

## ORAL HISTORY 2 TRANSCRIPT

JERRY C. BOSTICK  
INTERVIEWED BY CAROL BUTLER  
HOUSTON, TEXAS – 24 JUNE 2000

BUTLER: Today is June 24, 2000. This oral history with Jerry Bostick is being conducted in the offices of the Signal Corporation for the Johnson Space Center Oral History Project. Carol Butler is the interviewer and is assisted by Summer Bergen and Sandra Johnson. Thank you for joining us again today.

BOSTICK: Thank you. It's my pleasure.

BUTLER: Last time we talked about your early career, up through the Apollo Program. About at the end of the Apollo Program, you then moved up to NASA Headquarters in Washington. Can you talk about how that came about and what role you moved into there?

BOSTICK: That was, as you said, at the end of Apollo, and we were quite disappointed that it had to end at 17. We were just getting into Skylab. Skylab, although an interesting program, for me especially, I think, and most of the flight controllers, was not that exciting. It was pretty boring. In fact, that's what we were doing, was boring holes in the sky, just going around and around in Earth orbit. So it made me think about what I wanted to do for the rest of my life.

[Gerald D.] Gerry Griffin, who was a good friend of mine, lived just down the street, had been first a guidance, navigation, and control [GNC] officer and then a flight director during Apollo, had just been appointed Assistant Administrator of NASA for Legislative Affairs and

had moved to Washington [D.C.]. So I gave Gerry a call and said, "What's going on in Washington?" because I had spent some time there. In fact, I was a page and then a doorman in Congress and went to high school in Washington, to Capitol Page School. So I'd spent about two and a half years on Capitol Hill, and I thought, you know, legislative affairs and all that, that might be an interesting thing. So I called Gerry, and he said, "Sure. If nothing else, you can come to work for me. But let me talk to George [M.] Low," who was the Deputy Administrator at the time, "and see what he thinks or see if there's something else." That ended up, I went up for an interview.

George Low wanted me to come up to the Administrator's office and be, I think they called it at that time Assistant Executive [Secretary], was the official title. But we really called it "horse-holder," because there were three principals in the Administrator's office: the Administrator, who was [James C.] Jim Fletcher, George Low, who was the Deputy Administrator, and Willis Shapley, who was the Associate Deputy Administrator.

So for each of the three principals they had an executive secretary. [Henry E.] Pete Clements was the Executive Secretary, and Frank Hoban and I were titled Assistant Executive Secretaries. Usually Pete would hold Dr. Fletcher's horse, and Frank Hoban would take care of George Low, and I was to take care of Shapley. "Take care of" meant that we attended all of their meetings and screened their mail. It was kind of an interface between them and the other people at Headquarters, the Associate and Assistant Administrators.

They had really divided up the office such that George Low kind of managed internally. He managed the NASA centers. Willis Shapley took care of Washington. He worried about interfaces with Congress and the White House and the budget and all of that other stuff. Of course, Jim Fletcher was the boss. But because I had the most recent experience anyway in

flight operations and we were, as I said earlier, then flying Skylab, I spent probably more time with Jim Fletcher than I did with Shapley, because he wanted a daily briefing on what was going on in the missions. Pete Clements, who was really his principal horse-holder, also didn't like to travel, so anytime that Fletcher traveled, I got to travel with him. So that's how all that came about. It was a horse-holder's job. That's good description for it.

BUTLER: Certainly it sounded like it was something that was useful, though, for everybody.

BOSTICK: Hopefully so.

BUTLER: After you had been up there for a while, around about a year, you then moved over into the Office of Energy Programs. Is that correct?

BOSTICK: Yes, that's right. That was in '73, at the beginning of the then current energy crisis. All of the government agencies were trying to figure out what they could do to help out. So that was a question Administrator Fletcher had then is, what can we do?

The decision was to bring Jack [Harrison H.] Schmitt, a geologist astronaut who had flown on Apollo 17, up to Headquarters for ninety days to study that question: what can NASA do to help out with the energy crisis? Because I knew Jack, I was assigned to work with him on that question, in addition to my other horse-holder duties. So he and I spent the ninety days deciding if and what NASA could do to help energy. The conclusion was that, yes, NASA could probably have some things going that would help out. So we put together this final

presentation to take to the Administrator to say, "Yes, we should form an office. We can do something. Here's how the office ought to be structured," etc.

I knew, because I worked with Fletcher every day also, that if that was going to be the conclusion, that he was going to ask Jack to stay and head up the office. So literally as we were walking down the hall to give the presentation, I said, "Jack, I want to warn you. He may ask you, if he buys our conclusion that an Office of Energy Program should be formed, he probably is going to ask you to head it up. So you need to be prepared for an answer."

He said, "No, I don't want to do that. I want to go back to Houston and continue being an astronaut. No way would I do that." We walked on for a little while, and before we got to the office, he turned to me and said, "Well, how about you? Would you like to do that?"

I said, "No. No, I came up here to be a horse-holder, and I too want to go back to Houston."

In the middle of the presentation, after Jack had said, "We should form an office," Fletcher popped the question to him, and he said, "Okay."

And I thought, "Schmitt! You copped out. You said you weren't going to do that, but here you've agreed to do it." Then about five minutes later in the presentation, actually when I was up to give them part of the presentation, Jack raised his hand, and he said, "Dr. Fletcher, I may have spoken in haste earlier when I agreed that I would head up the office."

And I thought, "Okay. Now his backbone's coming out, and he's going to tell him, no, he's not going to do that."

He said, "I will only do that if you'll allow Jerry to work with me in the office."

So Fletcher then turned to me and said, "Well, Jerry, what do you think?"

I said, "Fine with me." [Laughter] So that's how that transition happened.

We did that for about another year, and as the government tried to get their act together with all of the various agencies trying to come up with solutions or ways that they could help out with the energy crisis. That's when we had long gas lines and high gasoline prices, not as high as they are today, but pretty high. But then the conclusion of the government overall was that they would form a Department of Energy and could consolidate everything into one department and one agency. So that's when Jack decided he would go off and run for the Senate in New Mexico, and I decided I would come back to Houston.

BUTLER: While NASA was having their own separate office for the energy situation, what sorts of ideas were you looking at at that point?

BOSTICK: First of all, we looked at the stuff that NASA was already engaged in, such things as solar energy, because obviously we had satellites that were powered with solar energy through solar cells. We also had several of the centers who had been looking at solar panels where you run water through panels and it is heated by the sun. Primarily at the Lewis Research Center in Cleveland they had been doing some work on windmills, because they had been an aeronautics research center and knew all about propellers and stuff. They said, "Well, a propeller is just another type of windmill, so maybe we could help out with that."

And we had some other research going on in things like Brayton cycles and ways that you could not only generate power for orbiting spacecraft, but if we went back to the Moon or Mars or somewhere, there were ways that you could generate energy or electricity. So it was those types of things that we were primarily engaged in.

NASA also, in fact, at the Johnson Space Center primarily, was engaged in what they call modular integrated utility systems, which the concept was if we do do long-duration missions, we're going to have to utilize everything we have on board as much as we can—waste materials, for example, to either generate water or electricity or to grow plants. It was that kind of a concept. Had a program that had been quite successful at JSC in demonstrating a few of those concepts. So we looked at that, and it was a viable concept, but at that time it was still very expensive. But we did, in fact, build a prototype modular integrated utility system house at Langley.

JSC didn't want to do that at the time. Chris Kraft was the center director, and in retrospect, I think rightly so, was not very interested in what we were doing in energy programs. He kept saying, "Our mission is manned spaceflight, and it is a distraction to take the stuff that we are doing research and that would benefit manned spaceflight and try to apply that to terrestrial uses. It's a good thing to do, but someone else should do that. We should concentrate on manned spaceflight."

So that was a kind of a problem for me and Jack in the energy office, because we had five million dollars, I think it was, to start out with, to divide up among the centers to do research projects. JSC, by and large, didn't really want to be a part of it at all, whereas Marshall, for example, would take anything. If you say, "We'd like for you to do research on how you can turn chicken manure into power," their first question was, "How much money are you going to give us?" and they'd take it. But Kraft at the time, although it frustrated me, I think rightly so, said, "No, I don't that's an appropriate thing for the Johnson Space Center to be involved in. If it's not going to benefit manned spaceflight, then someone else should do it."

A lot of those projects were then taken over by the Department of Energy once it was formed, or at least the terrestrial application part of the projects, so then NASA got out of the terrestrial energy business, and rightly so, I think.

BUTLER: It's interesting, in the light of mentioning the higher gas prices at the time, that all of this came about, and here we have been lately trying to figure out exactly why we're having prices as high as they are.

BOSTICK: Once again, yes. But it's also interesting to note that this was about, what, twenty-seven years ago now? And there were some predictions at that time that we would totally run out of petroleum resources within twenty years. Jack, being a geologist, was one of the people who clearly didn't believe those studies. He said, "There's more petroleum in the ground than we know about. We just haven't found it. It may be hard to find and it may not be very economical to recover, but there's a lot there." But it doesn't mean that we should rely on that. If we can come up with things like wind power. And we even looked at tides for a while, because that's a real interesting concept, that tides are free just like the wind. You can generate electricity with tides, but it's an expensive process. It's still not economical to do. It was an interesting sidelight, away from pure space business, I guess.

BUTLER: It's certainly something that has a lot of applications to the Earth as a whole.

BOSTICK: And we're going to need a lot of that when we go to Mars. We're going to have to generate our own electricity there.

BUTLER: Absolutely, and hopefully, with recent progress and discoveries being made there, maybe that'll happen a little sooner.

BOSTICK: Yes, if there really is water there, that sheds a whole new light. I'm very encouraged by that. I hope it's true, and I hope it inspires some people to be a little more aggressive about the possibility of sending people there.

BUTLER: Certainly is exciting news. That would, I would hope, help spur things.

BOSTICK: We should go find out.

BUTLER: That's right. You say that then after you had worked here for a while and as they were forming the Department of Energy, about that time was when you came back down to Houston.

BOSTICK: Yes.

BUTLER: You had mentioned that earlier when you were first proposing the idea for the Office of Energy, that both you and Jack Schmitt had been interested in coming back down here at some point anyway. How then did that come about? Was it again contacting somebody and saying, "Okay, I'm ready for another move"?

