ORAL HISTORY TRANSCRIPT

JERRY C. BOSTICK
INTERVIEWED BY CAROL BUTLER
MARBLE FALLS, TEXAS – 23 FEBRUARY 2000

BUTLER: Today is February 23, 2000. This oral history with Jerry Bostick is being conducted at his home in Marble Falls, Texas, for the Johnson Space Center Oral History Project. Carol Butler is the interviewer.

Thank you very much for allowing me to come up and visit with you today and for participating in the project.

BOSTICK: It's my pleasure.

BUTLER: To begin with, if maybe you could tell us how you became involved with, or actually what your initial interest was in aviation and aerospace and how that led to your involvement with NASA.

BOSTICK: Well, interestingly enough, I didn't have a lot of interest in aviation. In fact, I would say almost none. When I was in college, I majored in civil engineering, with a specialty in structures, although beginning in about 1957 with Sputnik, I did become interested in the manned space program, or in the space program, and then later on with the manned part of it. But being headed on a career path that didn't seem consistent with that, I mean, I wasn't going to be an aeronautical engineer, didn't want to be, or an electrical or a mechanical engineer, so I just assumed that that was something that I would always read about in the papers and would never be a part of.

I have to say I was somewhat envious of some of my classmates in college who started talking about jobs that they were going to at NASA, most of them [at Marshall Space

Flight Center] in Huntsville, Alabama. But I just thought, well, that's good for them, I'm going to go and be a structural engineer. In fact, I had accepted a job with Boeing [Airplane Company] in Seattle, in their weights and measurements department. I guess I was going to weigh airplanes and compute [centers of] gravity or something, I'm not exactly sure.

I was walking across campus one day with a friend of mine and he asked if I would go by the placement office with him. So I walked into the office, and the placement director happened to be there, and he said, "Oh, Bostick," he said, "I really need your help. I know you have accepted a job already, but I've been trying to get NASA Langley Research Center [Hampton, Virginia] to come here and interview for years, and they're finally coming, and now I don't have anybody to talk to him. So would you please go in and talk to this guy? He's coming next Tuesday or whatever, just act interested and please don't tell him you've already accepted a job. But I need some good interviewees."

Unfortunately, I don't remember the person's name, but he interviewed me and convinced me that I should go to work at NASA. So I got out of my job that I'd agreed to take with Boeing in Seattle, and in January of '62 I headed out for the Langley Research Center.

BUTLER: It seemed to work out pretty well then, right?

BOSTICK: Well, yes and no. I was in the structures division at Langley, and specifically in erectable structures. The branch that I was in was working on all kinds of equipment that you could package into small volumes and then deploy once you get into space, things like antennas. In fact, my specific assignment was to develop a space antenna that you could package in a small volume in a launch vehicle and then deploy it once you got into space. I thought this was really exciting, at least for the first couple of weeks.

Then I started asking my section head about what the program was and what was going to happen. As I developed the thing, what do I do, and questions like that, I didn't get a lot of real satisfactory answers out of him, and so then I ended up talking to the division chief. He said, "Well, you'll write all of this in a NASA tech note and it'll go into all the libraries at all of the NASA centers," and he said like there were thousands of them or something. "People will read it and they will then call you up and say, 'Hey, we need one of these,' and you'll probably continue to work in the actual development of that. But right now, for at least a year you'll just be doing research."

I said, "Well, what if nobody calls?"

He said, "Well, then we'll assign you another project."

This was all within the first month I was there, and I guess I realized that I really wasn't cut out for research, I had much rather work on known problems to try find solutions, other than pure research.

One of my co-workers in the division at that time was a guy by the name of Ed Martin, and I noticed that about two or three times a week for a couple of weeks in a row, he would disappear for an hour. That wasn't like him to do that, so finally one day I asked him, "What's going on here?"

He said, "Be quiet," and he called me out into the lab. He said, "I'm going over to the Space Task Group side of Langley Field. I've been interviewing for a job up there, over there, and it's going to be renamed the Manned Spacecraft Center and they're going to move to Houston, Texas."

I said, "These are the manned spaceflight guys?"

He said, "Yes."

I said, "Well, sign me up for an interview." [Laughter]

And he did, and I went over and talked to a gentleman by the name of Chris [C.] Critzos. Chris was a very nice gentleman, but he said, "Unfortunately, I don't think that we need anybody with a civil engineering degree. We're looking for electrical, mechanical, aeronautical types, and we just don't need any civil engineers."

So I was actually leaving the office, and Chris [Christopher C.] Kraft [Jr.] walked in and Critzos introduced me to Kraft and he said, "This young man works over at Langley and he wants to go to Houston with us, but I told him we aren't looking for any civil engineers."

So Kraft looked at me and he said, "You're a civil engineer?"

"Yes."

"What do you do?" I told him. He said, "Why do you want to join us and go to Houston?"

I said, "Well, I really would prefer to work on real problems, finding solutions to real problems rather than just doing pure research. Unfortunately, it's taken me a couple of months to figure that out, and I just would much prefer to work on the manned space program."

So he turned about to Critzos and he says, "Hell, hire him. We might need somebody to survey the Moon."

BUTLER: That's great.

BOSTICK: So they hired me and assigned me to John [P.] Mayer, who was head of mission planning and analysis at the time. So in April of '62, after just working at Langley for a couple of months, I was on my way to Houston.

John [H.] Glenn's [Jr.] flight had occurred at the time that I was at Langley, but as soon as I got to Houston, then they put me to work in mission planning on [M.] Scott Carpenter's flight, MA-7. In fact, on Glenn's flight there was some question about what the exact weight of the spacecraft was [at retrofire and] that might have caused it to miss the landing point a little bit. So specifically on Carpenter's flight, I generated a lot of plots, graphs, showing the variation in landing point for a given retrofire time, depending on spacecraft weight and also depending on the attitude of the spacecraft at the time of retrofire. I thought that was really exciting work. In fact, all of that data went into the MA-7 mission planning document and even a couple of the charts went into the flight data file that Carpenter took with him on board the flight.

But unfortunately, when I was in college I was in ROTC [Reserve Officers Training Corps], and when you graduate after being in ROTC, you have to sign a commitment to go into the service. I was in Army ROTC, so I had to go into the Army then, in May of '62, just before Carpenter's flight. I went out to Fort Bliss in El Paso, Texas, for nine weeks of officers' school, and had to listen to Carpenter's flight on the radio and read about it in the papers. When I heard that he had landed about 250 miles long because he wasn't in attitude [at] retrofire, I thought, jeez, didn't he look at my curves? [Laughter]

My ROTC commitment was for two years, but Chris Kraft somehow arranged for after my nine weeks of officers' school at Fort Bliss, he arranged for me to be assigned back to the Manned Spacecraft Center in Houston. So in mid June, I guess it was, of that year, I was back at Houston and again working on Mercury flights.

BUTLER: Well, it was certainly something that was important to the country as a whole, so I guess the Army saw the good of that.

BOSTICK: Well, we weren't at war at the time, and I guess they figured they didn't need me that bad. [Laughter] I'm not sure exactly how he did that, but anyway, I think there was something like twenty-two people there in officers' school class, and as I recall, they all went to wonderful places like Okinawa or Germany or something, and I got assigned to Houston, Texas. So they were a little bit envious of me there, you know. [Laughter]

But when I got back to Houston then I started working on the MA-8, Wally [Walter M.] Schirra's [Jr.] flight. Did the launch abort analysis. I hand-drew the plot board that they used in the control center at the Cape [Cape Canaveral, Florida] at the time for the launch phase that has all the limit lines, the nominal trajectory and the limit lines for the various aborts, established the different abort modes.

So then I got to go down to the Cape for his flight with Carl Huss, who was my boss in MPAD [Mission Planning and Analysis Division] and was the chief retrofire officer. So I obviously worked very closely with him, and he used a lot of the data, and the launch abort stuff was used by the Flight Dynamics Officer [FDO], who at the time was Glynn [S.] Lunney. So I got to go down to the Cape and support them there in the simulations and in real time. That was a pretty exciting thing. It's one thing to see the flights on television, but to be in the control center at the Cape where the building would shake when the Atlas launch vehicle went off, it was pretty exciting.

BUTLER: Oh, I can imagine. It must have been good now, since you said you'd worked on Carpenter's flight but then weren't able to follow it other than on the radio and such, must have been nice to be able to see everything you'd worked on being then put into place.

BOSTICK: Yes, it really was. I had to pinch myself a lot with that. I hadn't even been out of school for a year and here I am in the most wonderful job in the whole world. How could it get any better than this?

But I continued to work in MPAD and worked on Gordon [L.] Cooper's [Jr.] flight, MA-9, which turned out to be the last. We did a lot of planning for a proposed MA-10 flight, but that didn't happen. In the meantime, we, of course, started working on Gemini. I continued in mission planning, doing more or less the same thing that I had been doing for the Mercury flights on Gemini.

But not too long after the last Mercury flight, MA-9, Carl Huss, my boss, had a heart attack, and so they asked me if I wanted to work in the control center as a retrofire officer, and of course I said yes very quickly.

John [S.] Llewellyn, who had been the number-two retrofire officer after Carl moved up to the prime position and then I was the number-two Retro. Did that for the first three Gemini flights, and then after Gemini III, Glynn Lunney and Cliff [Clifford E.] Charlesworth, who had then come on board as number-two flight dynamics officer [behind] Glynn, came to me one day and said, "We think that you need to move over from Retro to flight dynamics officer." That sounded pretty good to me, because the flight dynamics officer was the lead trajectory guy in the trench, and he was really over the retrofire officer and the guidance officer, which was a new position for Gemini. So, to me, that was a promotion going from Retro to FDO, and I wanted to do it.

So I went to talk to John Mayer, who was my division chief, and he advised against it. I talked to Lyn [Lynwood] Dunseith, who was another branch chief at the time within mission planning and analysis, and he also advised against it.

BUTLER: Really?

BOSTICK: Well, they both kind of told me the same thing. "Hey, this is where all of the good work is. We're doing all the work and the flight controllers are just the people who sit at the consoles and do what we tell them to do. Without us, they wouldn't be anything, so we think you need to stay here." But after thinking about it for a couple days, I decided I really wanted to do it, so I went back to Mayer and told him and he said, "Well, I'm really disappointed and I'm going to refuse to sign your transfer." [Laughter]

So it went up to Chris Kraft then, because he was director of flight operations and over both—well, a part of the deal, if I was going to be a flight dynamics officer, was I had to transfer to the flight control division. Of course, that's the main reason John Mayer was against that, because I guess he was going to lose me and I was going to go to the flight control division. Because Lunney, rightfully so, felt that to be a flight dynamics officer was a full-time job and I wouldn't be able to continue what I was doing in mission planning. So it did involve the transfer of divisions.

So anyway, it went to Kraft, and he called me on the telephone one day and he said, "Young man, I understand you want to transfer to the flight control division and move over to flight dynamics officer."

I said, "Yes, sir, I do."

He said, "Why do you want to do that?"

I said, "Well, I really love working in the control center, and I think that's what I want to do."

He said, "So be it," and he hung up. [Laughter] That's the last I heard of that.

BUTLER: Nice and straight and to the point.

BOSTICK: Yes. That's the way Chris usually is about things like that, all things, I guess.

BUTLER: I guess he'd seen enough of your work up until then to know that if it was something that you wanted to do, then you were going to be able to be good at it and do it.

BOSTICK: Well, I would like to think that. It was a good move, in retrospect. It was a good move.

About that time we were bringing the control center in Houston along also. It had been under construction for at least a couple of years, I guess. After a lot of testing, it was decided that we would use it for the first time on the Gemini IV flight, but because of the little bit of remaining uncertainty, it was decided that we would activate the control center at the Cape also, and have a skeleton crew down there for the launch phase, which was the most critical. So Glynn Lunney went down as flight director and I went down as a combination retrofire officer, flight dynamics officer, and guidance officer.

BUTLER: Oh, my.

BOSTICK: Literally had a chair with wheels on it that would slide back and forth between the three consoles. Arnie [Arnold D.] Aldrich did a similar thing for the systems. He was a combined guidance, navigation and control officer [GNC] and the EECOM, the electrical, environmental [and communications officer]. So he also covered two or three consoles. Al [Alan B.] Shepard [Jr.] was the capcom [capsule communicator]. So we went down for a couple of weeks of simulations and then for the real launch.

As luck would have it, John [D.] Hodge was the flight director back in Houston and Cliff Charlesworth was the flight dynamics officer. They actually lost power in the control center, went down for a few seconds, and we kept saying, "Switch over. Switch over. We've got it." They wouldn't do it. [Laughter]

BUTLER: They were determined.

BOSTICK: Yes, but it worked out all right.

BUTLER: You've mentioned a couple times now the simulations and that you were a little bit involved with that in Mercury and then again here in Gemini. If maybe you could talk about some of what that involved and how that changed from the two different programs.

BOSTICK: Well, the simulations really served a number of purposes. The two main ones were to train people who were going to work on the flight, but also to test out our mission rules. Before each flight—and this is a concept that people take for granted, but if you think about it, it's a pretty darn good concept and it kind of applies to a lot of things besides manned spaceflight. I give most of the credit for developing that concept to Chris Kraft. Walt [Walter C.] Williams was also involved, but I give most of it to Chris.

It's a simple concept. Before we'd go into a flight, in your area of responsibility, [whether it be]…systems, trajectory, medicine, whatever, you'd sit down and you'd think, okay, what could go wrong. You'd write them all down. This could go wrong and it could go wrong here, here, and here. Then you write down your action to correct the failure or what's going on. So it's a concept of preconceived solutions to potential things that can come up in the flight. You do that on paper. We called them mission rules. You write down everything that can happen and then what you're going to do about it. So the simulation served to test that to see if you do have the right solutions. We would refine the rules as we went through the simulations.

The main difference in the sims [simulations] between Mercury and Gemini had to do with the control center. The control center at the Cape, the computers that drove all of the displays there, the tracking displays, the telemetry that came in from the remote sites from the spacecraft, were driven by computers that were in Greenbelt, Maryland, at the Goddard Space Flight Center [GSFC]. They had very limited capability. Then when we got into the control center in Houston, beginning with Gemini IV, we had our own bank of computers down on the first floor in the control center, and we had a lot more capability.

