ORAL HISTORY TRANSCRIPT

RONALD L. BERRY
INTERVIEWED BY CAROL BUTLER
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BUTLER: Today is October 18, 2000. This oral history with Ron Berry is being conducted for the Johnson Space Center Oral History Project at the offices of the Signal Corporation. Carol Butler is the interviewer, and is assisted by Summer Bergen.

Thank you for joining us today.

BERRY: You're very welcome.

BUTLER: To begin with, if maybe you could tell us a little bit about how you developed an interest in aviation and engineering.

BERRY: Well, I grew up in this town called Grand Prairie [Texas]. It's in between Dallas and Fort Worth. It's primarily, when I was growing up, the big industry in town was aerospace, really aeronautics. They had the big North American plant there during the war, where my dad worked, and then it became LTV [Ling-Temco-Vought, Inc.] and Chance Vought [Corporation], and it still exists today as LTV there. So that was primarily the big thing in town, what everybody talked about. I don't remember the war years so much, but afterwards I remember most of the talk being about aeronautics and various things. My dad worked there. He was a quality-control engineer, so he talked about it quite a bit.

In between my high school years, I would work there during the summers, you know, out on the flight line where it was 150 [degrees] or whatever, taking salt tablets. Then let's see. After my senior year in high school, I got to move inside where it was cooler, during that summer, and got to do some drafting work, helping engineers and so on, so that gave me a little taste of the aeronautics world.

BUTLER: That's certainly a good introduction to the world. Not many people get that opportunity to jump right into something they're so interested in. And you decided then—you went off to college and majored in aeronautical engineering.

BERRY: Right.

BUTLER: Did you have much knowledge of the space program during that time?

BERRY: Yes, I followed it pretty closely, you know, through the news articles. Of course, when I was in college, that was all the talk. Got to work on a lot of the—as school projects, college projects at MIT [Massachusetts Institute of Technology, Cambridge, Massachusetts], we got to work on a lot of space projects, you know, creating our own space missions to Mars and this, that, and the other. That, with following the news articles, with Sputnik and Yuri Gagarin and so on, it kept me up to speed on what was going on and kept me very interested.

BUTLER: Had you ever, as in high school, had you considered the possibilities of the space program before all of that happened?

BERRY: Oh yes. Even before high school, I was a big reader of science fiction, you know, Jules Verne and all the rest. I guess a lot of kids do. So that really probably first got me interested, coupled with, like I say, the environment in the town there.

BUTLER: Great. How did you—well, I guess through some of your course work then at MIT, was that how you learned about the opportunities at NASA for after you graduated?

BERRY: Not really. I had an idea I wanted to work for NASA when I graduated, but I went on and took a—I graduated in 1960, and NASA had not moved into this area at that point. You know, [President John F.] Kennedy had not made his big announcement, which was a year later So I went to Austin and I worked for the Defense Research Laboratory there in Austin, and while I was working there, I picked up a master's degree, part time while I was working. During that time is when it was announced that the Manned Spacecraft Center was going to be located here in Texas, which was very exciting to me because I had wanted to stay in Texas, since that's where my real roots were. So all that kind of came together.

So when they did move down here in '62, I put in my application. I finished up my schooling there in June of '62, so I had my application in and everything seemed to fit.

BUTLER: Good, good. What was the process like for interviewing to come to work at the Manned Spacecraft Center, since they were in the process of moving down here?

BERRY: It was pretty loose and chaotic. I had turned in my application when I got here for my interview appointment. They didn't know who I was. They didn't have any record of my application.

BUTLER: Oh, no.

BERRY: And so on and so forth. I was being interviewed by an Englishman who had come down here from Canada.

BUTLER: Okay.

BERRY: He was a great guy, though. Morris [V.] Jenkins was his name. I subsequently ended up working for him. We had a real nice interview, and I came right on to work. Began work there at the Petroleum Center, Houston Petroleum Center there on Gulf Freeway. Of course, NASA was scattered everywhere, and to go to meetings and so on, you'd have to get in a NASA cab and go from one building site to another and be bused all over the place, essentially. But it was fun and exciting.