BOSTICK: That's kind of interesting, I guess, because part of my agreement with George Low, who was the Deputy Administrator at the time, when I went to Headquarters, was that I most likely would not come back to Houston. That was a part of his career path thing, that, first of all, everybody should spend a little time at Headquarters, but then people should move around from center to center.

So when Jack Schmitt decided that he wanted to run for the Senate and I decided that I wanted to leave Headquarters after I'd been there for a couple of years, I went to see George Low. He said, "Okay, well, then I'll set you up with interviews at all the other NASA centers."

I said, "I really think I want to go back to Houston."

He said, "Well, I know, but that was a part of our deal." [Laughter]

So I had to go through interviews at Langley [Research Center, Hampton, Virginia] and Lewis [Research Center, Cleveland, Ohio] and Huntsville [Marshall Space Flight Center, Alabama] and Kennedy [Space Center, Florida] and all these places that I really didn't want to go to. I wanted to come back to Houston.

Finally, Chris Kraft, who was the center director, got involved and told George Low, "I'd like to have him back in Houston."

He said, "Well, okay, but you have to get specific. What kind of jobs are you going to offer to him? The bad thing is people come up here, they usually go back to their home center, and they go back to their old job."

Kraft said, "He can have any job he wants. I'll put him on my staff." So that's how it ended up.

Low finally said, "Okay. I guess you want to go back to Houston. Kraft acts like he wants you to come back, so I'm not going to interfere." So I got to come back home.

BUTLER: And it worked out well.

BOSTICK: Yes, I think so. The job that Chris had in mind was as chief of the Technical Planning Office. [Joseph P.] Joe Loftus, who was the chief, was going off to school for a year, and it was known that he was going to come back and most likely would want to come back to the same job. So I knew it was just kind of a babysitting job for a year, but it was an interesting job that involved allocation of research and technology money that came into the center, and technology transfer and advance mission planning, or advance program planning primarily. At that time advance planning was, should we do a space station, or should we do the Shuttle, or should we go to Mars. There was no lack of concepts that people were coming up with for what NASA should do in the future, so that's what the staff job was at the time.

BUTLER: And so you were in that for about a year.

BOSTICK: Yes, almost exactly a year, as I recall.

BUTLER: And during that time, you worked on something called the Space Transportation System User Charge Policy?

BOSTICK: Oh, yes. The Shuttle was coming about then. The obvious question came up, how much do we charge people to fly a payload on the Shuttle? How much is it going to cost? Because that was a part of the job of selling the Shuttle to the Congress and the administration at

the time. It was really being sold as a—that it would pay for itself, that we could fly enough missions and charge enough, either for NASA programs or other federal agencies and Department of Defense and people like that, that it would really pay for itself. So we did.

That came under the category in the Technical Planning Office of advance program planning. So we did all kinds of studies about how many flights a year could you really fly. We came up with some pretty astronomical numbers. And I had worked a little bit on this when I was horse-holder for Fletcher in Washington. NASA had contracted with a guy named Klaus Heiss, who was an economist. He had done a number of studies about how many flights you'd have to fly per year in order for the Shuttle to pay for itself.

So we updated those studies and went into more depth. I recall we would go to Washington to brief Jim Fletcher at the time and say, "We're now to seventy-five flights a year and this is how much it's going to cost." Then he'd say, "Well, divide by a larger number. We have to fly more flights a year." So we got up to some pretty astronomical flights per year just to make it economical.

To answer your question, the User Charge Policy Group that we put together and I headed, involved people from all of the manned spaceflight centers. Our challenge was really to try to come up with a realistic cost for the whole payload. How much is it going to cost? Then how do you divide it up? In most cases, customers would not want to utilize the entire payload bay. So one of the first questions was, do you charge people by weight or volume? Because they're both constraints.

We kind of came up with a compromise between the two, but based primarily on volume. We divided the payload bay up into essentially quarters, and said if you take up a quarter of the bay, it's going to cost you this much and these are the services that you're going

to get for that, because it wouldn't have been reasonable—some payloads would fill up the whole bay and really not weigh that much, but you still had to provide a lot of services and you couldn't fly anything else with them. So it was more reasonable to base it on how much space they can consume rather than only based on weight. Of course, you had to consider the weight also.

So the group basically came up with that policy that says if you want to fly on the Shuttle, depending on your size and weight and the services that you need, and we defined standard services, [this is how much it will cost]. That was the main thing that we did, which says that if you buy a quarter of the payload bay, you get X amount of power and you get so much telemetry, and you'd get hold-down provisions to tie you into the bay and all that, and this is what you get for that price.

BUTLER: Seems like a complicated process to have to—since you hadn't had really in the previous programs anything that had to take those things into consideration.

BOSTICK: It was somewhat complicated, but we tried to simplify it as much as we could. It had other constraints, that one payload had to be compatible with other payloads. They couldn't have emissions. A safety consideration. All of the payloads combined that were going on a flight had to be compatible. We tried to make it as simple as possible, because, as you would probably expect, everybody complained that it was too complicated, and I guess they still are.  
[Laughter]

BUTLER: It seems to be working, or at least it seems to work pretty well.

BOSTICK: And it's been simplified somewhat over the years. But there are some basic requirements. If we had not standardized services, then you would have to have custom accommodations for every payload that came along, and the cost would have been prohibitive. Although we were acting somewhat bureaucratic, I guess, in establishing the standards, we tried to make it as easy as possible, but as I said, everybody still complained that we were being too bureaucratic and we were establishing unreasonable requirements.

BUTLER: Having come back to Houston now, and this was more of an administrative managerial-type role and similar to some extent to what you had been doing at Headquarters, but very different from what you'd been doing early on in the control center, can you talk a little bit about that transition from Houston to Washington the first time and then back to Houston, what were some of the differences and challenges?

BOSTICK: First of all, going to Washington was a real eye-opener. I realized for the first time in my career, I guess, the importance of Headquarters, because in the past, you know, the people out in the field have not a lot of regard for Headquarters. They're seen as an impediment rather than a help.

But I realized very quickly when I got up there—well, I was shocked to find out the frequency and the intensity, I guess, of the communication between NASA and the Congress, and NASA and the White House, for example. The congressional interface between the Administrator's office or some high-level office at NASA was an hourly thing. I mean, some congressmen called and wanted to know this or that, and some high NASA official had to go up

on the Hill two or three times a day on an average, probably. The Administrator was probably up there a couple of times a week. There was quite a bit of interface with the White House also. I never realized all that stuff was going on. And the budget process turned out to be a lot more complicated than I had ever imagined.

Here I was in Houston, where NASA is king, you know. Everybody in Houston thought that NASA was number one and great. You go to Washington, and in the federal bureaucracy, NASA's like number 186 on the totem pole. For example, sometimes when the Administrator traveled, we used a Department of Defense [DoD] plane. So he would say, "I want to go to Boston on this weekend," and I would call up DoD and say, "We need an airplane."

They would say, "Oh, yeah, NASA. Well, we've got ahead of you, you know, all of these other agencies, Department of Transportation, everybody else." And it really shocked me—that was another shock I had—is how in the Washington environment, how low NASA was on the totem pole and what a competition for resources, including the budget, you know, that funded the agency, what a competition there was.

So I developed a higher appreciation for Headquarters, but also concluded that that wasn't the environment that I wanted to live in. That was best left to bureaucrats, and I didn't want to become a bureaucrat. I wanted to come back to Houston.

Although the job that I came back to was quite different than what I had been doing in flight control, it still had some operational aspects to it, like, how do we charge people for the Shuttle and how are we going to fly the Shuttle. So I think that my background helped somewhat that, and it was still, it was a pressing question and it's something that had to be solved. That's very much like the job that we had in flight operations. It's something that has to

be done, so you just go do it. So even though it was, you're right, it was somewhat different, it was still the same kind of challenge. I enjoyed it a lot.

BUTLER: Two very different worlds between the political bureaucratic arena and the operational field center.

BOSTICK: Yes, and I guess it made me believe in George Low's principle that before you get too high in a field center, that you should spend a little time at Headquarters. I know that's still probably a very unpopular thing, but I think you have to develop an understanding of what really goes on at Headquarters. You don't have to like it; you just have to know that it's there and necessary. And I think it would be beneficial for anybody in upper management to spend at least a year at Headquarters.

BUTLER: Certainly we've seen that a lot with people we've talked to on this project, that they have gone up there. Several of them have expressed similar viewpoints.

BOSTICK: Well, it was an eye-opener. Educational. As long as you learn something, you know it's not a lost cause.

BUTLER: Absolutely. You should always be able to learn something or get something out of what you're doing.

After you spent a year in the Technical Planning Office, then did Joe Loftus come back at that point and then you moved on into the Payload Deployment and Retrieval Systems Office?

BOSTICK: Right. Joe was about to come back, I think probably within a month. And that was an interesting transition once again. Late one afternoon after normal working hours—my office was just across the lobby from Dr. Kraft, who was the center director at the time, about five-thirty, six o'clock or something, he strolled into my office and he said, "Do you know what RMS stands for?"

And I said, "Root-mean-squared?" [Laughter]

And he said, "Okay, you're the guy for the job."

And I said, "What job?"

He said, "Well, Jerry [P.] Carr just left my office, screaming and hollering about how terrible the RMS, the remote manipulator system, the mechanical arm that's going to fly on the Shuttle, how terrible it is. It'll never work, it's going to be like a wet noodle, he called it. It's unsafe. Even though the Canadians are building it and they're going to give it to us, we shouldn't accept it, or we ought to go spend a lot of money and fix it, because it's terrible. Won't work. Useless."

So he said, "Tomorrow morning, I want you to talk to Aaron Cohen," who was the Orbiter project manager, and RMS came under Orbiter because it was a part of the Orbiter. "I want you to go talk to Aaron and see if you can't fix it."

"Okay. Yes, sir." So I went down to see Aaron and we established the Office of Payload Deployment and Retrieval Systems, which, of course, the primary piece of hardware

was the RMS. But we had to have other things like attachment fittings and visual aids, but the overall question was how do you deploy payloads from the Shuttle and how do you retrieve them and put them back in? So that's how that came about. Another one of those challenges from Dr. Kraft.