The sim guys, to start with, had a lot more capability to enter faults into the system and they looked a lot more real. In the Mercury control center, some of the faults that the sim people had to show us, they were a little hokey. I mean, they would even unplug consoles sometimes. You'd see a guy crawling across the floor, you know, and unplug it. [Laughter]

Beginning with Gemini, the simulation supervisors who conducted the sims had a lot more capability, and the problems or the faults that they gave us in the sims were a lot more realistic. Of course, they delighted in giving us four or five problems at once and things like that. We kept saying, "Come on, guys, this is a little unrealistic," but it was good training, very good training, and training from the standpoint of seeing how the controllers would react, but also to test out the solutions that we had derived in the mission rules process.

BUTLER: Would you often, or maybe not often, but were there instances where you'd established certain mission rules and then in the training realize that something needed to be changed in that?

BOSTICK: Quite frequently. In fact, after each simulation, we would debrief the sim and we would discuss, "Okay, I applied mission rule 7-62 and it says if this happens, you do that," and we would say, "Well, but that didn't really solve the problem," or, "You did it too quick," or something. So we would change the rules. That was a common occurrence. It wasn't a wholesale change, but that frequently happened, and we expected to do that. In fact, the debriefings sometimes could get very bloody. I mean, you know, "Why didn't you catch that?" or, "Well, you know, it wasn't my responsibility," or, "Why didn't you take action quicker?" Or the sim guys would say, "Well, I gave you this failure and you didn't even see it." So, you know, sometimes. I don't recall anybody getting mad at anybody or anything. It was good training, it really was. It was not an easy thing to do. I never dreaded going into sims. I always thought it was a good exercise, and felt much better after having gone through a couple of days of sims at least.

BUTLER: Certainly rather have all those problems or misses come up in a simulation than in a real mission.

BOSTICK: Yes, and it was in some respects rewarding, because if you did the right thing, you felt good about it. Or if you did the wrong thing, you'd say, "Well, at least I learned something. I did what I thought was the right thing, but it turned out maybe we need to look at that a little bit more." So the simulations were very valuable.

In fact, I've always thought that the simulation people were kind of unsung heroes in the manned spaceflight program, because they didn't get any credit for anything. They weren't in the limelight. Once the mission started, they kind of went away and started working on the next mission. But they knew their jobs, they knew the jobs of the people in the control center as well as the people who sat at the consoles, and they had to.

BUTLER: I bet they knew the spacecraft pretty well, too.

BOSTICK: Oh, yes. Oh, yes, obviously they had to know the spacecraft. We occasionally had what we called the integrated sims, which included the flight crew. Those were especially beneficial. Usually we would start out with what we called standalone sims with just the flight controllers. We'd go through the exercises. Then, of course, the flight crew was doing the same thing in their simulators. But then we would do integrated sims where we would both come together. Those were especially rewarding. It showed that we could work together as a team and that we agreed with their actions and they agreed with ours. In addition to training the people and exercising the mission rules, it was a team-building exercise.

BUTLER: Very important, especially in this business.

BOSTICK: Very important. Very important. In fact, in later years I've—you know, it seems like every two or three years there's a new management trend in total quality or teamwork, or all these courses that people [started coming up with]. I've been to a number of those, and after a while I thought, "Hey, this is what we used to do back in the sixties at the Manned Spacecraft Center. We just didn't call it this." [Laughter]

BUTLER: Just didn't have a fancy name.

BOSTICK: Yes. We were doing teamwork. We did all of this.

BUTLER: Certainly did.

BOSTICK: Somebody's making a fortune off of putting it in books and selling it to other people.

BUTLER: People buy a lot of different things nowadays.

Talking about the team-building and the teamwork, you had the flight control team and you had the support people that were in the back rooms, and you had the flight crews, and then you had the engineers working on the spacecraft and the managers. How were relations among everyone? Any reflections on that?

BOSTICK: The best I have ever seen, and it is teamwork. That's why I give so much credit to people like Bob [Robert R.] Gilruth and Chris Kraft, who made you feel—like when I was a GS-7, the low man on the totem pole, and here's Bob Gilruth, as a director of the center, he made you feel like your job was just as important as his. In fact, he would almost say that much as, "Hey, you know your job, I don't. You go do yours. Unfortunately, I have to sit up here and worry with all this budget and administrative stuff, and I'll try to take care of that, but you do yours." And that attitude was prevalent throughout the center.

Chris Kraft, for example, is the ideal boss that anybody's ever had. He did more to encourage people who worked for him than anybody I have ever seen. For example, if the center director, whoever, had a question about a given flight, then Chris would find the person who knew the most about that and have them go and answer the question, make a presentation or whatever. I found out later, that's not the way a lot of people operate. A lot of bosses, in fact there were even—well, as I'm sure you know, a lot of bosses want to give all of the presentations themselves. That's how naive I was.

I had worked at JSC, the Manned Spacecraft Center, Johnson Space Center, for probably a decade before I realized that everybody didn't operate like that. It was a real team atmosphere. It was that way with the managers, it was that way with the flight crew. I mean, they would tell you in a minute. Boy, I mean, I've had a number of astronauts tell me, "Boy, I respect you guys for what you do in the control center, your job. I wish I understood all that. I wish I could do it. I feel kind of bad because here we are getting all of the credit and you guys do all of the work." It was just real teamwork.

Within the flight control team, we had some real friendly competition, especially between the trajectory guys and the systems guys. Later on in Apollo, especially between the command and service module guys and the LM [lunar (excursion) module] guys and stuff.

But if somebody got into trouble during a flight or during a simulation or whatever, everybody in the room did everything they could to help out. The competition was ended at that point.

BUTLER: People recognized the need to have a good camaraderie, a good atmosphere, but also the need when it was time to be serious, it sounds like.

BOSTICK: Yes, and more so than I have seen in most jobs that I've had since then. In the control center, people didn't really try to do other people's jobs. I mean, we knew what our boundaries were. We knew we were responsible, that nobody else was, and so we didn't try to blame other people for our problems, or we didn't try to overstep our bounds and go help them when they didn't ask us or something like that. Jobs were well defined and people executed their responsibilities within those bounds. It was a good team. A lot of pleasant memories, looking back on it.

BUTLER: That's wonderful.

BOSTICK: You bet.

BUTLER: It really is.

BOSTICK: In fact, I have discovered in my later years that I measure my life by pre-1969 and post-1969.

BUTLER: That's interesting.

BOSTICK: If somebody says, well, in 1975 I did this, or something happened, or I read something, the first thing that comes to my mind, for some reason, is, well, that was before we first landed on the Moon, or it was after that. So I've kind of divided up my life into what happened before 1969 and what happened after 1969. I don't mean it was bad after '69. A lot of good things, a lot of good things happened after 1969. But it was such a pivotal milestone in my life, that that's usually the first thing I think about when a date comes up.

BUTLER: That's certainly a very critical milestone for the whole world it changed.

BOSTICK: I'd like to think so. I mean, it's really kind of sad to think here we are, what, thirty-one years now after we first did that in 1969, and what, twenty-eight years since the last time we did it. That's unbelievable. In fact, people frequently ask, when they find out I worked on the manned space program, "Well, how did you guys do that in such a short time period?" And I don't have a real good answer for that.

John [W.] Aaron, a friend of mine who was EECOM flight controller, and one of the best there ever was in the control center, said one time there was just an unusual way that the dominoes lined up at the time, I guess, or something like that. He said it much better than that. He's much more eloquent than that. But it was an unusual set of dominoes that lined up at the time.

We obviously had a challenge from the President [John F. Kennedy], and that was important. I mean, if you live in the United States, who's more important than the President? Especially back in those days. You think, hey, the President has established this challenge, the country, by and large, is behind it, it's the most exciting thing that's ever happened, and the money was available. So we just went and did it. And I'm not sure you could do anything like that again in that short a time period.

BUTLER: Certainly takes all of the right pieces coming together, everything from the President and Congress, down to having the right people in the right places.

BOSTICK: The right people. You know, again, if there hadn't been people like Bob Gilruth and Chris Kraft, Sig [Sigurd A.] Sjoberg, and a whole bunch of others, it wouldn't have happened.

BUTLER: They certainly made a lot that didn't initially seem possible become possible.

BOSTICK: Yes.

BUTLER: You started with minimum technology and so many things had to be created along the way.

BOSTICK: Yes. I guess we didn't understand that it wasn't possible. There were no textbooks. There were even no degrees then in aerospace engineering, especially not space studies. But I don't know, [it was] sometime at least in the mid-sixties or later before any colleges I ever heard of starting offering degrees in aerospace and there were textbooks. What we had to learn from in the trajectory area about orbital mechanics were a few NASA technical notes that people had written. Even the physics books didn't have anything about orbital mechanics. We had what today would have to be the crudest computers that you can imagine, you know, but we thought they were pretty good and we would just keep running trials and errors until we figured it out.

BUTLER: Well, they were certainly good in comparison to what else you had.

BOSTICK: Yes.

BUTLER: Made it all work.

BOSTICK: Beats slide rules, anyway.

BUTLER: You mentioned, we had talked up to about Gemini IV, and getting the control center in Houston, coming on line, and that you were down at the Cape for Gemini IV. Then the Gemini missions began to really get up to speed and really working to accomplish some of the critical goals of rendezvous, docking, space walking. What did you do in between missions, actually, I guess would be my first question, to help prepare for all of this and to help get ready for the missions, besides the training that you talked about earlier? Were there other daily activities?

BOSTICK: Well, at that point in Gemini we were also trying to get ready for Apollo, so we were trying to find out as much as we could at the time about Apollo, about the systems, the launch vehicles, and the spacecraft. But we were flying missions at that time fairly frequently. It wasn't unusual to have a two-month turnaround.

As you know, we had two identical control centers in mission control, one on the second floor and one on the third floor, and it wasn't unusual that we would have the simulations going on on both floors, one for a Gemini mission and one for an Apollo mission, maybe even two different Geminis at the same time. They were coming fairly rapidly. There wasn't a lot of time in between the flights to even stop and reflect about what had happened on the last one, except from a technical standpoint. It was one mission right after another, and there wasn't a lot of time to do anything else, except to work on the things you had to, like mission rules and procedures.

Each mission was a new challenge, because, as you said, we were doing new things and we had to learn how to do new things like rendezvous, which was the most exciting thing in the trajectory area, where I was. Of course, we were scheduled to first try that on Gemini VI, and we lost the Agena, the target vehicle that were going to rendezvous and dock with. So the managers, within a couple of weeks there, came up with the idea that we would launch Gemini VII first, and then VI a few days later, a week to ten days later, as I recall, which is about as quick as you could turn around the pad. In fact, there were people who questioned if that could be done, and that was obviously one of the controlling things. We only had one Titan launch pad at the Cape.

But we did that, we launched VII first, and then a week to ten days later, as I recall, we launched VI and it rendezvoused with VII, which was a great thing. We couldn't dock, because it didn't have anything to dock with. That was really a pretty exciting day when that happened, because even though we've never really talked about it a lot, among the flight controllers we didn't, we knew we were in competition with the Russians. We knew that to get from ground zero to landing on the Moon, there were a lot of things that you have to learn how to do. You have to learn how to get a man into orbit and sustain them there, for one thing, and you have to learn how to do space walks and EVAs [extravehicular activities]. You have to learn how to rendezvous and dock. You have to learn how to navigate and all that.

So we knew in the back of our minds for sure the technical targets that had to be met and we knew that the Russians, unfortunately, had beaten us by a few days or a few weeks on the first two, you know, getting a man into orbit and then on a space walk. So we knew that we were pretty close together. Neck and neck [really]. But then with Gemini VII and VI, when we rendezvoused, that's the first time we had really beaten the Russians at what we thought was a critical, one of the critical milestones that had to be met on the way to landing on the Moon. So we were pretty excited that day.

It's my recollection in talking with Kraft and [Eugene F.] Kranz and others, I think they agree, that that's the first time that we ever waved the American flags in the control center. We considered ourselves very, very professional and tried to hold down any celebrations, you know, in real time, or anything like that, because you shouldn't celebrate until the mission is over. But that's the first time that I recall that we ever made some slight exception to that and showed some enthusiasm in real time and waved flags, because it was a proud day.

Like I say, we didn't really sit around and talk about it, "We've got to beat the Russians," and all that, but we all knew that we were in a race and for once we had beaten them. We kind of waved the flags and said, "We're proud to be Americans and, oh, by the way, take that, you Russians." [Laughter]

BUTLER: [Laughter] Sounds good to me. I don't think anybody would quibble with you on that one.

That certainly took some interesting planning, too, on the part of the mission control, having the two flights up and going at the same time. That wasn't something that had originally been planned for in Gemini, if that's correct.

BOSTICK: That's correct. We had obviously planned to have two vehicles like the Agena, the target vehicle, and the Gemini, but not two live Gemini spacecraft with all the same, or very similar, telemetry streams and the same tracking beacons and stuff. Yes, we had to make some accommodations in the control center. We even had to do some of the stuff off line. We had what we call the auxiliary computer room, the ACR, over in the office wing of Building 30. The mission planning people over there were running some of the stuff on off-line computers and feeding it in to us in the control center. Mostly it's just to check on what we were getting out of the real-time computer complex [RTCC]. But on that mission for a few of the things that we couldn't do simultaneously in the RTCC, we were doing them over there. So, yes, it was a challenge, but that's kind of what made life interesting in those days.

BUTLER: You always have to have challenges to keep it interesting.

BOSTICK: Yes.

BUTLER: Of course, both of those missions were very successful, although one of the times that Gemini VI attempted to launch, they had the shutdown and the near abort situation.