BUTLER: What did you think of the challenge to go to the Moon, Kennedy's challenge that was now spurring all of this new growth at NASA?

BERRY: Oh, it was a great motivator, very exciting, all for it, and that's really one of the major factors I decided to come on with NASA.

BUTLER: Okay. When you first came in, what were your first tasks, your first duties or projects that you worked on, your responsibilities? You went right into the Mission Analysis Branch.

BERRY: Right, working for Morris Jenkins, as I said, the Englishman via Canada. He put me right to work on designing lunar trajectories right away. A good many of the folks there in the division, MPAD [Mission Planning and Analysis Division], were working on Mercury and Gemini, but that particular branch I went into was focused strictly on Apollo. So right out of the chute, got to do some exciting work, lunar trajectory work.

They had a small computer there in the Houston Petroleum Center, but also the big computer, where we had to go for most of the more detailed lunar trajectory work and rendezvous work, had been set up, a big computer, over in the Channel 8 studios. I don't know if many people remember that.

BUTLER: Haven't heard that one.

BERRY: Because they had the raised flooring. At that time all the big computer systems—they still do today, the big ones do—have to have the raised flooring so you can get under there and route all the wiring and so on and so forth. That was the only place NASA could find to rent that had the raised floorings for the bigger computers. We would go over there and spend most of the day and half the night over there running the trajectories and so on and so forth.

BUTLER: That must have been—well, actually, how different was that from work that you had done beforehand? Had you done much to prepare you for—

BERRY: I had done some orbital mechanics work both at MIT and at University of Texas, but nothing to the extent of what we were into here at NASA, so it was night and day. Even though we had seemingly a pretty long time to get ready, from '62 to '69, it was really a short period of time to get ready. So everybody was full bore.

BUTLER: What was—you talk here that you were involved with lunar trajectory planning for Apollo, but yet you mentioned that some of the other people were involved with Mercury and Gemini. What was the role of MPAD in general? I know it can't be very general because there was a lot to do. When did MPAD and the various parts become involved in the planning mission?

BERRY: MPAD would get involved very early, in the very early stages of any program, and provide the early mission plans or trajectory designs, if you will, for that program, and then they would follow the program in successive stages all the way to the operational. Then even the post flight, they would be involved in post-flight analysis and what happened.

BUTLER: So basically—

BERRY: So, cradle to grave.

BUTLER: Okay. That's good. Given, okay, here's the program, we're going to do unmanned flights and basically just lined out by the administration and passed on to planning then. That's certainly an interesting area because you're involved in so many different aspects of it all.

BERRY: Right. And it was not limited. MPAD's role was not limited to just the mission or trajectory design; they were also involved and had responsibilities in maneuvers themselves and in navigation. In Apollo, in the maneuver side, they were responsible for assessing, evaluating, and validating, doing independent verification of the onboard software, the onboard guidance and navigation. On the ground side, they were responsible for a lot of the major guidance, support, targeting, navigation that was done on the ground. There we were primary, as opposed to just assessing somebody else's work. We'd actually do the computer formulation.

BUTLER: Did MPAD involve a lot of work—you've mentioned the computers and such. Did much of the planning involve planning for the ground support equipment as well, or was that a separate area?

BERRY: MPAD's role was, like I said, in the computer formulation, what they call the requirements. In other words, laying out the equations that would be programmed by another group that was in another area, Flight Support Division at that time. But we were all in the Flight Operations Directorate [FOD]. So we would do the equations and so on for the ground software, transfer them over to the other group, another group who did the actual coding and verification, and whom we would support with independent verification support as they were doing their development of the software.

BUTLER: As you continued and as the program went on, you became head of the Maneuver Analysis System. Was this some of what you have just described here with lunar trajectories or did that have other tasks as well?