BUTLER: He's good at giving those out.

BOSTICK: Yes, he is.

BUTLER: And he's good at giving them to the right people, it seems.

BOSTICK: Well, hopefully.

BUTLER: Well, the arm has certainly been very successful.

BOSTICK: Yes, I take a lot of pride in that, because there were a lot of people, it turned out, who shared Jerry Carr's opinion. In fact, one of them was Glynn [S.] Lunney, who was in SPIDO, in the Shuttle Payload Integration and Development Office. Glynn was one of my heros. I had worked with him just about all of my NASA career. I really looked up to Glynn. In fact, I went to see him pretty soon after I talked to Aaron Cohen about, "What do you think about the RMS?"

He said, "It's a piece of junk. Get rid of it. It won't ever work. We're working on some other ways to deploy payloads, rotating arms. This thing with a cherry-picker sticking out of the

back of the cockpit, every time you fire the jets on the Orbiter, it's going to vibrate. It's probably going to break off. Just forget it. Career-wise, this is a dead-end. Don't go do that, because you're going to fail." [Laughter] But it worked out very well.

It was very interesting in working with the Canadians. We didn't have a lot of money. In fact, almost every time, the past five or six years, every time I run into Aaron Cohen, one of his questions is, "I still haven't figured out how you guys did that, because I didn't give you any money."

I'd say, "No, sir, you didn't give us any money. We had to scrounge to get it done."

But it worked out very well. We were very fortunate to get some real good people to work in the office. Milt Windler was one. In fact, it's interesting that when I started looking at people around the center that I could try to steal to come and help me solve that problem, I looked at primarily the engineering directorate and flight operations. My conclusion, unbiased as I am, even though I came from flight operations, was that the flight ops people understood engineering integration a lot better than the engineering people, because most of the engineers say, "Well, this is my system and I am an expert," and they are or were. They know that system better than anybody in the world. You say, "But how does it interface with this system over here?"

They say, "Oh, I don't know. That's his system."

"How about the one over here?"

"Well, that's not mine either."

Integration is the job of how do all of these things work together. Even though we didn't know it at the time, people in flight ops have to address questions like that, because you're flying them. You have to be concerned about how everything works together. So I

[found] most of the people, like Milt Windler, who had been in flight ops, a flight director on Apollo, he came over and was a great help.

We got some good assignments from the Astronaut Office also. We had [William B.] Bill Lenoir and [Norman E.] Norm Thagard, Sally [K.] Ride, [Judith A.] Judy Resnick for a while, and they were very good, very objective. They took the attitude that there's a job to be done here, and, yes, the Astronaut Office is against the RMS, they don't like it or are afraid of it or whatever, but they kept an open mind and were very, extremely helpful in deriving reasonable requirements, and working with the Canadians and the Orbiter people on how we were going to integrate this whole thing together. So, yes, I take a lot of pride in seeing that it works. In fact, the first time we flew the RMS on the Shuttle, I have to admit I went to Glynn Lunney and said, "Never work, huh?" [Laughter]

BUTLER: I think that's justified.

BOSTICK: Of course, it's used for everything. We had to develop not only the hardware, integration included operational techniques, because when you're going to retrieve a payload, you have to rendezvous with the arm already extended. So you're firing the thrusters on the Orbiter, and it does put a stress on the arm. So we had to come up with techniques that only used certain thrusters and different approaches and all of that. And it works. I'm very proud of that.

But when they were doing Hubble Space Telescope, the repair, and the astronauts were out there on the end and they were able just to move a few feet this way or a few feet that way, that way, very precise control, then I thought, "All right. It does work."

BUTLER: Absolutely. It's become a critical part of the Shuttle system.

BOSTICK: Yes.

BUTLER: You've mentioned some of the concerns that Jerry Carr had come in talking to Chris Kraft about. Were there a lot of actual engineering challenges that had to be overcome for the arm, or was it more just figuring how to use it with everything else?

BOSTICK: It was primarily an integration problem. There were some engineering problems or questions, like the stiffness of the arm. As I mentioned a number of times, the Canadian government had agreed to build the arm and to "give" it to the United States for use on the Shuttle. Of course, we were going to buy some more. So the immediate question was how you attach it to the Orbiter. There was a lot of argument about, "That's your side," "No, that's your side," and who's responsible for this and that. But we finally worked all of that out. The stiffness was an engineering challenge.

The control of the end effector itself, whether there's an astronaut on the end or you're just grappling a payload, was also a big question, because the arm has joints, like it has a shoulder and an elbow and a wrist and it has all those movements. You've seen cherry pickers out on construction jobs, for example. Most of them are limited to movement of one joint only at a time, so you move one joint, then you have to move the other. When you do that, you get some strange movements, like sometimes you think you're going to go up, and when you rotate this joint up, the end actually goes down.

So that was one of the first questions, and it took a lot of software to do that, to say, "I'm here. I don't care where the joints are." We don't want to hit anything, but the primary concern is, "The end effector is here and I want it to move that way. So don't make me move." And that was the input from the people that I mentioned from the Astronaut Office, is, "Let's develop the capability through software. I want to tell it I want to go plus X, two feet, or as long as I have my hand on the control and it'll do that."

Of course, the Canadians didn't want to do that. They said, "That's an operations thing, and if you do that, you have to pay for that, because we can get you to the same point, we just have to move each joint separately." So that was an engineering challenge.

Attaching it to the longeron on the Orbiter was another engineering challenge, because the longeron, or the side beam, on the payload bay is already built. That's the Orbiter. So it has a certain strength, and it also had a limited volume, because when you close the payload bay doors, it has to fit in this little space. So that was an engineering challenge, to build the base or the shoulder of the arm there strong enough and small enough that it would fit.

They were individual engineering challenges, but the big job overall was integrating all of that together: the Orbiter, the arm, the operation, the visual cues that your astronauts use. Because if you're standing up in the aft cockpit, looking out the back windows and it's way down here, it's really hard to judge what you're doing. So you had to develop even mirrors and targets and things to use as visual cues, and, as I mentioned, operational procedures for how you rendezvous with the arm out and how quickly you release payloads, and when you can grapple a free-flying payload, because if it's out there tumbling or spinning, you can't just go up and grab it, because you'll put enough torque on it to either break the arm or break it loose from the Orbiter. So a lot of operational procedures that had to be developed.

BUTLER: Must have been a little bit of a challenge, too, to even design a simulator for it on Earth, because the arm itself can't be used on Earth.

BOSTICK: That's right. The Canadians came up with a very good concept for how you could test the actual arm in a 1-G environment, because, as you said, it's just not strong enough to support its own weight in 1-G. It would break. You can't operate it. So they laid it down sideways on an air-bearing floor, on a very smooth, perfectly smooth floor, with little air jet pads to hold it up. So rather than being up like this, it's laying on its side, but then you could actually control the arm in a 1-G environment, you know, move it around. Of course, we had computer-based simulations also that were eventually developed that [would simulate] that.

We started out with a model over in Building 9—9A, I guess it is—where we used helium-filled balloons that would simulate the payloads. That's pretty good, but it's not obviously an accurate representation of zero-G, but it's about as close to the real thing. If you wanted to actually get into the real cockpit and use an arm, which in this case doesn't even look like the arm that flies on the Shuttle because it had to be beefed up a lot to do that, you could give the crews some simulation experience on retrieving and deploying payloads, which [helped with] primarily the visual cues. We spent a lot of time in building that and developing targets for the end effector, and visual cues and mirrors and cameras in the payload bay and cameras on the arm. We had to decide where do you put cameras on the arm that would give the operator the best view of what's going on.

BUTLER: Well, certainly it sounds like an interesting job.

BOSTICK: It was. It was a fun project. I enjoyed that. I think I enjoyed it somewhat just because people said it was impossible.

BUTLER: So that's the most fun, making the impossible possible. And here you had originally not even known what RMS was.

BOSTICK: I knew there was some mechanical arm, but that's about all I knew. [Laughter]

BUTLER: Came up to speed pretty quickly on that.

BOSTICK: But that's typical again of Chris Kraft, to find somebody who's not prejudiced about something and say, "Go fix it."

BUTLER: Certainly a good type of person to pick, because they can go in open-minded and say, "Okay, what can we do with this?"

BOSTICK: Chris has a knack for that.

BUTLER: From there, you moved on and you were involved with the Shuttle Program as a whole, the space transportation program, and getting into manifests. You were Deputy Manager of the Operations program there for a while. Did that all kind of come logically from your involvement with the arm and then previously with the policies and such?

BOSTICK: I guess it was logical. It's another one of those funny things. Glynn Lunney showed up in the office one day and said, "I've been offered a job in Headquarters as Deputy Assistant Administrator for Space Flight, and I'm really considering it. You spent a couple of years in Washington. Tell me about Headquarters and about living there. Where did you live?" and all of that. So we talked for probably a couple of hours about all of that. He said, "Well, I'm kind of inclined to take this job, and, oh, by the way, I've already talked to Chris, and if I take this, then you're going to come up and take over my job while I'm gone."

I said, "Well, thanks for telling me that." [Laughter]

So he went to Washington, and while he was gone, I guess I was originally Acting Manager of SPIDO, Shuttle Payload Integration and Development Office. Then sometime, I think before Glynn came back, we changed the name to STS Operations, which was Space Transportation System Operations, which was probably more descriptive of what we were doing, because we were involved in things other than just the payload integration at that time—how do you actually operate the Shuttle. So, yes, that's another one of those stories.

BUTLER: You always seem to be in the right place at the right time for these jobs.

BOSTICK: Or the wrong place.

BUTLER: You said you were more involved in operations as a whole, for the whole Shuttle then at that point. This was before the Shuttle actually began flying.

BOSTICK: Right. We still had the Shuttle Program Office at that time. Bob Thompson was the program manager. Of course, they were developing the Shuttle, and that's what they [should] do. But it was about time to think, okay, they're going to deliver this thing here pretty soon. So how are we going to fly it? Of course, those questions had been asked, but it was time to decide really within the parameters that had been discussed, things like, how do you land it? What kind of cross range? Do you just come for a direct, or do you fly around the heading alignment circle? What kind of crosswinds can you withstand?