BOSTICK: Yes, that was the second attempt, as I recall. Gemini VII had already been launched and it was Wally Schirra was the commander. It shut down on the pad and he was as calm and cool as you would expect, and he had his hand on the abort handle, but he didn't pull it. Tom [Thomas P.] Stafford, I'm sure, is very glad that he didn't. [Laughter] In fact, I talked to Wally after that, a number of us did, and I think the reason he didn't is he had seen some of the test dummies that they brought back from some of the ejection tests that had been run, and they were missing arms and legs. [Laughter]

The ejection seats were something, that was a entirely new thing on Gemini. We didn't have those in Mercury; we just had the launch escape tower, that was the way to get off the pad for the first minute or so of flight. But on Gemini we had these ejection seats, and everybody was always afraid of the ejection seats, and rightfully so. But Wally was pretty cool that day and he didn't pull the handle, thank goodness. That would have set us back quite a bit.

The amazing thing about that flight, besides the rendezvous, which made us all proud, but we accomplished another big milestone on that flight, is [that] the VII crew went for fourteen days. And if you've ever seen the inside of a Gemini spacecraft, you know it's not very roomy.

BUTLER: No.

BOSTICK: And, you know, to be in the air for fourteen days and not be able to stand up or really move at all with another person is not something that I would look forward to myself. [Laughter] But I mean, we proved that under harsh conditions, much harsher than what they would experience in Apollo, because it would be [more] roomy and without a lot of the conveniences that they would have on Apollo, I assumed were going to be developed, like better food and better toilet provisions and all that kind of stuff, they survived. I'm sure—I never talked to either [Frank] Borman or [James A.] Lovell [Jr.] about that, I guess, but it has to be the most miserable two weeks of their lives.

BUTLER: I can imagine.

BOSTICK: But that was a big thing. I mean, it sounds kind of silly now, but there were still people who questioned could people live as long as ten days in zero G [gravity]. Well, they lived for a couple of weeks, and it wasn't a big problem. They were a little awkward when they got back to land, but within a day or so they seemed to be, physically they seemed to be back to normal.

BUTLER: I'm sure mentally they were just ready to have a little bit of space for a while. [Laughter]

BOSTICK: I would think so. I should ask Jim Lovell that. I never have.

BUTLER: Certainly very unique experience for them, but did, as you say, pave the way for the future flights. Critical step.

Now, had you worked, going back a step, had you worked on Gemini V also?

BOSTICK: Yes. The Gemini V, as I recall, was the first time that I was the prime flight dynamics officer. That means I did the launch phase. So that was a good mission. I enjoyed doing that. As I recall, V was the one where they were to deploy a balloon and track it. That was going to give us some rendezvous experience and that didn't work at all, and that was kind of a nightmare. I guess they had some fuel cell problems on V.

BUTLER: Yes.

BOSTICK: My recollection of that, I was concerned about the balloon, because that was a trajectory thing and we hoped to get some good tracking data. I recall the systems guys agonizing over the fuel cells, and my only thought there was, well, that's a development item, and we have to have those to get to the Moon, so I hope these things work. [Laughter] But that was their problem, and if I couldn't help, then we left them alone.

So I wasn't directly involved in the fuel cell problem, only from the standpoint of thinking, well, if that means we have to cut the mission short, then there's certain things we have to do trajectory-wise to get ready for that. You're ready for that all the time, but if you hear in your headset, if you begin to pick up problems going on, your first thought is, "Hmm, okay, well, maybe I ought to sit up a little straighter in the chair here now, because if there's some problems going on, we might have to do some of this stuff that we've been planning for."

But V was a good mission. We learned a lot. You never have a mission that's perfect. I don't recall any that were. [Laughter] But if you learn from the problems that you have, that's part of the process.

BUTLER: Absolutely.

BOSTICK: In reality, we had a lot fewer problems in Mercury and Gemini than probably most people had anticipated. We were trying out a lot of new systems. Fuel cells, for example, nobody had ever—we didn't know what fuel cells were. Magic things, you mix hydrogen and oxygen together and it makes electricity and gives you drinking water. I mean, you know, that's pretty magical stuff. [Laughter]

BUTLER: That is, even in today's world. [Laughter]

BOSTICK: Yes. You know, these were pretty crude devices back in those days compared to what we have now. They worked, and we learned a lot.

BUTLER: Always a goal, learning. Well, we've talked about Gemini VI and VII, of course, next came Gemini VIII, which, unfortunately, had quite a few—not quite a few, but had a major problem with the thruster getting stuck in [Neil A.] Armstrong's flight.

BOSTICK: Oh, yes, I was again the prime flight dynamics officer, so I did the launch phase and then the rendezvous and docking, and probably felt as well as I'd ever felt in my life at the end of that. I mean, you know, really proud. I mean, we've pulled off a fairly significant operation here.

I remember—it's a memory etched in my mind, it was shift change time and the new shift was coming in, and I was just sitting there so happy thinking about I just want to go home and celebrate. Then we heard Neil and Dave [David R. Scott] at the next pass [talking about] "we're spinning out of control," and I mean, it was like, oh, my God, what's happened? This perfect day has now turned into the most horrible thing you can imagine.

John Hodge, as I recall, was the flight director that was on my shift, on the prime shift that had gone through launch phase and the rendezvous and docking. Anyway, he decided that due to the criticality of what was going on, that he wanted to keep his team there and stay on the console, and the new team that was coming in could help, but it wasn't the time to do the shift changeover. So we ended up staying and flying the full mission.

Of course, in a normal mission, we'd [have] for every revolution of the Earth, we'd have at least one contingency landing area planned, and we started looking at the possibilities of coming in. This was not in the best place in the world; it was up in the northwestern Pacific, as I recall. As I said, we didn't have any recovery forces or anything out there, but it was due to our knowledge on the ground [of] what was going on up in the air at the time, [that] we needed to get them home quickly. They had used up a lot of the attitude control system gas on the spacecraft, trying to control their spinning. The ground rules, the mission rules, said that once you get down to a certain level, then you come home, because you start running out of any backup for using the attitude control gas in the reentry. So we brought them in quickly, a bad place, and the recovery, I guess, was another whole story, but we got them back safe and sound, anyway.

That was kind of the first time when I had been on the console where we had really had a real contingency situation where we ended up having to act on it and abort a mission. We weren't real happy about that. We were very unhappy about having to have done it, but at the same time we were pleased that the mission had ended successfully and the crew was healthy. That's the main thing.

BUTLER: Absolutely.

BOSTICK: So that was a pretty exciting mission, too.

BUTLER: Certainly a lot that could be learned off of that one. Luckily, I guess, all the experience and training both of the flight controllers and of the flight crew was able to pay off to make that able to come together.

BOSTICK: Yes, it was a good test of what we had trained for, and once the decision was made, and it was made by the book and by the rules, and once it was made, it was just, "Let's go do it." The system worked, and as you said, it did point out the benefit of the training that we'd had and all the simulations that we had run. So we tried to look on the positive side of all of that. [Laughter]

BUTLER: Always a good thing to do.

BOSTICK: Time to go work on the next flight.

BUTLER: That's right, work on the next one and make sure that what happened before doesn't happen again.

BOSTICK: Yes.

BUTLER: Well, the next one was Gemini IX. Were you involved with that mission?

BOSTICK: Yes. I was on some shift in the control center, either as a Retro [or as a FDO]—I guess for all of the Gemini and Apollo missions and as we discussed in Mercury, in a back room staff support room thing. But I don't remember—I didn't do the launch phase and the rendezvous on [Gemini] IX. That's when we had what became known as the "angry alligator," I guess. We lost a target vehicle called the ATDA, augmented target docking adapter, I think, or apparatus. Adapter, I guess it was. ATDA, anyway. We launched it a couple days ahead of the IX mission, and it had a shroud, a two-piece nose cone over the docking mechanism, and it failed to release completely, so once again we weren't able to actually dock. But we did do a very successful rendezvous.

Because I'm a trajectory guy, I always thought that the rendezvous is the complicated part. If you get them up there within twenty feet, if they can't dock, that's like navigating somebody across the whole United States. If you get them within a block and they can't find a parking space, that's their problem. [Laughter]

BUTLER: Sounds reasonable.

BOSTICK: So I mean, I don't mean to belittle the importance of docking and the development of the hardware that had to go into that, but that wasn't my area anyway. I thought, well, at least we did the rendezvous part, we'll get this docking [thing] figured out here one of these days. We just kept having a problem with the target vehicle.

BUTLER: Well, a lot of these later Gemini missions, like IX, X, XI, and XII, were testing various different rendezvous methods. Can you talk about some of those and how they were important for Apollo especially? Some of them were they would go up and dock within one orbit basically, and others where they'd have different approaches. Were you involved much in that?

BOSTICK: Yes, because we had to obviously understand all of that and have the capability built into the computers in the control center to compute all the maneuvers. Rendezvous in space is a very interesting procedure, and there are some unsung heroes in that world of people who developed those procedures, like [Howard W.] Bill Tindall [Jr.] and Ed [Edgar C.] Lineberry, both of whom, unfortunately, are not with us anymore.

But they spent years and years, along with a lot of other people, but they were two of the leads who worked out some of the mechanics, orbital mechanics, of how you can rendezvous two objects in space. But in the early Gemini days, we had to tailor that sequence, and this is where people like me in flight control got involved with the mission planners to tailor the sequence, because we had to tailor it to the ground network. We had to have certain maneuvers occur near our over-ground stations so that we could know if they were successful and then track them after that and compute the next maneuver, etc, etc.

So when we started out, there were quite a few constraints imposed by the limitation of the ground system at the time, and the on-board systems, because you could only do certain magnitude maneuvers. For example, plane changes which dictated how close you had to launch the chase vehicle to [get] within the orbit of the target vehicle that you were going for.

But as we got more capability ground-coverage-wise and maneuver-wise and more experience in doing, we tended to simplify the process. On one mission, which I can't even recall which one now, we did a rendezvous within the first orbit, which was a pretty amazing feat. That put some real constraints on the launch [window]. It means you have to launch within a few seconds of the intended time, whereas if you're in an extreme case, or the longest case we used, we would take up to four orbits to accomplish the rendezvous and that gave you a lot more latitude concerning the launch window of the second vehicle that you launched to chase the target, because you could either slow it down or speed it up to make up time.

Rendezvous in space is basically a phasing and altitude problem. You just have to get the two vehicles at the same altitude at the right time and going at the same velocity. So it's like driving down the freeway at 85 miles an hour beside another car. You have rendezvoused with that vehicle, and relative to it, your speed is almost zero, just coasting along beside it.

But I found rendezvous to be a real interesting subject. Obviously we had to do it in order to accomplish the lunar landing. Unfortunately, as I mentioned, when we started out in Gemini, we had more constraints then than we knew we were going to have later on, but we had time to learn and overcome those constraints, and it all worked out.

BUTLER: It did work out very well.

BOSTICK: [Edwin E.] "Buzz" Aldrin [Jr.] was an interesting rendezvous guy. He like majored in rendezvous in college or something. [Laughter] We called him Dr. Rendezvous. So I would always get into discussions with Buzz about rendezvous, and I thought I understood it as well as he or anybody else. I think I did. I still think I did, except that Buzz would always say, "Well, now I'm coming up on terminal phase and the sun is coming over my right shoulder." I'm standing there thinking, "How does he know where the sun is now?" Because that's an aspect that I wasn't worried a lot about. It was one of the constraints, obviously, because you wanted good lighting for the chase crew to be able to see the target vehicle, but it always bugged me that Buzz knew where the sun was. Usually I would run back to the office after talking with him and I would run that case on the computer, and, lo and behold, he was always right, the sun was coming over his right shoulder just when he said it was. Dad gum, Buzz, you do know some things. [Laughter]

BUTLER: [Laughter] That's pretty good. Well, I guess that's how he majored in it in college, by knowing his stuff. [Laughter]

BOSTICK: Yes.

BUTLER: It came in handy for him on XII. He did some of the manual calculations, if I recall correctly.

BOSTICK: Well, he was always doing his own backup stuff, but the ground was prime. Our numbers were—we had the final say-so. They had a—it's almost a crime to call it a computer on Gemini; it was a very sophisticated calculator, I guess the way it was. It was the first computer we'd ever used in space. It could do some rendezvous calculations. Buzz had developed his own charts and stuff, and he was computing his own stuff and it came out pretty close. It was interesting. You need some capability like that on board, obviously, in case something happens to the ground. But we were prime and our answers were right. We never let Buzz forget it. [Laughter] But he had fun doing his own stuff.

BUTLER: Well, that's good. Somewhere during Gemini, I assume, is when—and this is kind of going back and talking about the teamwork and the camaraderie of the center—is when the "trench" name evolved and the special relationship between those members of the control center. Can you reflect on that a little bit and how that came about?

BOSTICK: Yes. In the control center at the Cape for Mercury, the retrofire officer and the flight dynamics officer had mechanical plot boards that they displayed the trajectory data on. For that reason they were off to the side of the control center, so as not to obstruct, so the plot boards wouldn't obstruct the view of the rest of the controllers of the world map up front.

Then in Gemini, we added the position of the guidance officer who in Gemini his primary responsibility was the Titan launch vehicle guidance system. So he, likewise, had mechanical plot boards, big, huge, humongous XY plotters with ink pens that drew on graph paper. They looked like something came over with Noah on the ark now, but that's what we used in those days. So it was kind of a little "trench" off to the side of the control center, on the right-hand side, that actually they faced 90 degrees to the right of everybody else in the control center.

Okay. Then we moved to Houston. Well, let me back up. The Retro, the FDO, and the guidance officer were a team. They all were concerned with trajectory and guidance stuff. The retrofire officer primarily worried about how to get the spacecraft back. The FDO was responsible for all of the tracking data that came in, the different sources, orbit determination, calculation of any maneuvers to get where we wanted to go, except for the retrofire maneuver. FDO worried about how to get there, the Retro worried about how to get back, and then the guidance officer was kind of the navigator of the deal. He monitored the guidance systems on board the spacecraft, the launch vehicle during the launch phase, spacecraft once it got into orbit. So we were all three concerned with the trajectory and guidance. We were all in the same branch together administratively and we worked as a team.

So now we get to Houston, a new control center. These plot boards are to be replaced with the big screens in the front of the control center with computer-driven plot boards. It turns out that a few of us, Cliff Charlesworth primarily, who was a FDO at the time, were really kind of reluctant to give up these old mechanical plot boards. So for Gemini IV and V in the new control center in Houston, we still had the old mechanical plot boards sitting out in the middle of the floor, and we finally had to give up the dinosaurs and use the projection plotters, and it worked out fine.

