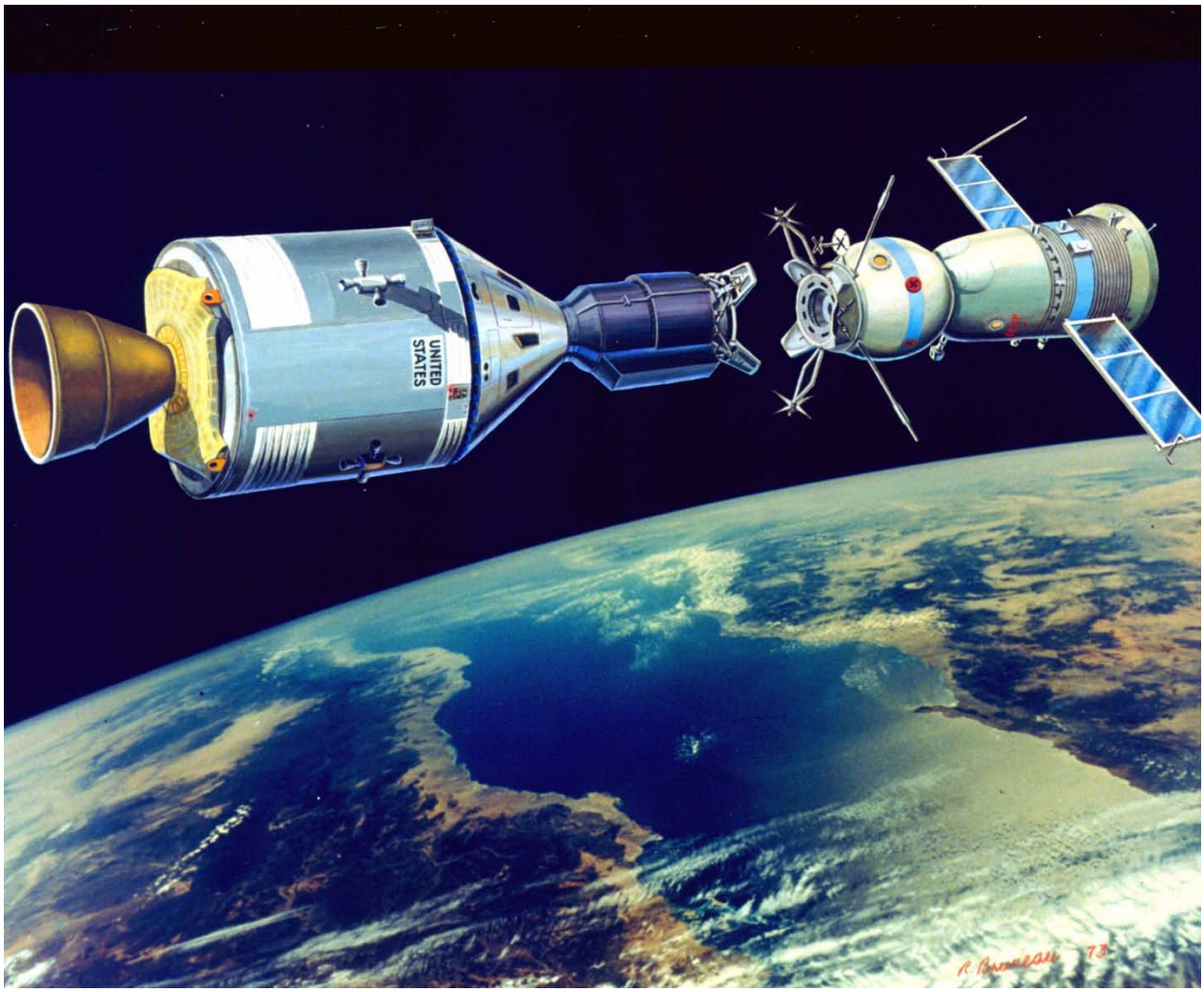
I was at home [when the Apollo 13 accident happened]. I was the president of the Dickinson Country Club. It ended up that all of a sudden I was both secretary and treasurer. The next year I became the president of country club. As president I helped to put the country club back on its feet, but that is another story. I was holding a board of directors meeting in my home, when I got a call from Phil Deans who was on the second shift. He told me that something had happened to the spacecraft but we didn't know yet what it was. I knew immediately that it was probably very serious. When I finished the meeting, I told the board members that I would be out of pocket for a while, which I was.