Again, these questions had been addressed, had to be addressed when the Shuttle was designed and then built, but it was time then to look at the real capability, because it was being built and had been tested. You say, okay, these are the physical limitations of the Shuttle, and here are more details about the limitations of the ground facilities, the network. How do you tie it in with all of that? We were involved in establishing those ground rules for how are you really going to operate this vehicle. Abort modes. Where do [we] have to have continuously abort landing sites? What kind of crosswinds or winds can we tolerate to launch and still come back and land at the Cape? And those sorts of things. It was becoming more an operations question than just what kind of payloads can you integrate into it and fly.

BUTLER: Pinning down all the specific details to make it all really happen.

BOSTICK: Right. And of course, the flight operations people, whose primary responsibility it is, had been working on all of that for a while, but any capabilities that you need have to be paid for. So the program office had to address those, look at what's been developed, what the ops

people want, try to decide somewhere in the middle, that, yes, this is what we can afford, and so that these are the ground rules for how we're going to proceed.

BUTLER: You mentioned setting up the abort sites, and these were around the world. That must have been somewhat of a unique challenge because before, in the early programs, you hadn't really had to worry about that in particular since you're landing in the oceans, and now you have to take into account all the diplomatic relations and international details.

BOSTICK: That was a little different than it had been before. In the past, and I wasn't directly involved in Mercury, Gemini, and Apollo in that, but basically what we had said is, primarily we're going to land in the water, and we told people where we were going to land, and especially the surrounding countries to make sure they were okay. But there was a kind of a general rule that we may have to come down anywhere.

So the State Department, I guess, advised people that we were going to be flying over their countries and there was a very remote possibility that we might have to have a contingency landing, but, of course, it never happened. And I don't know how seriously they took that stuff. But, as you said, here we come with the Shuttle, and we had one of the abort modes near the end of the launch phase would be to land somewhere on the African or European continent, depending on the launch azimuth. So we had to work through the State Department and go and make real provisions to do that and, in fact, spend a lot of money to develop runways and radars and landing aids and all that sort of stuff. So it was more involved, but primarily the State Department took care of the diplomatic part of that. There was always problems, things that had to be worked out, but it wasn't that bad.

BUTLER: One question that comes to mind [in relation to] all that is when the Shuttle does land, especially out at Edwards [or] White Sands, it takes quite a bit of effort and time to actually get the Shuttle onto the plane and ship it back to the Cape. How would all that happen? Would that all be possible if the Shuttle were to land on one of the European or African sites, or would that just be a very involved process?

BOSTICK: It would be possible, but, yes, it would be very involved. That's why, even until today, you really want to land at Kennedy, because that's where you have to process it. We landed once at White Sands. Boy, what a mess. I think they're probably still getting sand out of the vehicle. But, yes, it would be a real challenge to get it back home, but obviously possible or it wouldn't be planned that way. The Shuttle carrier aircraft, in fact, at least once has flown to Europe. It went to the Paris Air Show one year. It's possible, but it's not something that you would really like to happen.

BUTLER: But certainly if it is an abort situation, you want to get them down.

BOSTICK: Oh yes. But the price you would have to pay to get it back is worth it if you save the vehicle and the crew. That's something you have to plan for that you hope you never have to do.

BUTLER: Absolutely.

BOSTICK: But you plan for it.

BUTLER: As you were working through all of this and still being involved somewhat with what the Shuttle was going to be carrying, as well as the operations of it, and this was again so different from everything that had been done before, and you were [involved with] working with a lot of different agencies and so forth, did all of this come together without a lot of— obviously there was a lot of challenges and a lot of difficulties going into it and in even early testing on the Shuttle, but were there a lot of changes along the way, I guess, is what I'm asking, by the time that you came into it? Or were things pretty well settling down into the way—

BOSTICK: Operational aspects were settling down fairly well. We still had the challenge of integrating all the payloads onto the Shuttle, because to justify the Shuttle, we had counted on having a lot of different types of customers, other government agencies, including the Department of Defense and, of course, that had all been approved at the highest level, but all of these other agencies and especially the Department of Defense weren't too happy about that. They didn't, in some cases, have a lot to fly on the Shuttle, and a lot of stuff that they were going to putting into orbit, they really didn't want to fly on the Shuttle, especially the DoD. So that was the real challenge in the early years of operating the Shuttle.

Even internal to NASA, there were some departments in NASA that were a lot easier to work with than others in integrating their payloads. It's not much of an exaggeration to say most of the customers came in and said, "Here, here's my payload, here's my requirements. Now you satisfy all that and fly it," and that's it. We said, "Wait a minute. It's our vehicle. It's a national resource, but we control it, and we have these standards, these policies, and you have

to meet those. If you're going to fly with us, these are the rules." So a lot of the initial meetings didn't go too well with those customers, even, as I said, internally with some of the NASA customers. A few went extremely well, but unfortunately that was kind of the exception.

The DoD, they came in kicking and screaming. They had their own unmanned launch vehicles. They'd been flying [then] for years. They were totally independent. They operated under a veil of secrecy. They weren't really happy about coming out from under, revealing their secrets to anybody else, which they had to do in some cases to fly on the Shuttle.

So, by and large, we were not very popular with the Department of Defense. It created a lot of problems. In addition just to flying, they had to spend a lot of money here in Houston, primarily in the control center and then around the network, when we were flying their payloads, to protect all of their data. They thought that was a totally unnecessary expense, or one that they could avoid if they just continued to fly on their unmanned vehicles. Some cases, they even had to make modifications to their spacecraft to fit in the payload bay. At a minimum, they had to make structural changes to adapt to mounting their payload, attaching it physically to the Shuttle. In some cases, they had to add a structural ring at a certain location to put the longeron fittings in the right place so you can attach it to the Shuttle. They obviously weren't too happy about that.

BUTLER: It's always been a challenge, even from the early [Dwight D.] Eisenhower days, with the first satellites as to how to balance the national security and military Department of Defense needs against a civilian space program.

BOSTICK: Of course, a lot of the security aspects of flying the DoD payloads was new to us, but we had worked under constraints before, because we started out with what had been military launch vehicles, for example. It still had some classified data associated with it. So we had some experience with that, and we certainly tried to be reasonable about all of the DoD payload security requirements, and I think we were. In fact, I think in a lot of cases we thought that the DoD was going overboard, going to extremes in order to protect information. But we acknowledged, in the end, "That's your responsibility. We'll abide by your rules for security. It's your money. You're having to pay to make all of these modifications."

I think we spent probably 35 million dollars on the control center to make it DoD-secure, and probably the only part that you can see are the entrance doors. All the rest of it's in the walls. But they felt it was necessary, and we felt it was their call, and if they paid for it, we'd do it. But they weren't happy campers, I have to admit that, by and large.

BUTLER: Ultimately it did work out, so that NASA and DoD were able—

BOSTICK: Oh, yes, we flew quite a few payloads. Yes, it worked out, but I don't think that the majority of the DoD people were still too happy about it. It's something that they had reluctantly agreed to. Those were the rules, so they'd abide by the rules, but they didn't have to like them.

BUTLER: I think now they actually have separated again, is that correct?

BOSTICK: Yes. After *Challenger*, there were a lot of decisions made about what types of payload. I think the Department of Defense, once again, seized upon that opportunity to say, "Hey, just let us take care of our own," and I can understand that. If I had been on their side, I probably would have argued the same way. "We know what we're doing. We've been doing it for years."

But, of course, that was part of the justification for the Space Shuttle in the beginning. It was going to be a national resource, and it was and is. We were and still are, I think, spending a lot too much money on the expendable launch vehicles for other agencies. But it's hard to get everybody to agree to use one vehicle, and in the process of doing that, they have to be somewhat subservient to a sister agency, and they don't like that. It's unfortunate, but I can understand it, though.

BUTLER: Probably a process that continues to evolve.

BOSTICK: Oh, yes, as long as there's any question about—there's been a lot of discussion over the years about if we really are going to have a space transportation system [we'll] take it away from NASA and give it to the Transportation Department or somebody. Of course, it wouldn't help the other agencies, like NOAA [National Oceanic and Atmospheric Administration], for example. They wouldn't like that any better than NASA probably. And even though there's probably some good arguments that that would be a good thing to do, even people within NASA are reluctant to give it up. But if it's just pure transportation, I guess I would have to agree that that's not NASA's business. Somebody else can operate the Shuttle just as well as we can. It kind of hurts to say that, but it's true. NASA's job should be exploration and research that leads

to that. I'm afraid we've gotten kind of bogged down with boring holes in the sky with the Shuttle.

BUTLER: We have been doing that for quite a few years now. Maybe as Space Station begins to actually move along—

BOSTICK: Hopefully so.

BUTLER: —that'll help spur things and continuing discoveries on flights like Mars and such things maybe.

BOSTICK: Certainly hope so.

BUTLER: You stayed involved with the Shuttle for quite a while and moved into a couple of different roles, eventually moving up to Deputy Manager of the Space Shuttle Program. Was this change in the name of—where you still involved in the same types of work?

BOSTICK: It was more or less the same thing. It came time after the development flights of the Shuttle that the Shuttle—see, we still had the Shuttle Program Office headed by Bob Thompson, and the Space Transportation System Operations Office headed by Glynn Lunney. But after the development flights of the Shuttle, the first four flights, it was time to consolidate all of that into one, because then it was the job of continuing some development on the Shuttle to build more and to make a few changes, but really to operate it. So it was not a big change at the time.

I continued doing more or less what I'd been doing. The title changed. Deputy Manager for Operations, [Arnold D.] Arnie Aldrich, came over and was—I've forgotten exactly what his title was, but it was Deputy Manager, Technical. He was more concerned with hardware, the development of the Orbiter and external tanks and the SRBs, and all of the hardware. Glynn Lunney was the overall manager. As far as I was concerned, it was more or less a continuation of the same thing that we'd been doing for the last couple of years.

BUTLER: Did you have a chance during any of this time to go down and see any of the launches?

BOSTICK: Yes. Not a lot, but enough. I never saw a night launch, which I really would—I wish I had.

BUTLER: There's still time.