But again, these three positions were on the front row in the control center in Houston and down in what could be conceived as a trench. John Llewellyn, who was a retrofire officer at the time, was an ex-Marine also, in fact, has an extremely interesting history in the Korean War. He was one of very few survivors in a major battle. So he was always and ever the Marine, you know. Somebody said to him one day in a simulation, something about, "Why don't you get your act together, Llewellyn?" He said something like, "Well, you ought to get down here in the trenches with the rest of us and then you'd know what's going on." [Laughter]

So that's my recollection of how it became known as the trench. It was the front row in the control center, and if you've been there, it does look somewhat like a trench, and then Llewellyn called it that one day and that was it.

Then, I don't remember, *Newsweek* or *Time* magazine also did an article in the mid sixties about the flight controllers, primarily about Kraft, who was still the flight director at the time. But somewhere in the article it said, "And then there's the retrofire officer, the flight dynamics officer, and the guidance officer who represent the trench, the first line of defense in manned spaceflight." [Laughter] So there was a lot of pride about being a member of the trench.

BUTLER: Obviously for good reason.

BOSTICK: Obviously for good reason, yes. Right. We talked earlier about competition and teamwork and all of that. There was a lot of friendly competition and we would always tell the systems guys, "Don't forget, you're here, your systems are here to support our functions. Okay, now, it's our responsibility to fly this mission, so you just keep your systems working and stay out of the way, and we'll fly." [Laughter] Of course, they didn't quite see it that way.

BUTLER: Well, that's all right, friendly competition always brings out the best.

BOSTICK: Right. We always thought, and I think if you talk with John Hodge or Gene Kranz or any of the flight directors, except Lunney, because he grew up in the trench himself, most flight directors didn't really understand what we did in the trench. I mean, they knew what our function was, but they were not orbital mechanics. I mean, they understood a fuel cell. They could look at schematics and they could go look at the real box, and they could take it apart and look at it and kick and all that. Well, in the trajectory world, it's all software. We're getting in tracking data and computing maneuvers and doing all this stuff. So to most flight directors, what we did in the trench was some kind of a black art. [Laughter] Some people, I never did that, but some people in the trench would kind of pull the flight directors' legs occasionally or try to snow them occasionally. [Laughter] But you [couldn't] do that with Kraft or Lunney or Charlesworth, because they understood what [we] did. In fact, they could have come down and done it. Well, Lunney and Charlesworth did, but Chris could have done it, too. He understood that.

In fact, I think on the first attempt of Gemini VI, as I recall, but before some rendezvous mission, and Chris was still a flight director then, just before launch, not too far before launch, I remember he came down at the console and sat down beside me and started asking me these detailed questions about rendezvous. And I was thoroughly impressed that he knew enough to ask, I mean, very, very detailed questions. My conclusion from that was, he was testing me. He knew all along. He knew the answer to every question that he asked me, and I think he was—and I've accused him of this since then and he's denied it—it I really think he was just making sure that his FDO knew what he was doing. [Laughter]

Chris is an extremely intelligent person. He could absorb more data, I think, than anybody, and understand it, than I've ever known.

BUTLER: Sounds like certainly an interesting man to work with and work for.

BOSTICK: Yes. I feel very fortunate to have worked for him. One of the best things that ever happened to me.

BUTLER: Absolutely. It certainly does seem to have worked out well for you. I'm going to go ahead and pause right now and change out our tape.

BOSTICK: Sure. Okay.

BUTLER: Okay. We've talked pretty well about Gemini and covered most of the big details about it. Is there anything that you can think of that we didn't cover, that we might have needed to on any of the missions or any of the events going on during the Gemini program?

BOSTICK: No, I think we pretty much covered it. At least I can't think of anything else right now.

BUTLER: We can always come back to it later if we do.

At the end of Gemini, you were promoted and became the head of the flight dynamics officer section. Did this have a lot of changes in what you were doing, or did this just add a couple extra responsibilities?

BOSTICK: It didn't really make that much of a change. It made me the boss of all of the FDOs, but we still worked as a team. Yes, it gave me a few more administrative duties, but it really didn't—I mean, I liked it. It was a title and probably a grade increase or something, but as far as the work that went on in the control center in supporting the missions, it didn't make that much of a difference.

BUTLER: With the change from Gemini to Apollo, you mentioned that sometimes during the Gemini program you'd be running simulations for the Apollo missions and, of course, doing various planning along the way. What major changes were there, though, to the control room itself, or to even the training process, from one program to the next?

BOSTICK: Well, the control room itself stayed pretty much the same. By that I mean the same number of consoles. We did add a few positions in the systems area for Apollo. The main thing was that we had a lot more data, had a lot more stuff coming down on the telemetry stream, we had more tracking sources, better sources. We had a much more sophisticated, complicated spacecraft than what we'd had before, but to support that, we had a lot more data. So on one hand, the problem was more complicated, but along with the complication came more resources to be able to deal with it.

So basically the job in the control center really didn't change that much. We still had us guys in the trench worrying about the trajectory, how to get there and how to get back, how to navigate. We had the systems guys worried about hardware, the life support systems, the electrical systems, communication systems, and all of that.

A big difference was that in Mercury and Gemini we had flight control teams deployed out to remote sites, and so they talked [to the flight crews]. They had capcoms at each of the remote sites, and they had systems guys. They would monitor the spacecraft when it came over, and we didn't get that data in Houston. So with Apollo, a big difference was that we didn't have all these people out at remote sites anymore and all the data was shipped to Houston, and it made the operation a lot smoother than it had been with the individual remote sites. It helped in training, because all of the people that you had to deal with from a flight control standpoint were all in the same room. So that part of it made it a lot easier.

I really hadn't thought about that question before, but as the vehicles got extremely more sophisticated and complicated, our resources that allowed us to deal with those complications grew right along beside of us. So, overall, there wasn't that much of a difference.

BUTLER: Just a normal growth process.

BOSTICK: Right.

BUTLER: That's good. What was your first assignment with Apollo? Was it just to begin working on the first missions?

BOSTICK: Well, I had actually started on Apollo back in mission planning and analysis back in the early sixties. In fact, I had developed the Apollo launch abort modes, and that's one of the reasons I think that Glynn Lunney and Cliff Charlesworth decided they wanted me to transfer to flight control division and become a FDO, because the FDO is the person in the control center that's most concerned, [he] and the Retro, about launch aborts and limit lines and all of that. And I had done that for Apollo.

Then once I got over to the flight control division, initially we had separate groups of people working on Gemini and Apollo. I don't remember exactly when, but sometime near the end of the Gemini program, say, '65 or '66, along in there, we combined the Gemini [and Apollo groups]. Well, certainly before the end of the Gemini program, we combined activities within the branch and we had the same people working on [both] programs. It allowed the experienced people that had worked on Gemini to carry that over into Apollo, and the people who had been isolated on Apollo for a number of years before that were a good resource for us to tell us all the stuff that we'd missed while we'd been off working on Mercury and Gemini.

BUTLER: You mentioned the abort modes for Apollo that you had worked on earlier on. This was before you were working in the control center, as you said. At that time what planning had already been done for the spacecraft and for the boosters for you to be able to do that abort planning, and then did that change any by the time you actually got to the Apollo program?

BOSTICK: It didn't really change a lot. We already knew what kind of launch vehicle we were going to have. We had the specifications. It couldn't have been completely built yet. We knew, for example, that we had a launch escape tower once again, like we had had in Mercury. So that gave us the capability to look at the possible regions of failure in the launch phase; engines out, guidance systems failures that would carry [you] into unsafe regimes, and to design abort modes which would involve either using the escape tower or separating from the booster and landing the command module by itself in different parts of the Atlantic Ocean.

Then, of course, as the hardware was actually built and tested and we had to refine that a little bit, the exact parameters, but the basic abort modes stayed essentially the same all throughout the program.

BUTLER: It's interesting that you mentioned that you'd already been planning for the escape tower when you were first working on this, but yet then for Gemini they ended up using the ejection seats. Do you recall, even though it wasn't your direct area of focus, any of the discussion on that and how that came about?

BOSTICK: Not specifically. As I recall, it was basically as simple as nobody really liked the escape tower; it added more weight. Astronauts were test pilots in those days and they were used to ejection seats, so I kind of think that in Gemini they just decided they would try the ejection seats and very quickly decided that was not a very good solution either, and then for Apollo went back to the escape tower. But, as you said, I really wasn't involved in any of that decision-making.

BUTLER: Well, it worked out for both programs all right.

BOSTICK: Yes, and fortunately we never had to use any of them.

BUTLER: I think that's probably a very good thing all around.

BOSTICK: Yes.

BUTLER: Apollo 6 was your first flight as FDO for the Apollo program, is that correct, or was there one before that?

BOSTICK: Well, by this time I was chief of the flight dynamics branch and therefore over all the Retros, FDOs and GUIDOs, and, yes, I had worked most of the unmanned flights, or at least a couple of them as either the prime FDO or as a backup, usually in a backup role. Apollo 6, as I recall, Jay [H.] Greene was the prime FDO on that flight and I backed him up, but that's where we had a problem with the cross-wiring of the engines. I'm not sure that I ever—I was there, but I don't think I ever took the console in a prime position on Apollo 6. That's my recollection, anyway.

BUTLER: Well, that works. You probably remember better than what I have anyway. It was certainly an interesting mission. There were, as you mentioned, a couple interesting glitches that eventually did get worked out.

BOSTICK: Yes. Well, the Saturn V was a pretty enormous vehicle. Of course, with the FDO being concerned about the launch phase, the proper functioning of all of the engines and the various abort modes and all of that, it was a lot more complicated than it was back with the Atlas. But overall, it worked pretty well. We had a few problems with it. It had some pogo effect in the early flights, where it was kind of bouncing up and down, and a few development problems, but by and large, when we needed it, it worked.

BUTLER: It certainly did. It had an excellent record, especially in comparison with the Atlas.

BOSTICK: Yes.

BUTLER: Saturns came through all the time.

BOSTICK: The Germans from Huntsville [Marshall Space Flight Center] came through. [Laughter]

BUTLER: Absolutely. Did you then work on Apollo 7? Were you working on console at all for that one, do you recall?

BOSTICK: Yes, I pulled a shift on Apollo 7, it was not the prime shift. In fact, by that time I was heavily involved in Apollo 8 already. In fact, several months even before we flew Apollo 7, which was the first manned mission that actually made it into orbit after the horrible catastrophe that we had with the fire, a few people had been challenged by Chris Kraft to go figure out why on the next flight, which turned out to be Apollo 8, that we couldn't go all the way to the Moon, which was, in retrospect, a very aggressive move, because here we were, we'd had the disaster, the Apollo 1 fire, and totally redesigned the command module, and we hadn't even flown it yet to prove that it would work, and here we were working on going to the Moon, which at first was a big shock.

In fact, the first meeting when I was called to Kraft's office, I think it was just me and Gene Kranz and Arnie Aldrich, as I recall, and he asked us to look into the possibility of going to the Moon with the second flight. And I thought, "This man is crazy. What are we talking about?" [Laughter] But by the time we left the meeting, you know, I was already thinking, well, okay, why can't we, and what do we have to do, and what we have to accelerate. Within a couple of days, we figured out there's really no reason why we can't do this, which I think is the boldest, most aggressive thing that ever happened in the manned space program, was the decision, and I think it started with George [M.] Low, but I don't know. That's debateable, I guess, as to who came up with the idea at first.

Here, as I said, we just totally redesigned the Apollo spacecraft, had never flown it to see if it was going to work or not. We had a very logical path laid out to get to the lunar landing, and it involved at least two more flights in Earth orbit. So at that point we were a long way from thinking about flying it to the Moon. The capability that we had in the control center was not ready for that.

My initial reaction is, "Hey, we aren't ready for this. What are you talking about? We've got a plan here. We've got to go through 7, 8, 9, 10, and then maybe 10, we go to the Moon. But not on 8, not the second flight around." But after a small group of people looked at it for a few days, we couldn't come up [with] any reason why we couldn't do it, and started a lot of detailed planning. Our bosses didn't even know it. I couldn't tell Lunney, for example. John Hodge was my [division] chief at the time. I couldn't tell him that we were working on this. We were having to steal computer time over the weekend. We'd go back to Chris and say, "Well, I need these two other guys to be involved," and usually he would say yes. Sometimes he would say, "Okay, well, you can get one of them, but not the other."

They just didn't want the cat out of the bag, you know, until a real thought-out decision had been made.

So my involvement, to answer your question, my involvement in Apollo 7 at that time was kind of minimal. I just kind of held things together between shifts in the control center when nothing was going on, but already spending a lot of time trying to get ready for Apollo 8.

Kraft had already said to me, personally, "If we do this, you're going to go back and be a Retro," also. Because the question, the first time—well, when you start going to the Moon, actually we didn't call it retrofire anymore, we called it return to Earth, because you aren't just retrofiring out of Earth orbit, you're leaving the Earth orbit, so it was called return to Earth. That was the big question, if we had any problems, we obviously have to get back. So that was one of the conditions [for going ahead with the Apollo 8 mission].

Chris really made out the manning list himself for Apollo 8. I hadn't been a Retro, even though I supervised the Retros, but I hadn't sat at the console since Gemini, and so I had a lot of catching up to do to get familiar with all of the Retro stuff for the return to Earth stuff for Apollo. So I was spending most of my time on that.

BUTLER: I guess you breathed a big sigh of relief when at least technically everything went well with Apollo 7, so that you knew the spacecraft was sound.

BOSTICK: Yes, [there] was obviously a condition that [said] we [must] prove that the spacecraft works on 7, which we did. The biggest problem on 7 was non-technical, and that was [over] who's in charge, the astronauts or the ground. I think we settled that one. [Laughter]

But, yes, the spacecraft worked great. You see, [the other] thing, to go to the Moon on 8, we had to use the Saturn V, and we had had some problems with the Saturn V. But there was enough confidence in [the] hardware, both the launch vehicle and the spacecraft, and in the people, flight controllers, that the decision was made to go do it.