BERRY: It included lunar trajectories and primarily the trajectory from Earth orbit through the translunar injection, mid-course corrections, the lunar orbit insertion maneuver, breaking into lunar orbit, and then the trans-Earth injection to bring you back home, mid-course corrections coming back. We looked at all those maneuvers. We did not look at the lunar landing maneuver or the lunar ascent; that was done by another branch at that time, another section. But we would look at all those maneuvers, understanding what the maneuvers were about, assessing the proposed guidance schemes for those maneuvers, how you would go about monitoring those particular maneuvers. We developed abort contingency procedures that could occur during those maneuvers or even pre- and post- those maneuvers. So that was what we were about in the Maneuver Analysis Section.

BUTLER: As you—around in this time as you were in those roles and also as you probably transitioned into Chief of the Lunar Mission Analysis Branch, planning for Apollo 8 came along. At what stage did you become aware of that mission, and what were some of your thoughts on it?

BERRY: I was actually on vacation in California, the first vacation I'd had in quite a while. That was the summer of '68. Got this phone call from my deputy branch chief saying, "Guess what?

These people want to go to the Moon in December. You'd better get back home." And so I did. That was the first time I heard about it, was after they had made the decision to do that. Of course it was secret at that time, had not gone public.

So, got back and things were in pretty much of an uproar, everybody getting excited because that was coming in a year, year and a half before it was originally scheduled for. So we started supporting that potential decision with lunar trajectory scans, performance scans for the time period they were talking about, which was December, to see where we would be able to put the orbit and so on, when we would launch, starting to lay out the preliminary trajectory, which we were pretty well prepared tool-wise to do. We had the performance scans to do. But the thing where we were really behind the power curve was in having all of the planning tools ready to support it, because we were just four months away.

We had been on a schedule to gradually develop those over the next year to year and a half, and now we had to compress everything into a four-month period, which was bad enough, but the real crunch came in the real-time ground system, ground support system in the mission control center. It was nowhere near ready to support a lunar mission. So the only way we could see to do it was to convert some of our planning, continue with a crash program on developing our planning tools, but at the same time spin off a version of those planning tools that could go right into the control center to provide the real-time ground support system, as well as the planning function. So we had to really develop dual-purpose software at that time in a very short period of time, so that was the extreme challenge and crunch that we ended up working night and day on.

BUTLER: Well, it did all come together.

BERRY: Yes, and people in the Navigation Branch—it was called the Math Physics Branch at the time—were having to do the same thing for navigation. They had been developing navigation analysis tools to start analyzing the navigation situation, but they had to quickly turn those tools into real-time ground support software to support the navigation to and from the Moon and while in lunar orbit. So they had an equally large challenge.

BUTLER: Absolutely. At any point during this very challenging time, when everything was crunched to get it to pull together, were there any questions about whether you would make it, or was everyone just gung-ho enough that—

BERRY: We were determined to make it one way or another, but we did have to work very long hours, and it was scary, because, you know, there was always a chance we wouldn't. But we were determined to make it. We knew that we were going to be trying to do these things for the first time. Nobody had ever done them before. It was really an exciting time.

I remember I sometimes would literally have nightmares at night, and the consistent dream would be, we'd be on this trajectory to the Moon, and when we'd get up there, the Moon wouldn't be there. [Laughter]

BUTLER: That's quite a nightmare.

BERRY: Yes.

BUTLER: Oh my.

BERRY: Turned out it was there.

BUTLER: It was very definitely there. It was a very successful mission. Did you—seeing the mission's success and seeing that everything was so right on track, right where it was supposed to be, happening when it was supposed to happen, what was your feeling at that time as all that came together?

BERRY: It was one of real intense exhilaration and satisfaction. We were really thrilled with the whole thing, the way it worked out.

BUTLER: For good reason.

BERRY: Yes. I know we were criticized by some at the time, some atheist groups, as to why we were doing this at Christmas and so on and so forth, and I even had to develop a document to answer some potential court proceeding—I don't remember what ever happened to it—to show that really the fact that it came out when they were in orbit at Christmas was coincidental. We were aiming for December, all right, but the fact that it came out in orbit at Christmas was because we were trying to duplicate the same lighting that would be required on the front side of the Moon that would be required for the subsequent landing missions, and that's what caused us to be there at Christmas. It worked out very nicely, anyway. Very merry Christmas.