BOSTICK: Oh, yes. I have to do that. Yes, and it was kind of fun to go back. I didn't witness any Apollo launches, because I was in the control center here, and I really missed being in the control center at the Cape when we first started out with Mercury, because you could hear it and you could feel it. The building even would shake. So I kind of missed that all during Apollo. I never, unfortunately, got to see an Apollo launch.

I saw one Skylab launch. I went down with Dr. Fletcher when I was working with him. We rode the vehicle out from the vertical assembly building out to the pad. Well, actually we

only went about half way because it...takes a long time, but that was interesting, and then we saw the launch.

I saw a couple of early Shuttle launches. It was more reminiscent of the Gemini-Titan launches because of the solid rocket boosters. They make a very distinctive sound. It's like the whole air is cracking. It's a very sharp, distinctive cracking sound. That brought back a lot of memories.

But Shuttle launches still, even today, I remember the STS-1...launch. I had worked in the trajectory world most of my life designing launch profiles, and I obviously had worked on the Shuttle and I knew exactly what was going to happen, but when it's unsymmetrical, when it lifts off and this unsymmetrical thing starts rotating around, it still looks kind of strange to me. Still haven't gotten over that.

BUTLER: That's understandable, I think. Must have been rewarding to see it all come together.

BOSTICK: But I would like to go see a night launch. Have do that sometime, I guess.

BUTLER: I'm sure there are still a few contacts that you can make the arrangements.

BOSTICK: Hopefully so. Hopefully so.

BUTLER: Certainly an interesting sight to see. Then you moved in to be Director of Mission Support. Obviously this is for Shuttle missions, but what was that? What were your duties there?

BOSTICK: Gerry Griffin was the center director at that time, and he decided that it would be better if he didn't have as many people reporting directly to him. So he kind of reorganized the center and grouped several directorates or divisions up together and formed this thing called mission support, that included five divisions: mission planning, flight simulation, flight software, flight support, which was the control center, and data systems, which had responsibility for operating all the computers around the center.

But the job was to provide the facilities for both training and execution of the Shuttle flights. That was primarily the Shuttle mission simulator and the control center. But then, in addition, to do the flight software and the mission planning for the Shuttle flights. Probably one of the best jobs I ever had. I really enjoyed that job. That was good.

BUTLER: Certainly sounds like it would be interesting.

BOSTICK: It was.

BUTLER: Were there any particular incidents or challenges during that time that really stick out for you?

BOSTICK: The continual struggle, of course, was the budget. We were under a lot of pressure to reduce the cost of operations. Hans Mark was the Deputy Administrator at this time, and he was really putting a lot of pressure on us to cut down on the cost of operations. We were making a real serious effort to do that.

I can't remember one single incident, but I do recall John Young walking into my office a number of times. This is back when he was still flying, and said, "I understand you've decided not to put this capability into the SMS because it's going to cost too much money. I don't think the government wants to operate like that. I'm not sure I want to fly if I can't try that out on the ground before I get in the vehicle." So there was a lot of pressure, especially from the astronauts, that they have as much capability in the Shuttle mission simulator as they could. I understand that, and I think we were able to provide most of that. In some cases, there had to be some compromises.

The budget and the pressures from not only the astronauts, but my old buddies, the operators in the control center who obviously want to always have more capability, but you had a stack of money this high, and that's all you had. So you had to be very judicious in how you utilized that money. That was a daily challenge, I guess. But it was still fun because it was operational, and I obviously like operations.

BUTLER: Did you ever get a chance to go down and help out in any simulations or participate in—?

BOSTICK: I did fly the SMS [Shuttle Mission Simulator] [because I'm the kind of] manager, I guess, that I think I can better appreciate what people are doing and what challenges they have if you go and find out. I did a lot of what people now, I found out later they called it management by walking around. In fact, at that time I had people in a number of divisions who said, "Gosh, I've been here for twenty years, and you're the first director that's ever been in my office." But I had a policy that if I needed to talk to a division chief or a branch chief or something, I didn't

call them and tell them to come to my office. I would say, "Can I come to your office?" And we would go and talk about it. Because I think that's how you really find out what's going on, is you go to their territory. Yes, I flew the SMS, and I am not a pilot. I had never flown an airplane or anything, but in the first attempt, the first time I got in the SMS, was a landing simulation, and I did land it.

BUTLER: Great.

BOSTICK: I won't say how many tires blew out, but it was successful, which surprised the hell out of me, frankly, that I was able to land it. Tried it a couple of more times and was not successful, to be honest about it. But I got a better appreciation for both what the developers of the facility were going through and the people who support the simulations and the crew themselves, what they had to contend with, and why they were arguing about they needed certain capabilities and all that.

Also rode in it a couple of times for a launch simulation, but it's kind of hard to screw that up. You just kind of sit back and watch it go. Of course, they were kind to me. They didn't give me a lot of faults that I had to do. Yes, that was fun. I enjoyed that. I tried to do the same in the other facilities, like the control center. I would show up at two o'clock in the morning sometimes when they were doing the network validation tests or something, just to see what's going on, to try to have a better understanding for what the problems are that the people keep telling me about. That's one of the reasons I liked that job so well, also, because I had a lot of opportunity to do a lot of hands-on stuff that I enjoyed.

BUTLER: Certainly good to be able to be involved and to see that you're having an impact on things.

BOSTICK: I'd also go over sometimes when the crews were simulating the payload aspects—because of past experience I did know a little bit about the payloads and especially the RMS operations. So I would show up over there sometimes at night and watch the crews. That was fun and beneficial to do that. It was a fun job. I really enjoyed that job a lot.

BUTLER: Must have been interesting comparison when you had been back in the control center, you, of course, ran simulations for those missions, and it must be interesting to look at how the technology had changed, how the procedures for the simulation changed, and the whole process.

BOSTICK: Yes, it was, and how things had advanced and improved. Unfortunately, one of the big challenges that we had was that the software in the Shuttle mission simulator hadn't really advanced all that much, even some of the hardware, the computers that drove them. In fact, we were way behind in the technology that was available, and that's one of the things that a lot of the astronauts kept coming and telling me about it. Like, "Hey, you ought to go up to DFW [Dallas-Ft. Worth airport] and see the American Airlines simulation facilities and see what they have," and I did because of that. And they were right. As far as visual displays and things, they were a lot more advanced than we were, but again it was a budget problem, with money. That helped me to raise some of the priorities, to see that we were a little behind in the technology, you could do better with that. It's a lot better now than it was twenty years ago, but they're still probably behind.

That's always a problem in the space program, because the Shuttle itself is 1970s' technology, by and large. They've done a lot of upgrades with the heads-up displays and the glass cockpits and all of that, but just because if you have to be concerned about reliability, by the time that any hardware really gets on the Shuttle, it's probably at least ten years old. It takes a while, and that's hard for people on the street to understand, why that is that way. The flight computers on the Shuttle now, by any standard, are antiquated, even with all of the updates that they've had.

BUTLER: It certainly is interesting to a lot of people. A lot of people do think of NASA as state of the art and cutting edge. Yet you really wouldn't want to use, at least with software, state of the art, something right off the shelf, because there could be all these bugs and testing problems as such.

BOSTICK: It's a little hard to fix a virus when you're in the middle of a launch phase or something.

BUTLER: That would be very bad. It'll be interesting to see how it continues to grow and change with the times. We'll probably be using the Shuttle for a while yet.

BOSTICK: Yes, I expect that we are, and there are a lot of upgrades that really need to be done that I think would be cost-effective. But it's hard to convince the Congress at this point that that much more money should be spent. So those poor guys over there now that are fighting the

daily budget battles, it's much worse than it was when I was there. I had to admit that. Maybe that'll get better. I don't know.

BUTLER: We can hope.

BOSTICK: We can hope.

BUTLER: Eventually even though this was one of the most fun jobs that you had had, you did decide to move on from NASA.

BOSTICK: Yes.

BUTLER: How did you come to that decision?

BOSTICK: Very awkwardly. [While] in that job, I had had the opportunity—I was asked directly to be considered for a couple of other jobs within NASA. One was Deputy Associate Administrator for Space Flight, to go back to Washington, and I really didn't want to go back to Washington. One was to be Deputy Director at KSC. And these weren't direct job offers. They would say, "Can we put your name in the hopper? We're going to consider four or five people for these jobs." I said no in both cases, and that bothered me. It bothered me a lot that here I'm saying I've gone as far as I want to go, and I'm turning down opportunities. I had a continual debate with myself.

I mentioned [this] to a good friend of mine, Bob Sheets, who at the time worked for Grumman [Aerospace Corporation]. I didn't talk to him as a Grumman employee. He was a close personal friend. Our families had a lot of ties and all that. We were neighbors. He came back a week later or so and said—and I'd said, "This bothers me that I'm turning down opportunities, because I love my job so much, but it still bothers me that I'm satisfied with where I am."

And he said, "If you really decide you want to consider other things, you should consider going outside of NASA. One of those opportunities would be with Grumman."

I said, "Oh, really?"

He said, "Yeah."

I said, "There's nothing I could do at Grumman that they would want me to do."

He said, "I don't think so." So he came back within a couple of weeks and said, "They're ready to make you an offer."

By then I had kind of decided that even though I loved my job as much or better than anything I'd done in a long time, or ever, maybe, that I really should not be complacent, that I shouldn't be satisfied with where I was.

So I had decided that I would consider other opportunities, and Grumman convinced me that they were really interested in civilian space and were going to be heavily involved in Space Station. They were already building the wings for the Shuttle and were working on a lot of other payload-handling devices and stuff that I was familiar with. So I said okay.

The first thing I really did for them was to assist on the STOC proposal, the space transportation operations contract. At that time NASA was going to consolidate a lot of the operations activities and turn it over to a contractor. So we bid—"we," Grumman—bid on that

and lost. Rockwell was the winner on that. But that was part of the agreement that I had with Grumman that if we did not win that contract, then what I'd do then. So they put me in charge of all their civil space activities. Grumman had a Space Systems Division that had both military and civil space activities. So they divided that up between the two, and I was Vice President of Civil Space Operations.