I'm convinced that if that had not been done there in, well, it started in the summer of '68, I guess, that we would not have met the President's goal to land on the Moon before the end of the decade, because as I mentioned earlier, when we first started into this, it was square one or square zero. It [doesn't] take you long to figure out how [do] I get from here to landing men on the Moon. Well, there's all of these milestones you've got to do.

With Apollo 8, just sending a crew around the Moon and going into a lunar orbit and coming back home, that was a very, very high percentage of all the things that was on our milestone list. We honestly had a lot of things to do to check out the lunar module. That was a big [unknown]. In fact, that was the prime driver for taking Apollo 8 to the Moon, was that the lunar module wasn't ready. That was supposed to be the next flight after 7, was to check out the lunar module in Earth orbit like we had done the command and service module [CSM] on 7, but it wasn't ready to fly. So the options were to sit and wait, or to do something bold.

The NASA management, whether it started with George Low or George [E.] Mueller or whoever, I give a tremendous amount of credit for even considering something like that and then for getting all of the inputs and saying, "Okay, yes, I'm willing to take that risk. Let's go do it." Unfortunately, I don't think you see decisions like that being made in NASA today. But that's old-timers that like to say that. [Laughter]

But it was a very bold and daring decision and one that obviously worked. As I said, I don't think we would have been able to meet the President's goal of landing men on the Moon by the end of the decade if we hadn't done it.

BUTLER: Do you recall, were you in the control room when the command was given for the first time that for them to make their—they'd made Earth orbit and they were ready to move out and go to the Moon, the translunar injection?

BOSTICK: Yes, I remember probably as much or more about Apollo 8 as any other mission, just because it left such a lasting impression on me. We had so many firsts, you know, starting with, as you mentioned, translunar injection, and it hits you, my God, we're leaving Earth. I mean, translunar means you're going to the Moon, and oh, by the way, you're leaving Earth and somewhere up there you're going to hit a point where you're going to leave the gravitational influence of the Earth and be under control of the gravitational influence of the Moon.

We're shooting for a target that's not there yet. Translunar injection is kind of like duck hunting. You don't shoot at the duck; you shoot way out in front and let the duck fly into it. So we're aiming at this point up in the sky, and we're depending on things we've never done before, tracking data, computing maneuvers, relaying the information to the crew, loading it in their computers, and doing all this. A lot of miracles and magical things, almost, have to fall into place to make it all successful.

When you consider the margin of error and how, as viewed from the Earth, that the altitude that we were shooting for above the Moon wasn't even as thick as a sheet of paper. So there were a lot of firsts involved, a lot of memorable events.

The fact of when it occurred, over Christmas, also was extremely special after translunar injection, and it really did—and we're all fairly intelligent people, we knew what we were doing, but I tell you, for at least a half an hour there were a lot of us around looking at each other saying, "We're really going to the Moon. We've got these guys headed out of Earth orbit. They're leaving us." Then there was almost a fantasy with, well, what's the equidistant point? The flight director would say, "Tell me, FDO, when we're exactly equidistant from the Earth and the Moon." It was something that was kind of a nice little game we could play. Then [tell me when we have] left the sphere of influence of the Earth and [are under] the influence of the Moon.

We did very detailed minute-by-minute return to Earth planning. Okay, if this happens now, then we'll have thirty minutes to figure it out. Okay, so here's a time we can fire up the engine and then come back to Earth and where we'll land. I mean, we probably way overdid that, but in a situation like that, there's no way to overdo it, because you can't be cut short.

Then, of course, when we got there, you'd say, "Hmm, these guys are going to go behind the Moon and we're going to lose contact." On the way there, by the way, was wonderful, because we could talk to them all the time. There probably was excessive dialogue also, just because we weren't used to that. We could talk to them all the time. [Laughter]

Then the next big thing was when they go around behind the Moon and we lose contact. All the flight controllers kind of sit there and after a while they realize we have no data, we can't talk to them, this would probably be a good time to take a break, but we don't take breaks. [Laughter] It was kind of awkward, it really was. We can't desert them, all get up and leave the control center, but for the next twenty-five, thirty minutes, however long it was, there's no way we can talk to them, we have no data, so why not? [Laughter] So there was a big rush on the restrooms then all of a sudden.

And tremendous satisfaction, by the way, on the part of the people in the trench especially. When we did lose them, lost the signal as they went behind the Moon, it was [snaps fingers] exactly when we had predicted it. So, yes, orbital mechanics works. [Laughter] God works. He brought the Moon in exactly the right spot at the right time.

Then a very similar thing when we had acquisition of signal on the way back, as they came around from the back side of the Moon, it had to be one of the happiest moments of my life and for most of the people, I think, in the control center. Again, it was, hey, orbital mechanics works, and there has to be a God, because he's doing His part. [Laughter]

Then when the crew started reading from the Bible, I think it was kind of the first time that a lot of us could relax enough to say, "Hey, we just sent people around the Moon and it's Christmas. And they're reading from the Bible and relating this, 'God created the heavens and the Earth.' This is unbelievable." [Laughter]

BUTLER: Absolutely.

BOSTICK: One thing that I regret about my career at NASA, especially for the first ten years while we were going to Moon, is we didn't really have a lot of reflection time. We were working so hard, flying so frequently, that we didn't have time to sit back for a few days, a few hours, a few weeks, whatever, and just say, "We're flying men in space and we're doing all of this. We built a new spacecraft from the ashes of Apollo 1, and here twenty-one months later we're flying people to the Moon."

Again, John Aaron said it better than anybody I've ever heard, he said, "We gulped fine wine." We didn't have time to enjoy it. I've talked to a lot of the astronauts about the same thing, especially the ones who walked on the Moon. It's just a crying shame that most of them didn't have time just to stop for a minute and look at Earth and look at all the stars and stuff and say, "My God, I'm on the Moon!" [Laughter] They were so busy that they had very little time to do that, and that's kind of, I think, how most of us that were in flight control feel about the sixties. It just went by so fast, that we didn't really have time.

I think, I know for me personally, that Christmas day, or Christmas Eve, I guess, when the crew of Apollo 8 started reading from the Bible, at that point we had accomplished a big part of the Apollo 8 mission and, in my mind, a big part of the whole Apollo program. So it was a moment just to relax, and so that's one of those unforgettable moments of, hey, you know, we can sit here and take a sigh and say, "Thank you, Lord, for letting me be here and be a part of this." But we still had a long way to come back home, so we straightened up and we got back to the consoles. Of course, the transearth injection was a big sigh of relief to get them headed back home.

Again, although we were, for the most part, fairly intelligent people and we were all trained for this, you're headed home at 36,000 feet per second, you think, "We're just going to crash into the atmosphere and land this thing." [Laughter] We've only known that all of our lives, but this is the first time we've done it. I mean, we are going around in Earth orbit and we're going to fire the retros, these guys are coming in, and we have this little bitty corridor that they have to hit. If they're too shallow, they'll go skipping out and go into permanent orbit about the sun or some other nice thing like that. Of if they're too steep, we're going to burn them up. So let's pay attention, guys. Make sure we do this right. [Laughter]

So we probably overdid the mid-course corrections and the tracking and the planning and all. But not really, because that's something you don't want to screw up.

BUTLER: Certainly not.

BOSTICK: But Apollo 8, certainly with me, and I think with a large percentage of the flight controllers, is a standout mission in our memories. I've told people, on Apollo 8 we baked the cake; on 11 we just put the icing on.

BUTLER: Many people agree with you on that. We've heard very similar—

BOSTICK: The interesting thing is, again, unfortunately, most of us didn't realize that until much later. I mean, again, we were so busy, we didn't have time. [It was one of] those frivolous questions, like "which mission stands out in your mind." You say, "What? I'm busy. Don't bug me now." [Laughter]

BUTLER: "I've got a job to do."

Well, and you did still have the goal in front of you to actually land on the Moon.

BOSTICK: Oh, yes, but, boy, what a motivation. By this time we knew we were well ahead of the Russians. I mean, we, or at least me personally, I rightfully, as it turned out, suspected that we were ahead, because we were much more visible in what we were doing. Of all of these thousands of things that had to be done to get from here to the Moon, we were clicking them off. The lunar module would be a snap. We'd figured that out. Just go land that little thing. [Laughter]

BUTLER: Well, Apollo 8 certainly was a bold step and a great success, as you've said. Made a big difference for the program ahead, and the lunar module did come along and get up to speed and the next couple of missions tested it out.

BOSTICK: Worked wonderful, yes, obviously.

BUTLER: Were there any particular thoughts that you had or reflections on Apollo 9 and 10 and their goals in both testing out both ships in Earth orbit and then with the dress rehearsal for the lunar landing?

BOSTICK: Well, I think, let me go back to Apollo 1. You know, at the end of Gemini we were pretty confident that we were going to meet the President's goal. Apollo 1 was a big blow. Not only was it a technical failure, but we lost three people, and most of us knew those three people. And that was hard to overcome. But we were still working—hard.

Apollo 7, for flight controllers, was a success in that the hardware worked and we were extremely grateful and happy, but it was not a fun mission because of the problems that we'd had, the debate between the ground and the crew about who's in charge. It was not something we were proud of, okay?

Then we hit Apollo 8, and I've already talked too much about that, but we were on fire after Apollo 8. The team was so reinvigorated after 8 to a point that I hadn't seen since the middle of the Gemini program, maybe, or the early Mercury even. I mean, but after 8, boy, it was full steam ahead. We weren't trotting; we were running. We're going and we've got to do 9 and 10, and then we're going to land those guys. And they worked like clockwork [Apollo 9 and 10], a few minor problems here and there, but we proved that the LM works and that the techniques work. I thought Tom Stafford was almost going to land on 10, he got so close. [Laughter]

So that's what I remember about 9 and 10 is, yes, from a technical standpoint and a procedural standpoint we still had a lot to do, but we were running full steam and we were doing things right and left, and they were working and we were all happy and we were going to land on the Moon. Nobody could stop us now. [Laughter]

So then when we got to 11, it was, "Okay, Neil and Buzz, it's over. You guys just go do it. It's anticlimactic now." [Laughter] Until we got into the mission, then it was like I described earlier about 8. I think it hit most of us then, again, "Hey, for all of our careers we've been working on this one goal, landing men on the Moon, and there's still a lot of nay-sayers. The Moon's made out of cheese. It's made out of dust. It can't be done. And today we're starting the mission that's going to do that."

So it was kind of like 8, it was another sobering time, and it's good that it was, because, as I said, through 9 and 10 we were running full speed. I mean, you know, go get 'em, charge 'em. I think it's good that we got a little sober after the launch of Apollo 11. We didn't talk about it, but I've talked about it since with people, especially Kranz. Of course, he's kind of an emotional guy, gung-ho guy, anyway. But I think it hit a lot of us that, "Hey, today we're going to do what we've all been planning on doing for our whole careers; for the last ten years." [Telephone interruption.]

BUTLER: We were talking about the launch and how sobering to think about that day.

BOSTICK: Yes. So the closer that we got to the Moon, I think the more serious we all got. It was another one of those moments, I guess. People not involved in the program frequently ask, "Well, did you really that you could do that? I mean, did you really think it was going to work, or were you just scared to death that they were going to crash and get killed?" The answer is, no, I knew we could do it. There was no doubt. I mean, there was some doubt, very small, that we would successfully land, but the alternative to that was an abort, and, you know, we wouldn't be able to land, if you'd have to abort and go back into [lunar] orbit, but we'd get the crew back alive. I mean, that's not something you worry about. I mean, we were all comfortable enough that that option was covered.

But I have to admit that during the descent, and I was not on console at the time, I was there as a supervisor for all my guys who were doing it, as an observer. I think every team that ever worked in the control center was there for the descent, and at least every astronaut who ever flew or wanted to fly. The control center was pretty full for that. In fact, I sat by [Charles C.] Pete Conrad [Jr.], who was scheduled to go next. He couldn't find a place to plug in up by the capcom console, so we had a spare place to plug his headset in down on the FDO console, and I invited him down there.

That has to go down in one's mind also as a fairly good day. It was not without its problems. Had a few computer alarms on the way down, but Steve [Stephen G.] Bales, who was one of my guys, an outstanding member of the trench, came through like we all knew he would, and the whole team did and he obviously had a lot of people talking in his ear from the backroom. And Will [William E.] Fenner, who was also on the console.

We landed and there was not a real sense of relief or exuberance at landing, because that's a very critical time still in the mission. We had to make decisions about do we stay, or no-stay, a lot of powering down the LM and systems checks. So I don't know, it was probably at least another twenty or thirty minutes before it hit me and I think most other people, "We've got guys sitting on the Moon." [Laughter]

Then it was, "Okay. Now they do their job [while they're there] and now we've got to get them back." So we started thinking about, well, we've got to launch this LM and rendezvous with the CSM and do all that and get back home."

But I think, well, for me personally, it was not even until after the mission was over and for the first time in my career anyway, I took like a week off, and said, "Okay. We've done what we came to do, we want to do it a bunch more times, [but] we have proved it can be done. We met the President's goal. We beat the Russians. So there ain't nothing to this landing on the Moon stuff. How many times do we want to do it again?" [Laughter]

That was, for me anyway, the first time in seven or eight years that I had just really been able to take some time off, several days, and say, "Okay, here's what we did and it's done and we were successful."

BUTLER: Successful and ready to move on.

BOSTICK: Yes. That's probably why I still measure all of the events in history as pre-landing and post-landing.

BUTLER: Certainly makes sense.

BOSTICK: Yes.

BUTLER: It absolutely does. Quite a momentous event.

The next mission in line, Apollo 12, then got into even more detailed trajectory-type work. They wanted to land very specifically. In Apollo 11, Apollo 10, and Apollo 8, you'd begun to deal with the mass cons [mass concentrations] and some of the surprises there, and as you mentioned, well, Neil Armstrong when he was landing didn't land precisely where they had planned.