I thought [the Movie, *Apollo 13*,] was a very good film, but it was not a documentary. It could not cover everything that happened in detail. A good example of that was that a number of things, such as energy conservation, were lumped together under Ken Mattingly. It was pretty accurate on what had happened but not necessarily who had done them.

Dr. Faget asked me to be the deputy manager and lead engineer to design a Space Station while he was designing the Space Shuttle. This was done under Dr. Faget's Advanced Design Group headed up by Rene Berglund. We designed a Space Station using the Saturn booster, but President [Richard M.] Nixon had cancelled the booster, which was a big, big, mistake. Then we had to design it to be put up with the Shuttle. You saw the model of it upstairs, yesterday. That was the concept that we developed back in the early 1970s, and we had to put it on the shelf because we didn't have the money to develop both at the same time. I also went through an iteration on an Earth Operational Space Station under Bob Piland, which was a better design of what I showed you yesterday. That was also cancelled which was also a bad deal.

I was also the lead engineer from E&D under Rene Berglund to develop the Apollo-Soyuz docking concept. The objective of Apollo-Soyuz Test Project [ASTP] was to test the

compatibility of rendezvous and docking of the American and Soviet spacecraft and to open the way to international space rescue as well as future joint man flights. [Artist concept of Apollo-Soyuz Docked]



Glynn [S.] Lunney, who had been a lead flight controller, was made the project manager. The Apollo Command Module and Soyuz docked on July 17th of 1975. Deke Slayton was on that flight.

Here is an interesting antidote. We went over to Huntsville, Alabama, for a staff meeting with von Braun and his people. Coming back, we would have to fly from Huntsville to Atlanta

[Georgia], change planes to go to New Orleans [Louisiana], and then on to Houston. It was not an easy trip and very time consuming so von Braun gave us his Grumman twin engine jet airplane, the Gulfstream, to fly directly to Houston. He was going to send us back on that.

When we took off down the runway, all of a sudden there was a loud explosion. Boom!! Guy Thibodaux had just laid back in his seat, and this projectile came through the door right by his head, hit the ceiling in the aisle over my head, and dropped onto the floor. Stuff came falling down from the ceiling and burned holes in my pants. I jumped up, and I stomped on it one time. I realized that I was stomping on a red-hot piece of metal. Chris [C.] Critzos was there. He was an assistant to Dr. Chris Kraft in Operations. We threw some magazines on top of it, then he got a fire extinguisher and he sprayed it. This was during takeoff. The pilot was able to stop the plane before it ran off the end of the runway.

Chris Critzos wrote up an accident report on it. He talked about a fire in the cabin. I don't remember any fire. This red hot piece of metal dropped right down beside me, and I pulled my right leg over like that and it just missed my leg, but burning flakes came sprinkling down from the ceiling, and burned holes in my pants. That was a close call, but it was something.

[End of interview]

[1] *Vide supra* 5

[2] Joseph Adams Shortal, *A New Dimension – Wallops Island Flight Test Range: The First Fifteen Years* (Washington, DC: NASA, 1978), 300.

[3] No. 69-54: Manned Spacecraft Center Announcement regarding E&D Program Support Office, dated April 30, 1969.

[4] Position Record (# 711130), AST, Technical Management 770-30-S (GS-1301.1-15, dated and signed 3/31/71).

[5] Letter from Director Robert R. Gilruth to John B. Lee regarding MSFC/KSC/Headquarters Review, dated October 16, 1964.

[6] Memorandum from HB/Manager, Space Station Task Group [Berglund] to EA/Director of Engineering and Development [Faget] referencing Comparability Effort for the Space Station Phase B Definition Study, dated August 30, 1970.

[7] Letter from Lt. General Sam C. Phillips to John B. Lee regarding Letter of Appreciation, dated February 3, 1969.