I oversaw such projects as the orbital maneuvering vehicle [OMV], which Grumman was a sub to TRW on that. We had quite a bit of the activity. We had all of the front-end activities on the OMV, little mechanical arms, more small RMSs and stuff that you could go up and service payloads. We still had the Shuttle wing. Some in Space Station, we were bidding on a number of different aspects of the Space Station Program. Even though most of the stuff was based in New York, they allowed me to stay in Houston, which was part of the deal also, because I didn't want to move to New York. So, yes, I did that for a number of years.

It was interesting to deal back with the people I had known at NASA, but from a contractor's standpoint, and it was one of the things that convinced me that I really did want to leave NASA at the time, because I'd worked for the government all my life, and I really wanted to see the other side of the fence. I wanted to learn what's different, and I learned quite a bit on the outside, that I'm thankful for. It was a different experience.

BUTLER: At this point, if we could go ahead and take a quick break and we can change out our tape. [Tape turned off.]

We were talking about the transition over to Grumman, and you were saying that you wanted to experience how it was different on the outside, from the other side. What were some of those differences that you noticed?

BOSTICK: One of them is economics, money, budgets. The companies obviously are in business to make a profit. You can come up with all kinds of nifty things you [want] to do and [good] ideas. Even on the government side there are screens that you have to go through to get approval for projects. But I found that on the industry side, there are more screens and they're finer screens. The bottom line is, are we going to make money off of this project? So any proposals that you would come up with are heavily scrutinized, and that's one difference.

Of course, the big difference is that in my case, where we had civil space projects, that you had a federal agency that was your boss, that would tell you how to do things. Even though the contract said you have freedom to go do this this way, they still like to tell you how to do things. So that was quite different to have to not only answer to the company bosses about, "Why are you doing this, and why aren't you making more money?" and all of that, that you had people on the government side that were also continually telling you what to do. That took a little while to get used to that. But the big difference in management, I certainly don't mean to imply that I didn't worry a lot about budgets and money at NASA because we did and I did, but there's more pressure in industry.

In the government, it was more a tradeoff of dollars and risk. I like that approach. "Here is how much it's going to cost to do this project. If you spend that much money, here's the risk you're taking." If you could spend a little bit more, you could reduce the risk. But that's what really what budget exercises in the government, I think, boiled down to, is trading dollars against risk.

On the industry side, yes, you have to worry about risk, but it's still the bottom line. When you get up to the president and the chairman of the board, they say, "How much money

am I going to make off of this?" They don't worry a lot about the details of what you're doing and all that. It's return on investment. That was interesting. I knew that, but I hadn't personally experienced it and gone through it. So that was the big difference, that and still having the government bosses on the other side. But it was educational.

BUTLER: You stayed with Grumman for a number of years then.

BOSTICK: About eleven years. Right.

BUTLER: And you had mentioned some of the things that you were involved with, the OMV—

BOSTICK: Which got canceled.

BUTLER: —which got canceled, unfortunately, and the Shuttle wing obviously, and then some work on Space Station. What else?

BOSTICK: We were successful on at least two aspects of the Space Station that we were bidding on. We won a contract as a sub to Boeing out of the Marshall Space Flight Center in Huntsville, Alabama, for the crew accommodations, the crew quarters in the habitat module. We also then won the overall systems integration contract for the Space Station. That, of course, was headed by Fred [W.] Haise [Jr.], and they were headquartered up in Reston, Virginia, where the NASA program manager for Space Station was at the time. Because NASA had gone through this big thing about, we aren't going to go with lead centers anymore, we need to pull the management

back to Headquarters. They ended up at Headquarters, but not physically. They were across the border in Virginia, in Reston, just right outside the District.

I ended up going there because they ran into some problems. They got some low grades from the government. The whole program was under a lot of scrutiny and pressure from Congress. So Grumman, I think at NASA's insistence, decided they would kind of regroup the management of that contract, and I ended up going up there for about two and a half years, I guess. After they had reorganized it, they brought in [Thomas J.] Tom Kelly, as the head of the Grumman part of the operation, and [Robert E.] Ed Smylie, actually from the outside. He was ex-NASA, and I had, in fact, gone to college with him and worked at JSC with him. He was head of crew systems at JSC, responsible for space suits and other crew accommodations. I had worked for Tom Kelly also before Grumman.

So the two of them asked me to come to Reston, and I did that for a couple of years before NASA decided that they wanted to do away with the work packages, the individual contractors that were building Space Stations—our contract was an integration [contract] over that—and consolidate all that into one. So that's how that terminated then, is when NASA decided that the idea of not having a lead center and consolidating the program management near Headquarters, they decided [that was not a good idea] after all, go back to the way that things were done [in the past] and move it back to a lead center and, of course, it came back to JSC and Boeing became the lead contractor.

BUTLER: Space Station certainly has gone through a lot of changes.

BOSTICK: It has. I reflect back and I have to admit my own prejudice, because I was with Grumman at the time and doing the integration job and that job was terminated. I think about it frequently. One of the things that Mr. [Daniel] Goldin, the Administrator, used to convince Congress that the program was out of control and Grumman was out of control is because we had allowed the budget to go up to 18 billion dollars and a number of assembly flight up to 24. So that was proof that we were just totally out of control. Now the budget's over 100, and the assembly flights are over 100, or they were the last time I looked. So it's a very difficult task.

Space Station somewhat, I think, due to NASA's own actions, is a complicated program because of all the international partners and the way it was originally divided up between the centers, which I didn't think was a good idea at the time, and in retrospect I think that's been proven correct. You just get all the centers arguing about who's in charge. You have to have a lead center. Somebody has to take charge and be responsible.

One of the most difficult things about Space Station, though, is the international aspect. The good part of that is other countries are paying. The bad part is that really again nobody is in charge. The U.S. on paper is in charge, but if all these other countries are spending all of that money, you have to listen to them and you have to make accommodations for them. So it's not easy. I don't envy the people that are struggling with that today. It's a very difficult task, and it's taken more dollars and more time than any of us hoped, but hopefully we're getting close to having something. I think it's important that we do that.

BUTLER: It's got a lot of potential to it once we can get it going.

BOSTICK: Yes, sure, it does. Again, I would hate to see NASA just be satisfied with Space Station, though, because that's research and it's Earth orbit and it's boring holes in the sky again, you know, going around and around. But it's important to start, and I do think it is right for NASA to do that. That's a very legitimate part of its charter, I think. But I would certainly hate to see the agency do that at the expense of giving up exploration, because I think it's not only important to the agency, it's important to the country, that if we give up the concept of looking at what's over the hill, especially now that there's a good possibility that there might be some water on Mars, we ought to go find out. That's, I think, NASA's real charter, to not be satisfied with just doing research and transportation and stuff. We've got to get back to exploring.

BUTLER: That's certainly something the human race has been doing all along, is moving forward, exploring, and facing new challenges.

BOSTICK: Yes. Yes, and it would really be sad if we stopped that. I don't think any of us—back in 1972, we were very disappointed that the Apollo Program was going to be ended at flight 17. We thought, "Okay, well, this is just kind of a temporary setback. We'll go back [to the Moon] and/or we'll go to Mars. And it may take twenty years." But, you know, well, here we are almost thirty years later and we aren't doing that yet. I really feel bad about that. I think it is a mistake.

You look back at the marvelous thing that happened: America landed men on the Moon. You try to explain that to somebody, and you take a historical perspective and look back at that. That occurred over a three-year time period, 1969 to 1972, and you say, how could a country

achieve that much over that short a time period? Or if you want to look from the beginning to the end of the lunar program, it's about a real ten-year span. In the overall view of things, from historians looking back over as long as America's been here, 250 years or so, or when we get to 300 and look back, you say, jeez, why in [such] a short period of time did we achieve so much and then stopped doing it? That's hard to explain. That's embarrassing, I think.

People are still interested in it, much to my surprise and happiness that they are. Occasionally I have the opportunity to talk to school kids, and they know more about Apollo than I would ever expect them to, because obviously they were born a long time after it happened. But they still have a very inquisitive minds and have a desire to go explore. Boy, it's a shame that we aren't really taking advantage of that, I think.

BUTLER: It certainly is. Hopefully we can help keep the kids interested, and they can then move into jobs and careers—

BOSTICK: Yes, but it's a challenge, because their question is, "Why aren't we doing that anymore?" And that's hard to explain. I need help. Somebody needs to explain to me why we aren't doing that. You know, there are a lot of good reasons, but you stand back from all of the reasons. You look back, and some of that really doesn't hold water. The other answer is, I'm afraid that we just aren't bold enough. We aren't being as aggressive enough. No, it's not an easy thing to do, and there's a lot of competition to do other things on the Earth. But it's never been easy to do hard things, and it won't ever be. So you might as well bite the bullet and go do it.

BUTLER: Absolutely.

BOSTICK: Who knows what we'll find on Mars? Maybe nothing. I don't believe that. Just going to the Moon, we found out a lot about ourselves and how the Earth was formed, and are still learning, I guess, on that. One of these days this planet's going to get full, and it would have been nice to have another place to go.

BUTLER: Absolutely, and there's always more out there to learn about.

BOSTICK: It's better than the alternative.

BUTLER: Absolutely. Even though ours is a history project, hopefully by doing this history, it does help to inspire those people that read about it and hear it in your words.

BOSTICK: I think it's good to record the history as it happened, and hopefully it'll make people ask questions about, why aren't we still doing that? Why did we stop? Why don't we start again?

BUTLER: One of the ways people get inspired is through science fiction and movies and Hollywood in particular. I wanted to ask you about your involvement with *Apollo 13*.

BOSTICK: Yes.

BUTLER: I know that your son was involved with Ron Howard. If you could tell us kind of how that came about and [some of] your experiences on it.

BOSTICK: I had spoken by telephone with [James A.] Jim Lovell [Jr.] probably a couple of times while he was writing the book, and with Jeffrey Kluger, his co-writer, a number of times. They were asking questions about specifics from Apollo 13. Then one day out of the blue, I got a call from my son Michael, who worked for Ron Howard at Imagine Films, and he said, "Dad, I just came across a synopsis for a book that Jim Lovell is writing about Apollo 13, and I want to talk to you about it. [I think it would] make a good movie."

I said, "Yes, is this the book that he's writing with Jeffrey Kluger?"