BOSTICK: Yes, the Apollo 12 was a real challenge, because, as you mentioned, we had those mass concentrations, mass cons, which means that, you know, the Moon's not homogeneous. It's got big rocks, kind of like Earth. We had a real good model of the Earth for doing trajectory stuff, but obviously we didn't have one for the Moon, and it took a while to figure all of that out. Emil [R.] Schiesser and others over in mission planning and analysis did a great job in doing that. So we knew, we felt confident that we were getting better at lunar orbital mechanics as we had flown around it a number of times.

So on 12 they wanted to land as close as they could to the Surveyor spacecraft, the unmanned spacecraft that had landed there previously. That was kind of a real challenge for us FDOs, and we kidded back and forth with Pete Conrad about "We're going to put you right down on top of it and you're going to have steer a few feet off to the side, so that's up to you. But you're going to put you right on top of Surveyor." And we essentially did. [Laughter] I think he believed us after that.

Unfortunately, though, 12, the things that most people remember about 12 is the lightning strike in the launch phase where John Aaron came through with flying colors and saved the mission, and then the pinpoint landing. A lot of people don't even remember that.

The other thing they remember, though, as another problem is the camera went out, so there really are no television pictures from the Moon on 12. So I kind of feel sorry for that crew, because in history, that mission's just kind of wiped out, because there's not a lot of documentation video-wise of that mission. But technically it was a huge success.

We did the pinpoint landing. They extended their lunar EVA times. They conducted all kinds of good experiments. As I recall, even more, you know, we always planned more than we thought they could do, and we gave them more than we thought they could do in a normal time line. But they were even asking for more stuff to do. So it was, overall, a very successful mission, probably so successful that by the time we got to 13, that the public at large was just kind of blasé about the whole lunar landing thing. It's amazing that the impossible can go, within a year, to something that everybody just takes for granted and doesn't even want to pay any attention to anymore. There were people who just said, "It wasn't meant for men to land on the Moon, and it can't be done, and you'll never do it," and then when they did, they said, "Oh, okay, no big deal." [Laughter]

BUTLER: Totally amazing. It's still hard to believe.

BOSTICK: Yes.

BUTLER: You mentioned Apollo 13, and that certainly did bring the space program back into the public eye, for unfortunate reasons, but luckily it did all turn out well. Can you share some of your thoughts about that mission and the events that happened and what your involvement was on it?

BOSTICK: Well, from a flight controller's standpoint, Apollo 13 was probably the most at the same time frustrating and satisfying mission that we ever flew. By that I mean it was a disaster that we had to overcome, but we overcame it, and that's why it was satisfying and rewarding. More than any other mission, it put the flight control team to a test, and it wasn't a systems test or a trajectory test or a communications test, it tested everybody in the control center, and we pulled it off. Talk about something impossible.

At the time that it happened and by the time we figured out more or less not what had caused it, but the results of what had happened, things were looking kind of dim. I never did and I don't think anybody else in the room ever gave up. I mean, it never occurred to me that we wouldn't get them back alive. I just didn't know how. But I guess I don't know if I was playing tricks with my mind or being overconfident, but I would not allow myself to think we aren't going to get these guys back. It was always a question of how.

But, you know, everything fell into place just like it should have and like we were trained for it to do. When the explosion happened, we were not on a free return trajectory. Prior to that, in going to the Moon we had used what's known as a free return trajectory where that with minor course corrections, hopefully even without any, that if you went around the back side of the Moon and were not able to go into lunar orbit, i.e., you couldn't do the lunar orbit insertion burn, that you would come back to Earth, and hence a free return.

But because of the landing site and the launch window and other things and fuel efficiency, on 13 we were not on a free return trajectory. We had just passed within a few minutes the last direct abort opportunity. But us experts in the trench, the trajectory guys, knew that there was some fuzz on any kind of boundaries like that, so we started immediately computing options to come home immediately, and there were still some options. We could do it for another thirty minutes or so, and we let the flight director and everybody else know about that.

The problem was, we didn't know if we had an engine. The service propulsion system engine on the service module we were pretty sure was not going to work. I mean, the service module was dead or dying, and the odds of it working were just pretty slim. So we gave that up, and the immediate thing then was, well, let's get them back to a free return. Until we figure out where we are, at least let's get them back on a course that would bring them back to Earth. So we did that within a few hours of when the accident occurred. At that time the crew had already abandoned the command module and done down to the lunar module.

Of course, the systems guys were trying to figure out things that nobody had ever done before or ever thought of before, like how do you power down the command module when it's in orbit. Now, why would you even write a procedure to do that? If somebody had bought that up before the flight, we would have said, "You're crazy. That's wasting time. Why would we do that?" Well, it turned out that this very unusual circumstance that we had, then the command module systems guys were trying to figure out how to power down the command module, and oh, by the way, we'd like to reserve the option to power back up because we need it when we come back into the atmosphere. Oh, okay, no big deal. We'll go figure that out.

Then the LM guys were trying to figure out how to get three people to live inside a vehicle that was designed for two, and to have them to live for three or four days maybe, when it was only designed to accommodate two people for like a couple of days and that's it. [At maximum.]

So everybody was busy. In the trajectory arena, once we got them on a free return, then the immediate question—that was, by the way, back to the Indian Ocean and in several days, which we didn't like, but at least they were coming back. So we then, not knowing how the systems guys were going to figure out how to make everything work, we started figuring out every option that there was on how to speed them up, get them back quicker, and there were a number of opportunities for that. We could bring them back to the Atlantic Ocean, and that's quicker than the Indian, where they were headed, but we didn't have recovery forces out there. But so what? They're commercial ships and they can do that. But if we could afford enough thrust out of the engines, we didn't know which engine at the time, then we could bring them back to the Pacific where the recovery forces are.

But we soon realized that the engine had to be the lunar module descent engine, the one that was designed to allow the craft to descend on the Moon. It wasn't designed to do maneuvers in orbit. It certainly was not designed to do a burn when it's docked with the command and service module and push it around. In fact, we didn't even have the capability in the control center computers to compute a maneuver like that. So we had to crank up this auxiliary computer room, the ACR that I mentioned, over in the office wing of Building 30, and we did make some real-time modifications. We brought in all of the IBM programmers and the flight software people, the mission planning people, and made some changes in the control center, in the software, to allow us to compute docked burns using the LM descent propulsion system. I don't remember how long that took, but a few hours, and normally it would have taken a couple of months. But we did it and did it to our satisfaction that [it] would work.

So that continued to go on while we went around behind the Moon, and by that time the systems guys felt that they could squeak out enough consumables in the lunar module to keep the crew alive until we got back to the Pacific. So we computed a maneuver to do a couple hours after we passed by the back side of the Moon to speed them up and bring them into the Pacific.

An option at that time was to bring them back to the same point in the Pacific, but a day earlier, twenty-four hours earlier, and that would be better obviously, right? I mean, less consumables, bring them back. Problem with that is in order to do that, using the LM descent engine, we would have had to get rid of the service module, to get rid of the mass that it represented, because the engine was not [powerful enough]. The LM descent engine would not do a burn large enough to speed it up an extra day if the service module was attached. So, rightfully so, everybody concluded that that's a little risky to do at this point.

We don't know what happened back there. We've got to use the command module and its heat shield to survive entry back into the Earth's atmosphere. We think we're close enough on the consumables, so let's don't speed it up the extra twenty-four hours, just get them back to the Pacific and we could do that with the LM descent engine and the service module still attached.

So we did that, and they're headed home and that's another good feeling. The systems guys, by the way, are still trying to squeeze every ounce of consumables out. The command module guys are trying to figure out how to power the command module up again from being dead for three days, to bring it back to life. They, of course, would like to delay that as long as they can, because they only have limited power. All they have in there are batteries that were intended for emergency batteries for entry, because there are no fuel cells anymore.

So it was probably the greatest example of teamwork that I've seen in my life. All of the systems guys, the LM and the CSM guys and the trajectory guys are all working hand in hand in an extremely well-integrated fashion to make it all come out. It was give and take the whole time. Like, "Well, I've got to have power to use the navigation system just for a few minutes to figure out where they are, but I can't spare the power. Well, got to figure out something else we've got to turn off."

That went on for the whole time. We were pleading with the systems guys, "We need such and such to turn on, because we have to track them. We want to turn on their computer and we want to do a star check and we want to do this and that."

They'd say, "But we don't have the power. They're going to run out before they get back. So anyway, you can't do that, you've got to figure out another way to do that."

So we had guys figuring out how—we always double checked or triple checked or quadruple checked everything we did. One of the things that we'd do trajectory and navigation-wise is to have the crew to check attitude, always out the window. We would give them the attitude, we would send them commands to go into the computer, or we would send them by voice and they would put them in their computer, and then the spacecraft would go to a certain attitude. But just to make sure, look out the window and see if you see this star, or if you see the Earth's horizon. The Earth horizon was a check that we'd always use for getting [into] entry attitude, because [the spacecraft] obviously has to be in the right attitude to enter the Earth's atmosphere.

But the problem then was that they couldn't see the horizon, because it was going to be dark. So Chuck [Charles F.] Dieterich, one of the Retros [on duty], came up [with] the idea, okay, well, they can't see the Earth, but they can see the Moon. So let's do a Moon horizon check. We figured out when it would be visible, and sure enough, it worked great.

The closer we got home, the more comfortable the systems guys got about, yes, we're going to squeak this out. They had the horrible problem with the carbon dioxide in the [lunar module] atmosphere. They ran out of lithium hydroxide canisters in the lunar module, and so the carbon dioxide wasn't getting filtered out and they were to the level of hypoxia, I guess.

The systems guys, and these were people outside the flight control team, over in the crew systems division, [Robert E.] Ed Smylie and Jim [James W.] Correale and others, who figured out a way to use the command module lithium hydroxide filters in the lunar module, because one filter was round and the other one was square. Whoever thought we'd have to use one in the other? I mean, it was one of those things that if somebody had brought it up they'd say, "You're crazy, that's a dumb thing." But they figured out using cardboard and duct tape how to hook the thing up, and so that was one big hurdle overcome.

Finally squeezed all the consumables, but us guys in the trench were going crazy because you have a very narrow corridor in which to hit the Earth's atmosphere, or you'll just skip out or burn up. You've got to hit it exactly at the right angle within very little tolerance either way, and it kept getting more shallow and more shallow, the angle kept getting smaller and smaller, and we said, they're going to skip out. We couldn't figure out what was causing that.

We had everything turned off that would be causing any vents or anything. A spacecraft has all kinds of things they have to vent to get rid of, water and air and stuff, and it always screws up the trajectory and we were always arguing with the systems guys, "Can't you control your vents? You're messing up my trajectory."

But here we just really could not figure out what it was. At first we thought it was the helium, which is used for pressurization in the lunar module descent engine. It's used to pressurize the fuel and force it into the engine. It's called ullage pressure, before you burn. But that wasn't it, because the helium disc finally burst and it was gone, so we knew that wasn't causing it. The crew heard it on board and the systems guys saw it [the pressure loss] on the ground.

So we did one mid-course correction. In fact, we overshot. We made it a little steeper than we thought, than the optimum, but it would still be safe if it turned out there, but we were unsure enough that if it kept shallowing it would creep up and still be acceptable, but it kept creeping, it started creeping up higher. So, unfortunately, we had to do another mid-course correction not too long before entry to get it back in the corridor.

It turned out later, and we didn't figure it out until after the flight, the systems guys, I guess, figured it out, that the lunar module cooling system, which circulates water to heat-producing instruments and takes the heat out, like you have any kind of a system in a lunar module that produces heat, it would be on a cold plate that they ran water through and would therefore take the heat out of the instrument, but it would put it into the water. Then the hot water, boiling in some cases, went out what was designed and described as a non-propulsive vent. It was a T-shape. It would go out and spew in both directions and therefore be "non-propulsive." Well, guess what? It was propulsive. That's what was screwing up our trajectory all the way home. But we overcome that.

Probably the most tense moment on Apollo 13 was during entry when we hit blackout. Blackout occurs in entry because an ionization shield builds up around the spacecraft as it's coming in and the voice link signals can't get through that ionization shield. So for a few minutes there you lose communications, and we call it blackout. On previous flights we had been able to predict that extremely well, as to when it would occur and within a few seconds of when it would end, not as precisely as other things in spaceflight, but fairly precise.

So here on Apollo 13 we've gone through the most tiring, excruciating time in our history, working twenty-four hours a day and pulling off four or five miracles in a day, you know, and here we've got them back home and…this impossible thing has worked out, and they're coming back and everything's fine, and we lose them in blackout. Then the end of the blackout comes and we call them, there's no answer. There's no answer. We're all saying, "Oh, no." I mean, "No, no, no, not after all of this." You know, it's done. It's over. We've done the impossible. It went on for like another minute and a half and we couldn't contact the crew, and then all of a sudden we hear them. To this day, to my knowledge, nobody's figured out why the blackout lasted as long as it did.

BUTLER: Really?

BOSTICK: No. It's one of those things that nobody seems to understand. We don't know why it happened. But I'll tell you, it was one of the worst moments of my life. All of us were just so dead tired that we couldn't even hardly stand up, and here we'd done all of this, and as I said, had pulled off these major miracles and done the impossible, and then here ten minutes before the mission is over and for some reason we lose them. It was just a real downer. But then when we heard them, everybody got well real quick. [Laughter] You probably saw more exuberance, more elation in the control center, more screaming and clapping at that time than we had ever done before. And we didn't care, unprofessional or not. [Laughter] We deserved this time on our own to scream and holler a little bit.

We were always very controlled, tried to be. Like when the chutes came out, there was, "Yay! That's good." But the mission was not over, and we always waited until we had the crew out of the spacecraft and on the deck of the ship and then you could relax and celebrate. But on Apollo 13 when the chutes came out, I mean, after we heard them at the end of the blackout, and then when we saw the chutes out, it was just uncontrollable. Like to hell with this control stuff, it's time to scream and holler and clap hands.

BUTLER: It's only natural. You're human.

BOSTICK: Yes, yes, yes. But again, from a flight control standpoint, that has to be the most rewarding flight that any of us ever flew, because it proved that we were worthwhile and that there was a purpose for us and there was a purpose for men in flight, because if it had been an unmanned flight, it would have been lost. It would have been over.

You say, well, but it was over then anyway because you didn't accomplish anything after that. No, that's not true, because what we accomplished was we learned a lot from a systems standpoint from the crew observations, from the pictures that they took of the service module after it had blown up. We learned a lot from that experience. That's what's kind of frustrating to me personally about some of the failures, especially the Mars failures that have recently occurred in the unmanned program. Unfortunately, we didn't learn a lot from those failures because they didn't have the data to figure out really what happened.

To me, you don't like to fail. Nobody likes to fail. But it's acceptable to take some risk and fail if you're left in a position of still gaining knowledge. If you can find out why you failed and correct it and make sure it doesn't ever happen again, then that's a bad day, but it's acceptable. You don't like it and you don't plan for it, and you don't want it to happen, and you hope it never does, but if you fail and learn, it's not a total failure. That's an unsolicited comment, an aside. I'm sorry.

BUTLER: No, that's certainly true.

BOSTICK: I think Apollo 13 really proved the usefulness of men in space, and there are a number of other examples throughout the program. But it's hard to replace somebody's eyeballs up there looking at something.

BUTLER: Absolutely.

BOSTICK: I'm an obviously very proud member of the ground crew, but the ground can't do everything. You've got to have some eyeballs and some human brains up there. Computers are wonderful things, and, boy, they're getting better every day, but they will never replace a human brain, at least not in my lifetime, I don't think, and I don't think ever. I think that Apollo 13 was just a very outstanding illustration of the benefit of having people up there.

BUTLER: It showed human ingenuity and all that experience and training that all of you had had, too, all just paid off and came through.

BOSTICK: Yes. Yes, we went to the Moon a bunch of times after 13, but, again, the proud thing about that is how quickly we recovered, because this wasn't to the magnitude of Apollo 1, because, unfortunately, we lost three people on Apollo 1. But as far as a technical setback to the program, it was a pretty major blow, Apollo 13 was. But we recovered, again just like we did on Apollo 1. We figured out what happened, what went wrong, what to do to preclude that from happening again, and started flying again very quickly, because we still had a lot of things to do on the Moon, things like using the rover and getting more samples and doing all kinds of geological experiments and trying to figure out if there's any useful stuff in the lunar soil.

Unfortunately, we only went back four more times after that and, in my opinion, didn't complete the job, and haven't been back since, but still accomplished a lot in the flights after Apollo 13. I think proved that the whole program was worthwhile.

BUTLER: Very definitely. Very worthwhile.

Talking about the later missions, a lot of them went to different locations on the Moon that were greater challenges to reach based on location, based on the terrain, and so then had different challenges for the trajectory aspects of it and the planning. Were you involved in any of those missions?

BOSTICK: Oh, yes, that's why it was not ever dull. We never did anything twice, because that'd be too easy, the same way. But, again, it was a tradeoff thing. The geologist, and rightly so, wanted to go to different regions. They wanted to be challenged and really go see some different things and collect some good stuff, and we understood that. We would explain the limitations from a trajectory standpoint. If you'd left it up to the geologists, they would have gone to the back side of the Moon. They wanted to see around, [wanted] to land over there and see what it was. In fact, [Harrison H.] Jack Schmitt had us off for a while working on some of that, trying to land on the back side of the Moon.

Each mission was a challenge for all of us because it was different from the past. Each landing site had its own particular thing, the terrain going in, how much tracking you could get before you had to begin power descent. Then you had to worry about the coverage after they left the Moon during the ascent, because you had to pull off another rendezvous. The rendezvous around the Moon was strictly controlled from the ground. They had limited capability on board. But all during Apollo the ground was prime, and so you had to figure out when you could talk to them and when you couldn't. It was a challenge.

In my recollection, the mission planners and the geologists, the experimenters and all that, were always able to work out a compromise that suited everybody. I mean, we understood what they wanted to do, they understood the constraints, and we would argue back and forth about doing this and why does it take that much time to do that. But it all worked out pretty good. We had our friendly debates and arguments.

One of the most interesting things that I remember about the later duration missions was the rover. You wouldn't believe some of the discussions over the years—of course, we started planning years before we ever used it—about how far we would let the rover go and to get away from the lunar module. Because, again, the scientists wanted to go miles and miles and miles. The question was, you've got to make sure you get back. We talked about everything from dragging a string to dropping birdseed. [Laughter] All kinds of crazy navigational schemes. Some of them probably even would be embarrassing if we talked about it, but we were trying to figure out how to do the job and to accommodate the people who wanted to go off to faraway places.

As most things do, logic prevailed and common sense prevailed, and the distance that they could go was really limited by the systems, their life support systems that they had and the battery power of the rover to get back and all of that. We generally would try to stay within view of the LM. [And when we couldn't,] we tried to keep it in a straight-line distance, so that when they returned, they just had to follow the tracks to get back.

But I can remember when we first began planning a lot of that, that was a real question, is how can you be assured, how can you guarantee that no matter where the crew goes in the rover, they'll be able to get back to the lunar module. [Laughter] We certainly didn't want to leave them driving around the Moon in this little Jeep, "LM, where are you?" [Laughter]

Part of it was extremely sophisticated navigation systems, which we really couldn't afford, or didn't even have time to develop then. That's the kind of thing that probably 99.9 percent of the people who watched [from the ground] never even thought of. It sure looked like a lot of fun, though, didn't it?

BUTLER: Oh, absolutely. It looked like great fun.

BOSTICK: I think John [W.] Young probably had the most fun of anybody driving around on the Moon and even running around. In fact, he scared us sometimes. He didn't worry about falling off the rover or turning it over or even falling down on the Moon by himself. I don't know, that would be a good question to ask all of the astronauts, who do you think really had the most fun [on the Moon]?

BUTLER: That is a good question.

BOSTICK: I think it would be John. John is a very serious and sober person, but, boy, I tell you, a lot of it is facade. I mean, he tries to project this image of a dumb Oklahoma guy that doesn't know anything. He's one of the smartest people you ever met, to start with. But, boy, he plays that, "I'm from the farm and I don't know nothing," thing, he really plays that to the hilt. He's gotten a lot of mileage out of that. But he's very serious, but also he is one of the funniest guys you've ever met, as opposed to Conrad, who was always joking. He never was serious. And that's good. But John could be extremely serious and then, boy, the next minute he's a laugh a minute.

BUTLER: Quite a personality.

BOSTICK: Quite a personality.

BUTLER: Toward the end of the Apollo missions, you also took on duties as a range safety coordinator, is that correct?

BOSTICK: Yes, that started back about at the end of the Gemini program.

BUTLER: Oh, okay, that far back.

BOSTICK: Glynn Lunney had been the range safety representative at the center. That's when he was a flight dynamics officer. When he became a full-time flight director, then I took over that job from him. It was an appointment from the center director, I guess. But the reason that it was a flight dynamics officer was because the FDO and the range safety officer were worrying about essentially the same thing in the launch phase. The range safety officer is trying to protect the mainland, both people and facilities. He doesn't want the launch vehicle—he wants it to keep going out over the water. He didn't want it to turn or go straight up, or turn and come back over land and harm people or facilities.

Of course, we NASA guys wished the range safety officer would go away, because we don't want anybody blowing up our launch vehicle. Especially the flight crew; people are sitting on the end of this thing.

So it was mandatory that the FDO and the range safety officer worked extremely close together to know what each other was going to do. The range safety officer had a plot board, [that] looked very much like the ones that the FDO had, but he had limit lines on his, based on danger to people and facilities. So it was the job of the range safety coordinator, me after Lunney, to spent a lot of time at the Cape with the range safety officers, explaining exactly how our systems worked, the capabilities, explaining our limit lines during the launch phase, and convincing them that we would abort the mission and keep it away from the things he was worried about long before it got close to his limit lines.

It was mostly a pre-mission job then to gain mutual respect between the two people and to ensure that they had a clear understanding of what our capabilities and limitations were and then in real time to coordinate it. I mean, on launch day, we talked for a couple of hours before liftoff and we had code words back and forth. That was always a fun thing. If you hear this code word, it had to be two syllables, like "baseball" or something. But you recognized his voice and if he ever said that, that meant he was getting ready to blow it up, so we had to take action ahead. But that's what that job was.

It was a very rewarding thing, because in the early, early days of Mercury, I guess, there was not that kind of communication between the NASA control center and the range safety officer. This was an Air Force person, and in the early few days of Mercury, they kind of took the attitude, "This is my missile range and I'm in charge and I'll blow it up when I want to." [Laughter] That was shortly overcome by Glynn Lunney initially, who was the first JSC range safety coordinator, after they realized they needed someone to talk to, these people who wanted to blow us up.

Then I took that over at the beginning of Apollo. Of course, at that time we were already—"we," the Johnson Space Center—was already talking about the Space Shuttle. Then when it became a reality at the end of the Apollo program, then it became a similar job of explaining the Shuttle systems and trying to talk the range safety people out of having a flight termination system. "Just don't worry about it, we'll take care of it" type thing.

But it was another rewarding job, because they had some good people down there, and I made some good friends. We developed a mutual respect for each other.

BUTLER: Very important, since it's such a critical job to fill, it's good to have that respect and understanding between the two.

BOSTICK: Yes. Certainly didn't want to have anybody blow up our launch vehicle. [Laughter]

BUTLER: I'm sure the crew would appreciate that, as well. [Laughter]

BOSTICK: Yes. Yes.

BUTLER: Well, I'm going to go ahead and stop the tape one more time and change it out and then just have a few last questions.

Looking back on Apollo and as the missions were coming to a close, what was your general feeling, or even the feeling of the center and the people you were working with? Were people ready to move on to the next step, Skylab and Shuttle, or were there some thoughts about, "Gee, we came this far, we were working so many years to land on the Moon, why don't we do this more?"

BOSTICK: I think we wanted to do it more. Of course, all good things must come to an end, but we did have at least a couple more Apollo flights planned. They were rather abruptly curtailed because of financial constraints. That was a letdown, and it was also a big emotional letdown just after Apollo 11. Even though we were very busy and working very hard, there was a question of, well, how much longer do we want to keep doing this? So there was a lot of talk at that time about either a Space Shuttle or a Space Station. They were kind of in competition with each other as to what would be the next big program.

In the meantime, the Marshall Space Flight Center had really come up with the idea of Skylab, because it was using one of their empty boosters, the S4B stage. So once we started into Skylab, I think most of us in flight control, and even probably throughout the center, were getting pretty bored. This is just, "Yes, we're keeping people up there for a long time, but it's still Earth orbit. Hey, we've been to the Moon. This is easy. There's no challenge to this."

There were problems and we had the problem with the panel not deploying and they had to figure out how to overcome that with the parasol, the umbrella, to shield it and all of that. Each flight had its own set of problems, but we didn't feel like other than proving how long that men could live in space and doing some scientific experiments which most of us non-scientists really didn't understand [or care that] very much about [unfortunately,] I'd have to admit, you know, but it was just pretty boring stuff.

We wanted to keep going with the manned exploration, and there was a lot of talk then about, "Well, we've done exploration, now we have to exploitation. We have to prove that there's a benefit to this. We're running these experiments on Skylab and we could do the same thing on Space Station, a permanent manned presence in space."

That's attractive and had its own set of challenges, but then in competition with the Station was the Shuttle debate, that says, "We want to immediately begin to prove that useful things can be done in space and we can carry payloads back and forth, and we can put up communication satellites and materials processing satellites." There was a lot of talk about things like how you can make perfect ball bearings, and all kinds of things you can do in space. Benefits to medicine.

So I think the last couple of years of the Apollo program and throughout Skylab there was a lot of personal questioning going on among the people that worked at JSC about what we want to do next, what does the country want to do, what does NASA want to do, what did I want to do. I personally was terribly bored with Skylab. I mean, it was just—and I argued that there was no need to have the trajectory guys even go to the control center. That was a very radical idea at the time, probably still is, but there's not anything that we had to do that we couldn't do from our office. So why go over there and sit at the console and twiddle your thumbs for twenty-four hours?

So there was a lot of that kind of discussion. Of course I lost that debate. They wanted warm fuzzies. The flight director wanted to see people right there. He wanted to go and talk to them, and even some of the younger people who hadn't spent all those years in the control center, they wanted to go over there because, hey, that's where the excitement is. Well, guess what? The excitement's gone.

That's when I and I think a lot of others really started thinking about other career paths, and there's got to be something beyond flight control. [Laughter] Can't be a flight controller the rest of your life. Of course, we wanted to go to Mars, but that seemed to be out of the question because we didn't have the public support for it. Certainly not support from the President like we had with Kennedy. But we thought surely we'll do that within the next ten to twenty years, no question, by 1990 at the latest, we'll have men on Mars. Unfortunately, it wasn't in the cards.

BUTLER: Not the same kind of motivations that there were, I guess, that helped get to the Moon.

BOSTICK: Well, it was [both] motivation and dollars. I think people were beginning to question, is it worth the money that you've spent. And that's an argument that I frequently make and others, but it's an argument that you can't win. There are always people who argue, well, there's too much to do here on Earth. And certainly there is a lot to do here on Earth. But, first of all, there's no guarantee that the money that you save by not doing things in space is going to be spent on Earth, or that it's even going to be spent well.

The money doesn't always solve all of the problems that we have on Earth. I think that it's a very important part of human beings' psyche to be explorative. Every great thing that's ever happened to the world, Americans for sure, has been a result of exploration. If we stop looking over the next horizon and trying to see what's there and learning how to deal with it, then I think we're doomed, I mean, the Earth. I don't know what that means. I don't know that we can find a planet or a Moon or something where hundreds of thousands of people can live, or that we can find some resources there that we need here, but I think there's an answer somewhere in there.

The Earth's population keeps getting larger and larger, and regardless of what we do to try to protect the environment, basically it gets worse as the population goes up. There's not a whole lot, I don't think, that we can really do about that. If you have the Earth fully populated, it's probably not a real desirable place. Energy is still a problem. We are going to run out of natural resources energy-wise here one of these days. And even the Moon is a potential help for that.