Mike said, "Yes. How'd you know that? How'd you know about Jeffrey?"

I said, "Well, I've talked to both of them in writing the book."

He said, "I think it'd make a wonderful movie. We only have an eight-page—I think it was—synopsis of the book." The book wasn't completed at the time. "But I think we should buy it and get the movie rights to make a movie. What do you think?"

I said, "I think it would be a very boring movie. What are you going to do? Are you going to do a documentary? People are tired of documentaries."

"No, we're going to make a movie-movie out of it."

I said, "That means you're going to screw it up. You're going to embellish it."

"No, we're going to stick to the facts. It's an exciting story if you just stick to the facts."

I said, "I'm not so sure about that."

Anyway, he fortunately didn't listen to me, and that day they bought the rights. After he talked to me, he went to Ron Howard and convinced him that they should spend the money to

buy the rights to the book. They did, and then I was asked to be a technical advisor on the movie. I had a lot of trepidation about that, because I didn't know what a technical advisor did, but I could imagine. [I was told,] you first help with the script, because the script is going to be based on the book, but you've got to have a script. They had hired Al Reinert and [William] Bill Broyles [Jr.] to write the script. That was okay, but I was afraid they wouldn't take my inputs or wouldn't take them all, anyway.

Then the other aspect, they said, is to come during the [filming] and make technical inputs and say, "This is wrong." But if you say that's wrong and the director says, "I'm sorry, but we're going to do it this way anyway," then you shut up and go back to your corner. So I wasn't really looking forward to doing that.

But it turned out great, because it turns out that Ron Howard wanted to be as accurate—I mean, he was a nut for accuracy. He wanted everything to be as accurate as it could possibly be, so he was very receptive to inputs. It also helped that Tom Hanks was also the same way. He's an absolute space nut. He can tell you the name of the crew of each manned spaceflight from early Mercury through the first twenty-five Shuttle flights, or at least that's what he could do while we were making the movie. He'd probably go beyond that now, and I can't do that and I was there. But not only could he tell you the date of the launch and who was on the crew, but where he was when the launch occurred, which was usually playing hooky from school. Anyway, he wanted to make it accurate also. So it turned out to be a very good experience.

I was a little nervous about it because at the time I worked for Grumman and I was taking leave without pay to go help with the movie, but my immediate boss at Grumman at the time was Fred Haise, who had turned down the opportunity to co-write the book with Jim Lovell because he had the attitude that—in fact, he said, "That's in the past. I don't want to

dwell on that. I'm moving on. I've got other things to do. I don't want to waste time on that." So I knew that was his attitude. In fact, when I talked to him about, "Can I take off time to go work on this movie?" he said, "Well, it's your own life. Do what you want. I think it's a waste of time." [Laughter]

But also it involved people like Tom Kelly, who had been my boss at Grumman at one time, but he was "the father of the lunar module," so he was portrayed in the movie. And Ed Smylie, who was a lifelong friend and, of course, the astronauts. I was a little nervous about how they would react to it, but it turned out much better than I had thought. Most people, even the people like Fred Haise, who were portrayed, and obviously Jim Lovell, but other astronauts like [Eugene A.] Gene Cernan, have come to me and said, "Hey, that was really good. You guys did a good job." And I said, "Whew."

At the premiere there we had here in town, I sat between Gene Kranz and Fred Haise, so I was like sweating BBs the whole time. Of course, I figured Gene would like it because his role was somewhat embellished. That was one thing that I had worried about in making the movie and had made inputs, but there're so many characters, so many people involved, that you can't have each portrayed individually. So the Gene Kranz role in the movie, as well of a lot of others, were a combination of all of the flight directors. You have to do that, and I understood that. So I figured Gene would like it because it really kind of embellished his role, and he did, of course.

But Fred didn't say anything after the movie. We got on the bus to ride back to where we had parked our cars after the movie. I was sitting behind him again on the bus, and he didn't say a word. So I wasn't going to say, "How did you like it?" Finally about halfway back to the parking lot, he turned around and he said, "I didn't chew gum." And I said, "Oh. I'm sorry.

Well, Bill Paxton, who played you in the movie, liked to chew gum.” So then he said, “I never chewed gum.” [Laughter] So that was his big thing, and I thought, "Okay, if that’s your biggest complaint."

But, yes, again, it was a good experience, even though I really didn’t think it would be possible to make a commercially successful movie out of that mission, I guess because I was too close to it. It was a personally rewarding mission from the standpoint that us flight controllers got to prove that we were worthwhile, that we actually did something and it worked out all right. But I was really surprised that it was commercially successful and pleased that I had had a very small part in the movie.

It was a real good experience, but it spoiled me for movie-making because of Ron Howard and Tom Hanks and the whole crew, because it was—of course, it was the first time I’d ever been involved in a movie, and people kept telling me on the set, the actors, "I’ve never seen anything like this in my life, how well everybody gets along, how cooperative everything is." One of the examples of how interested they were, Gerry Griffin was also a technical advisor. So before they started filming, Ron Howard said, “Bostick and Griffin, when you come out before we start shooting, we want you to spend a couple of hours talking to all of the actors and telling them two things, what flight controllers are and what they do and what they did on the mission, and then really what happened during the mission from your perspective and how the astronauts and the flight controllers reacted to all that.”

Gerry and I thought about that for a while and talked to each other and agreed how we would divide it up. The both of us said, "This is going to be tough, because they don’t want to hear all of this. They’re going to sit there and say, 'Hey, look, I’m an actor. I know my lines, I know how to act, so who’s this NASA nerd up here telling me all this?'" Well, we couldn’t

have been more wrong. Two hours went into a day and a half, and they wouldn't stop asking questions.

Finally Ron Howard said, "I'm sorry. We have to call this to an end. We can't spend any more time in doing this." But that's how interested they were. They wanted to know everything that happened. So that was a good start. I thought, oh boy, these guys really—as I said, I had never been involved in anything like that. I expected the actors to show up and do their lines and go home and that's it.

Tom Hanks, for example, all his scenes were in the cockpit in the spacecraft obviously, but he showed up every day when we were in the control center. We were filming all of the control center stuff, and usually how they make movies like that is if there is dialogue between the spacecraft and the control center, somebody off set reads the line from the spacecraft and that cues the people and they react and then they put all that in. Then they film the spacecraft stuff and they put all that together. Well, Tom Hanks showed up every day and he personally read his lines just to cue the people in the control center. All the actors and even Ron Howard said, "I've never seen anything like this." Of course, he was getting paid to do the movie, but he wasn't getting paid to do that. He got paid the same way whether he showed up every day or not. But that's how interested he was in making it come out right.

I think the *Apollo 13* movie was kind of like the Apollo Program itself, that that'll never happen again. As John Aaron once said, all of those dominoes won't line up again like that. I've worked as a technical advisor on a couple of other movies since then, and I learned that, no, you can't repeat that. It'll never happen again probably, unfortunately.

BUTLER: It's nice it was able to come together so well.

BOSTICK: Yes, it was. I think it did a lot for NASA. I'm still amazed at how many kids have seen it and continue to do it. I go to an elementary school in Austin once a year to talk to a sci-tech class. I keep thinking every year that they're going to get tired of this. But I swear, each year seems like they know more about it and are more interested. So they still like to see the old guys. But I'll keep doing it as long as they're interested, and they really are. I'm happy to say I think the movie had a lot to do with that.

In fact, Congressman [F. James] Sensenbrenner [Jr.], I think, I'm not sure, but at least a couple of congressman commented at the time that the *Apollo 13* movie was the best thing that happened that year to the NASA budget, that it helped them get the NASA budget through Congress a lot easier than it had in many years. They attributed that to the movie. So you say, "Hmm. That wasn't so bad after all." [Laughter]

BUTLER: I can see that would happen.

BOSTICK: It was good P.R. for the agency.

BUTLER: Because it showed a successful point for NASA. Even though the mission had so many problems, they were able to come through it so well, and showing all that teamwork.

BOSTICK: Yes. And I didn't realize, I guess, to the extent that Lovell and Haise had thought that the mission was really a failure. I guess they felt like they were treated that way by NASA. If you look at their mission objective, of course, they didn't accomplish it. But they obviously

felt a big letdown, but they both kind of felt like they had failed. Hopefully, the experience with Lovell of writing the book and then doing the movie and all, it's more accurate, I think, that the original mission objectives were not met, but the mission was not a failure.

Missions fail when they go wrong and you don't know what happened and you lose the spacecraft or you lose the crew or whatever and you have no reason or no data to tell you why. It was a horrible thing and the mission objectives weren't met, but I think it taught NASA a lot about a lot of things, how to prepare better for risk and then how to deal with risk. It was kind of an eye-opener that, hey, we shouldn't get too complacent. I'm not saying that we were, but it was a reminder that, don't. Things can still come up and bite you when you least expect them. So it was not a failure.

BUTLER: And it was even a success all these years later when it was able to help in the NASA budget process and get people interested in it again.

BOSTICK: Yes. And hopefully that makes Lovell and Haise feel better about it, anyway.

BUTLER: Hopefully so.

BOSTICK: I think it did. I'm sure it did.

BUTLER: You mentioned at the time you were involved in the movie, you were still at Grumman, and now you've retired.

BOSTICK: Yes.

BUTLER: Did you go onto anything else after that?

BOSTICK: Well, I had some relatives and some friends who, unfortunately, passed away well before their time, and I vowed that, if possible, I was not going to allow that to happen, that hopefully I would get to a point where I could retire and enjoy life. So in '96, I guess it was, I decided to do that.

Glynn Lunney, though, kind of spoiled that for a while. He was at the United Space Alliance at the time and he called me a number of times and said, "Why don't you come over and help me out." I really had no desire to go back to work, but I did because of Glynn purely, because he'd been a lifelong friend. I'd worked with him. I'd been his deputy probably three or four times in my career. I thought, "If he wants me to come and help, I'll go and see what I [can] do." So I did that for about a year and a half at U.S.A., United Space Alliance.