I mean, you know, nuclear power turned out to be not such a good thing here on Earth. Maybe we could put a nuclear plant on the Moon. I'm not really advocating that, but I'm not sure why not, and I think that we certainly could do that. We've already done quite a bit of work on how to transmit energy. There's a lot that we can do with solar power. We worked within NASA for a number of years on solar satellite systems, and that's still a possibility. But maybe we put a satellite farm on the Moon, maybe we go back to the Moon and mine helium 3.

There's all kinds of energy things that I don't think we're adequately addressing right now. We're just kind of putting our head in the sand and saying, "Well, that will all work out, and in the meantime let's don't spend any more money on space, because that doesn't really help us out here on Earth." It's very unfortunate.

You say, "Why Mars?" Well, because I don't know and nobody else does. Nobody knows what we're going to find there, just like Columbus didn't know what he was going to find there and Lewis and Clark didn't know what they were going to find.

BUTLER: We didn't know what we'd find when we went to the Moon.

BOSTICK: Yes. It's really interesting that, especially after the movie *Apollo 13*, young kids are just so excited about space. There's a little boy that's about eight years old, lives across the street here in Marble Falls from me now. He is a space nut. He's read everything there is to read. I've run out of material to give him. He probably knows as much as I do about it now. [Laughter] It makes me so happy, though, that there are people like that. Interestingly enough, he said to me one day almost exactly what I've been saying for years, he said, "I don't know what we would find in space, but we ought to go look. How can you not go look?" How do you explain to an eight-year-old kid why we aren't? So for those of us who think we ought to be doing something, we could get really depressed that we aren't.

The Shuttle is a wonderful vehicle. I'm proud of the work that I did on that program, for longer than I did on Apollo, probably, and Space Station. I worked on Space Station. I'm sure some great things are going to come from that, but it's not being bold and aggressive like we used to be back in Apollo. The Space Station is another Skylab. It's larger and better equipped. I think [not] even larger as it turns out, as far as habitable space, but it's an experimental facility in Earth orbit, and in that respect it's another Skylab.

We've just about worn the Space Shuttle out, and it's been a wonderful vehicle, but we need a new one. We need one that's a lot more modern, because it's really thirty years old. It started flying twenty years ago. But it was based on designs that were formulated ten years before that, so it's a thirty-year-old vehicle. You can keep refurbishing it and it'll keep going forever, probably, but we need some different programs to do some bolder things, I think.

BUTLER: I think there's a lot of people that would agree with you. Hopefully, without too many more years, we'll see some more coming along.

BOSTICK: Unfortunately, I can't really figure out the mechanism that would cause that to happen. It doesn't do any good to complain about it unless you can do something about it. It's easy to say, "Well, the government's not doing the right thing. The people aren't motivated." But it doesn't do any good to say that unless you have a concrete answer for, "Well, what are you going to do about it?" And I don't have that answer, unfortunately, that's what's frustrating. I hate to complain without having some proposed solution, and my proposed solution is let's start planning a mission to Mars.

Interesting sidelight to this, [what we're] talking about there, I worked for Jim [James C.] Fletcher when he was the administrator in the early seventies. At his retirement, his second retirement, because President [Ronald] Reagan brought him back after the Challenger accident, so at his second retirement party I got a chance to talk to him for a few minutes and he said, "Jerry, if you were the NASA administrator, if you were in charge, and Congress authorized a manned Mars mission, where we would go to Mars? What would be the first thing you'd do? How would you handle that?" Because he obviously had been thinking about it, and he was that kind of guy, he always asked those kind of questions.

I said, "Well, first thing I would do is I would probably establish a new NASA center in Utah," because that's where he was from. It's a good state, right? Been to Utah. "And hire a bunch of college graduates and put them to work on it."

He said, "Oh, no, you couldn't do that."

I said, "Why?"

He said, "Oh, that's too drastic. We've got enough centers."

I said, "But, look, Dr. Fletcher, right now you've got every NASA center fighting each other over what role they're going to play on Space Station. I mean, they're stabbing each other in the back. So what are you going to do? Would you divide up the Mars program among all these centers and let them fight about it, or would you pick one as the lead center and make the rest of them so mad that they'll never cooperate?" I said, "You know, what people don't realize is one reason that Apollo was successful was, planned or unplanned, NASA formed a brand-new NASA center in Houston, and because of the judgment of people like Bob Gilruth, Chris Kraft, Max [Maxime A.] Faget, didn't want to hire a bunch of old aircraft workers, aerospace engineers, experienced people. They wanted us stupid college guys, like me, who didn't know any better. They said, 'Okay, you guys, we're going to put a man on the Moon in ten years.' 'Oh, okay, we'll go do it.'" [Laughter]

And I was serious. If NASA were to get approval to do a manned Mars mission now, I am 100 percent convinced, unfortunately, and it hurts to say this, even the Johnson Space Center couldn't do it. You would have to go somewhere. Kansas, Utah, I don't know. Start all over again. Get a bunch of good leaders like we had, Gilruth, Kraft, etc., and hire a bunch of smart college people. College graduates now are a lot smarter than we were when I graduated from college. I mean, there's no lack of talent, and young people like to be challenged.

I have no doubt that if the President and the Congress were to approve a manned Mars mission by 2010, within this decade, and NASA did form a new center populated mostly by people in their twenties, as we were at Manned Spacecraft Center forty years ago, that it could be done. I have no doubt that it could be done. They would have the extreme difficulties, they'd have more bureaucracy to fight than we did, they'd figure out a way around it. They'd pull it off just like we did. Nothing would make me happier than to see that.

BUTLER: That would be wonderful. It'd be great.

BOSTICK: But it would be a kiss of death to try to divide it up among the NASA centers right now. That's a sad commentary, but if we don't realize that, then we're really hurting.

BUTLER: Yes. You mentioned again, and you've mentioned throughout, a lot of the leaders and the people that you worked with that really made such a big impact on you and on the program as a whole. Were there any other thoughts you had on those individuals, or on any other people that—

BOSTICK: Oh, gosh, yes. Of course, I've mentioned Gilruth and Kraft. And enough said, they did their jobs. They were wonderful people to work with. I had to add to that category Carl Huss who was my real first day-to-day boss in mission planning and even in the control center. Just a real inspiration, would not accept any kind of bureaucracy BS or anything. His favorite phrase was, "You've got to learn how to be operational." He would put down people in the program office or anywhere because they weren't operational. I mean, it's time to check your gut. I mean, it's yes or no, you've got two minutes to debate this, don't waste all day, make up your mind. That's being operational. Get all the facts [and analyze them].

Glynn Lunney for sure. I am extremely, extremely fortunate to have worked most of my NASA career with Glynn. I've been his deputy probably three or four different times in different jobs. Well, first of all, he has a great human resource capability. He knows how to motivate people. People like to work for Glynn. That's a special talent. More so than anybody I have ever known, though, he can take a most complicated situation, the most convoluted set of circumstances and sort out all the crap and come to a logical conclusion in less time than anybody I've ever known. It's just an uncanny capability. I mean, you know, everybody else, even some real smart people that I've known, can look at a situation and just wring their hands and say, "Oh, me, what are we going to do?" Glynn just kind of casually sizes it up and he says, "Well, you take this and you throw that away and you ignore that, because that ain't got anything to do with it, and it's not time to deal with that yet. The most important thing, the first priority is, you've got to do this, and then you got to do that, that, and that." Then everybody kind of says, "Oh, he's right." [Laughter]

Lyn Dunseith is another extremely brilliant person, very much like Sig Sjoberg. A very nice person. Never raised his voice, never screamed and hollered. Just very easygoing. Very much alike, Sjoberg and Dunseith, very, very super people.

John Mayer, who was my division chief in MPAD, very smart guy. Cliff Charlesworth, prince of a guy. He and Lunney probably taught me more than anybody else, on-the-job training, probably because they were my bosses, along with Huss. But very patient, or at least I always thought he was, and you might get some debate about that. [Laughter] He put up with a lot of crap from me, I know. I thought he was extremely patient.

Those are the ones that really stand out. Max Faget was a person that I didn't ever really know that well until after Apollo, but he was a god. I mean, there was Wernher von Braun and there was Max Faget. I mean, he invented the Mercury spacecraft and he designed the Shuttle. I probably went to the other side of the hall when I saw him coming, you know. [Laughter]

Then after I had served a couple of years in [NASA] Headquarters [Washington, DC], and I was back at the Johnson Space Center in the technical planning office, Max walks into my office one day and closed the door. I thought, "Oh, me. Okay, what have I done now?" Because one of the things that I did in that job was divide up research and technology money that the center got between the various directorates, and he was head of the engineering directorate. I thought, "Okay, well, I haven't given his directorates enough money and he's coming in to rake me over the coals."

But he closed the door and he said, "I have a question to ask you." I'm just about to tremble. He said, "My secretary tells me she's reviewed every office, every division, every directorate, every staff office at the center, their input and output, as far as memos and documentation and all of that. She says your office is the most efficient. Would you tell me how you do that?" [Laughter]

So for thirty minutes then I sat and lecture Max Faget on how to run an office. [Laughter] I remember going home and telling my wife, "Okay, yes, I think I've arrived today." [Laughter]

But Max Faget is just a brilliant person. He still used a slide rule. He could figure out stuff on a slide rule faster than we could on a computer. And it never stopped. Just anytime we had a major technical problem in the control center, he was one of the first guys that got called. I mean, not only because he controlled a lot of resources that we used, but because of his brain. I mean, he was just a very brilliant guy.

For example, on the first Shuttle flight, we had a horrible problem with the pressure buildup at engine ignition and before liftoff. The engines are running for three seconds or so before they release the bolts and liftoff. It was causing a back pressure, and actually it was bending some components on the Shuttle. Not a good situation. We were in endless meetings on how to solve that, contractors and people.

One Saturday, in walks Max, who had pictures and some prototype material and stuff he'd gone and bought with his own money, some sailcloth, and he'd set up this thing in his backyard and stuff, and figuring out, "Hey, well, now here's what you need to do. You stretch this cloth across there and put water in it and then on ignition it'll finally burn this away, but the water will stop the pressure from coming back up." It's the solution they still use today. I swear he did it, I don't know, within a couple of weeks and by himself.

BUTLER: Wow.

BOSTICK: We probably would still been in those meetings trying to figure out how to do that without Max. He has to be up there. Not a real personable guy, and he'll tell you that. But a brilliant mind, brilliant engineer. I wish I'd had the opportunity to work more with him. Hopefully a little of his engineering smarts would have rubbed off. [Laughter]

BUTLER: Certainly a lot of very unique and good people that you had a chance to work with.

BOSTICK: Yes. As I think about it especially, I'm the luckiest guy in the world because of just how I got there and then to have that many good people around. I'll tell you something, and I haven't told many people this, and I have to be careful because they don't understand it, I guess, but I spent a couple of years at NASA headquarters, and then when I left NASA I went out into [the] aerospace [industry] with the Grumman [Aircraft Engineering] Corporation, outstanding company, and I could talk all day about what a good company it is and what good people they had.

But I learned at both headquarters and at Grumman, what I hadn't realized until I got in those environments was that at JSC in the sixties I was surrounded by competent people. It wasn't just a few like Gilruth and Kraft and Dunseith and Lunney and Charlesworth and Faget. I mean, yes, they're the standouts. Everybody was competent. The teamwork that we had was just incredible.

Unfortunately, I didn't find that outside the Johnson Space Center. And it's not just knowing who the people are, but what I hadn't realized is that at JSC, if you needed help, you could get it really quickly. There were people there who not only knew, were smart enough to solve the problem, but were willing to do it. I didn't find that at headquarters. I didn't find that in industry, either. It wasn't just Grumman; I spent a couple of years with United Space Alliance in my last job. Smart people. Some of the same people. Even Glynn Lunney, he was there, that's the reason I was there. But nothing like we had at the Johnson Space Center in the sixties. And until you get taken out of that environment, unfortunately you don't realize that you're in it.

BUTLER: When you didn't have anything else to compare it to.

BOSTICK: Right. Yes. But I was surrounded by competence, and that's a luxury that you don't find, unfortunately.

BUTLER: Certainly pretty unique to be able to have that experience, that situation.

BOSTICK: Yes. I think that probably the only way to create it again is, like I said, if we get another great challenge, is to get a bunch of guys in their twenties and tell them to go do it, and they'll figure out a way to do it.

BUTLER: Well, maybe we'll see that happen.

BOSTICK: I hope so. I hope so. I'm not nearly as optimistic as I used to be. [Laughter]

BUTLER: Well, Columbus certainly had his share of difficulties along the way, so maybe we're just in one of those dry spells, and there's hope yet.

BOSTICK: Yes. It just seems a shame that, of course, this is a sign I'm getting old, but it's incredible for me to now meet people who weren't even born at the time we landed on the Moon. It's like a historical event rather than an ongoing thing. In fact, there are even people, "Oh, did you all really do that, or is that something you made up?" [Laughter] It's kind of sad.

BUTLER: It's very sad.

BOSTICK: But even on the counterpart, the really young kids that I run into, like here in a couple of weeks I'm going to Austin to talk to an elementary school class, and I've done that a number of times, that just gets me all jived up again, because they are so gung-ho. This is the Grissom Elementary School, and they've had some experiments on the Shuttle.

BUTLER: Great.

BOSTICK: In fact, you could give them the Mars project and they'd pull it off. [Laughter]

BUTLER: Well, they certainly are still enthused about it, like you said and they've got a lot of ideas, and they certainly do have a lot of experience on their own. They are playing with computers more now than a lot of us have been.

BOSTICK: Oh, yes. I heard something recently that the Air Force has been able to cut back on their training drastically because the people, the recruits they're getting now are so much more qualified, have much better hand-eye coordination than in the past, that they've been able to eliminate or cut back a lot of their in-flight, in-cockpit training time, and they're doing it on the ground with simulators. Like you can buy software and run on your own computer.

BUTLER: That's pretty interesting.

BOSTICK: I'm sure it's true that kids now that play computer games all day long, they probably have good hand-eye coordination.

BUTLER: Certainly do. Certainly do. Well, I want to thank you very much for sharing all of this with me today. It's been fascinating.

BOSTICK: I hope I didn't bore you to tears.

BUTLER: Not at all. Not at all. I thoroughly enjoyed it.

[End of interview]