Then Glynn decided that he was going to finally retire. He told me that ahead of time. He said, "I've decided I'm going to hang it up." I said, "Okay, I'll leave the same day you do, because you're the only reason I'm here." So I did. I did that in '98. I've been totally retired for a couple of years, and I really enjoy it. Occasionally I get a call from somebody that says, "Would you be interested in consulting?" I say the only consulting I do is I wake up in the morning and I consult my wife on what I should do today. [Laughter]

BUTLER: That's a good kind of consulting to do. Well, you certainly have been involved with a number of interesting things over your career. I think you've earned the chance to sit back and do whatever you want to do.

BOSTICK: Also, I try to enjoy whatever I'm doing, and right now I enjoy retirement.

BUTLER: Good. Looking back over your career with NASA, was there any point that to you was the biggest challenge? And then in retrospect to that, what would you consider your most significant contribution or accomplishment?

BOSTICK: That's a good question. I've always enjoyed challenges. It would be hard not to put just the manned space, Apollo Programs, specifically landing on the Moon was a challenge.

As far as a challenge that also had some resistance, or some people saying, "We don't want to do this. You're wasting your time," probably the biggest challenger was the remote manipulator system, because it was a technical challenge, it was a management challenge, it was a budget challenge. As I mentioned earlier, there were a lot of people that thought we were wasting our time and money and shouldn't do it. So that's my quick answer, I guess. If I thought about others—I think my whole career was a challenge, but that was some of the most challenging times, and therefore it's one of the things I'm the proudest of, probably. Of course, I'm most proud of Apollo. That's obviously something that you never forget, and that has to be way above anything else on the pride list. I'm just proud I was there, and any part that I played to help hopefully, but just to being there was very rewarding.

BUTLER: Certainly must have been.

BOSTICK: That's the good news, and there's always bad news. It's hard to say, well, then what after that? Because I think for a lot of us, after Apollo it was kind of a "Is that all there is?" [Laughter] It's hard to follow something like that. I don't recall ever having any conversations with anybody about that at the time, but over the years I've talked with a lot of the flight controllers that I worked with and a lot of the astronauts and, boy, they went through the same thing. You can imagine some of the astronauts, especially the guys that went to the Moon. You say, "Okay, now what do I do now? What else? What can top that?" I mean, I thought I was having a struggle, but nothing compared to those guys. That's a tough act to follow.

BUTLER: Certainly a lot of people did go through tough times with that.

BOSTICK: But that has to be the high point. That's the thing I want to tell my grandkids the most about, I guess.

BUTLER: Absolutely, and well you should want to. Hopefully they can share some of that through your oral history.

BOSTICK: I hope they'll always be interested. The ones that are old enough now are. Space program and basketball. [Laughter]

BUTLER: Well, okay. Basketball involves some trajectory work.

Looking back, you had mentioned, we talked about it in your first oral history, how you even got involved in the first place. You had already had a job lined up and weren't going to be doing anything with the space program. They pulled you in to fill in for an interview. Would you ever have imagined—

BOSTICK: No. There's no way I could have designed it any better. No, I never imagined. In fact, I was obviously excited about the manned space program when I was in college, but because I hadn't chosen that as a career path, I never thought I would be a part of that. I was just excited about that it was going on and I was a U.S. citizen and the U.S. was involved, but I never thought I would be a part of that.

It's just a real uncanny chain of events, I guess, that I was lucky, happened to be in the right places at the right time. Couldn't have designed it any better if I had tried, and I never did. That's one reason probably that I lucked out. Because I was never one of those people who thought, "Well, here I am on my career ladder. What am I going to do next?" type of thing. I probably should have paid more attention to that, but I just tried to enjoy what I was doing at the time and doing it as well as I could. Yes, as you think back about how I ended up at NASA and then how I ended at JSC and how I ended up being associated with people like Kraft and Lunney, it's a pure lucky chain of events. I have no complaints about it. I feel very fortunate.

BUTLER: We feel very fortunate you've shared so much of that history with us.

BOSTICK: Well, thanks for letting me bore you.

BUTLER: Not at all. It's very interesting. Is there anything that you can think of that we have missed or haven't touched on?

BOSTICK: No, not really. I'm impressed with the research that you and your office have done just in coming up with the questions. You remembered some stuff that I had forgotten about, and I know that has to be a challenge. I admire you for doing what you're doing and encourage you to keep doing it. Hopefully one of these days it'll be something the historians can—a real resource that they can use.

BUTLER: We certainly hope so, and we try, as you said, to do the best we can and certainly enjoy our jobs.

BOSTICK: Well, I think it shows.

BUTLER: Thank you. I was going to ask Summer and Sandra real quick if they had any questions.

BERGEN: I have a couple. You talked about the RMS and all the resistance that you had. Was there some point at which you finally convinced all those who had opposed it, or did they have see it in action before they were convinced of its—?

BOSTICK: In most cases we had to prove it. The people were like from Missouri: "Show me that it works." One of the best things that we did was getting the right astronauts involved

because the primary resistance was from the Astronaut Office. That's where it really started, with Jerry Carr going to Kraft and telling him it was a piece of crap and forget it.

But, yes, we were, I think, extremely fortunate in having the right people across the center, but especially the Astronaut Office, because if we had had somebody with that attitude that had come to help, they wouldn't have helped a lot, especially Bill Lenoir and Sally Ride who, as I recall, were the first ones involved, came in with an attitude of, "Okay, this is an assignment. I have an open mind, and we'll look at it, and we'll try to fix it." Because first thing I told them, "Hey, this is going to happen whether you like it or not. The Canadians were spending millions of dollars, and they're building a good product. They have a lot of pride in what they do, and it's going to be a good product. [It] may have some problems, but we can fix it." And that's the attitude that they took.

But in most cases, yes, we couldn't convince people with viewgraphs that it was going to work. We had to produce hardware and do some ground tests and stuff and really show them, and even get some of the nay-sayers in the simulator and show them, yes, this is going to work.

There wasn't really any economical viable alternatives, also. You could come up with other ways to deploy payloads that arguably would be as or more effective, like springs. That sounds simple, but you start designing the springs and how you release the latches, and it's certainly possible to do, but it's more involved than you would think. Or you do rotating arms, which was one of the concepts they had, but how do you retrieve them? If there's a satellite up there that you have to go and either put in a bay and bring home or service it while you're there, then you've got to have some way to get into the proximity and to dock with it, attach to it, and send people out and work on it. Over the years, nobody's ever come up with anything better than the RMS. Fortunately, we did finally show them.

BERGEN: Something to be proud of. I have one other question. You touched on it briefly talking about [other] things. I was wondering what your perspective was on what was the greatest challenge in the transition from Apollo to Shuttle for NASA as a whole?

BOSTICK: Gosh, that's a real good question. A lot of technical challenges that are obvious, I guess. The Space Shuttle was probably arguably the most sophisticated vehicle of any type, especially flying vehicle, that was ever put together. To launch something as a rocket and then to land it as an airplane with no air-breathing engines, it just comes in like a glider, as you well know, and lands. To do all the things it does in orbit, there are a lot of technical challenges and a lot of operational challenges.

I think that a big challenge to NASA, though, was kind of, what path should we take in the future? There were people who wanted obviously to continue the Apollo Program. There was a lot of argument in the early seventies about, okay, what should we do next if we aren't going to continue to go to the Moon? Should we build a space station or should we build a reusable spacecraft like the Space Shuttle? It was a big debate then, and, of course, it was finally concluded, well, a space station's not going to do you a lot of good unless you can get people back and forth to go to it. So let's build a space shuttle, and then we'll build a space station hopefully a few years later. We'll use that.

There was also talk then about, people would say things like, "Well, we've been doing exploration of space and now we have to do exploitation of space. Let's do useful things." They're logical things and they make sense, but as I look back on it, it was probably a bad decision that NASA made. Let me explain that. The decision, I think, was made when I was at

Headquarters and saw some of the arguments in the Administrator's Office back and forth. Probably the biggest mistake decision-wise that was made was to try to justify it on an economical basis, in other words, this thing will pay for itself. It was the right thing to do at the time probably, because it was a tough fight in Congress and even with the administration to get any funding or to get approval to undertake any new program. I'm sure that the NASA people involved at the time realized that it was really the only way they were going to get it approved.

But, boy, we are still struggling with that decision, that the Shuttle has to pay for itself, as opposed to being a national resource that we used to gain knowledge and one of the ways it pays for itself is through knowledge and not through dollars. Yes, it costs money, but it's worth it. As I said, we're still struggling with it, the agency is still struggling with that, because it's an expensive vehicle to operate. But it's unfortunate that we ever even get to that argument, because I think some things are worthwhile doing in space regardless of how much they cost. That's obviously a debatable statement, but we still should be exploring and not just exploiting space.

It was a big difference in Apollo and Shuttle, management decision-wise. Obviously there wasn't the national mandate that we had, and we didn't have a President standing up and saying, "As a country we're going to do this," and we weren't in competition directly with the Russians like we had been before, although we really still were, but the public wasn't as aware of that. Ironically, the Russians had decided to build a space shuttle also, and did build the Buran [shuttle], which, I don't know if you've ever seen it or seen pictures but you wonder where they got the plans. [Laughter] It even flies around on the back of an airplane.

The end of Apollo was kind of a crossroads for NASA, I think, and the beginning of the era where we have to prove that everything we do is going to pay for itself, and it still carries

over into Space Station. You can't just tell people that you're going to do all this medical research or any kind of technology, crystal growth or that type of stuff. They say, "Well, how's it going to pay for itself?"

That's one of the real challenges I think the agency has now, is to convince people that there is inherent benefit in basic research and there's some that can only be done in zero gravity, so we need to go do it. It's easy to fall into the trap of claiming we're going to make ball bearings or something and it's going to pay for itself, or we're going to discover a cure for cancer. And maybe we will, but we shouldn't promise that ahead of time, I don't think, because we don't know if we are or not. Because usually most discoveries come from things that you don't expect. Nobody set out to invent penicillin. We should try that, too. It's a trap, I'm afraid, to get into that we shouldn't have a space program unless it pays for itself. It really can't and it shouldn't, because it should be a national endeavor that continues to pursue the unknown.

BERGEN: Thank you. Those are all the questions I had.

BUTLER: Thank you again so much.

BOSTICK: Thank you. I enjoyed it.

BUTLER: I did, too. And hopefully you'll be able to enjoy reminiscing with some of your—

[End of interview]