BUTLER: Absolutely. Absolutely. And it was certainly, for a lot of people, with everything that was going on in the world, it was a nice way to end what had been a bad year for many different areas. Because you were so caught up with things in the space program, were you much aware of what was going on in the rest of the world, the war and the civil unrest and things? Or were you pretty focused on—

BERRY: Really pretty focused on that. I would occasionally try to catch up with the news, but we were so totally focused and consumed by the mission, that we had very little time for anything else.

BUTLER: I can certainly see why. There was a lot that had to go into it to make it all come together and make it successful. Where were you during—well, during Apollo 8, but actually during any mission, how did your role fit in with the actual operations of the mission?

BERRY: We would generally be in the staff support room, supporting the main Mission Control Center room, and we would be there to monitor everything that was going on with trajectory and guidance and, later, navigation standpoint, and to let them know if they were making the right decisions, or to comment on what decisions they were making. They would ask us questions. It was that kind of thing. So we were right across the hall from the main control center, usually. Occasionally we'd go into the control center and sit down and chat with the front-line flight controllers if a particular problem was coming up.

BUTLER: In planning for a lunar mission or Apollo 8, but also for some of the later ones, what were the various—you talked about some of the areas that would be covered, but how would you go through the stages of building that plan for the mission, or was there a regular way that it was done?

BERRY: It evolved into a regular way. The way it evolved was early on with the mission, preferably a year or two ahead, rather than this four-month business, you would start with a preliminary trajectory plan or mission plan, and that would support the early feasibility studies or it would support where you wanted to land in terms of Apollo. We would work with the lunar scientists and determine where they could think about landing for the particular time period you were talking about, or if you could not land there, what kind of mission constraints that had been imposed prior to that, to what extent they'd have to be relaxed to be able to land in a particular place. So you'd do all that in the preliminary plans that you would lay out, which would consist of scans, performance scans showing where you could land on the Moon, what areas.

When a landing site was picked out, then you would actually develop a preliminary trajectory that went to that specific site for everybody to look at and to show absolutely that it was feasible from a performance standpoint.

Then following that phase, you'd go into what they called the reference mission or reference trajectory phase, and that was a little bit more detailed version of this trajectory. You would do it in more detail, add more degrees of freedom in the simulations and so on, and that was used for all the rest of NASA to do their detailed planning against. That's why they called it a reference plan. That would typically come out six to nine months before the mission.

Then in the period six months on in, you would usually do one or two operational plans, trajectories, which was even more detailed, and that's the one that you actually flew to. As you went through these successive plans, after each plan would be put out for distribution to the community, you'd have a round of comments and criticisms or whatever, and you'd incorporate, you'd have big meetings to decide which of those comments would be incorporated in the next version that would come out and which would not. So that was how we stepped through the thing, typically. But, of course, in the case of Apollo 8, everything was compressed. It was just one big working at your computer and having meetings. It's all a blur.

BUTLER: I'm sure it is. I'm sure it is. As you were going through these various stages from the preliminary to the reference to the operational, and you mentioned having meetings and talking about what changes would be made, would there be many major changes? Obviously there was a variety of changes, but would there be many major changes to the plan?

BERRY: No, not really. It would normally be how long you stayed in orbit before you do this or that. And also at about this time, of the reference trajectory, when it came out, you would start having these meetings called mission techniques meetings. They originally were called data priority meetings, but they eventually changed the name to mission techniques meetings. These are initially chaired and run by the deputy division chief of MPAD, a guy by the name of Bill [Howard W.] Tindall, who was a genius at this kind of thing. But it was not just an MPAD thing; it was the entire community.

The purpose of the mission techniques was to say, "Look. You've got this trajectory that you want to fly to and you've got this hardware and software that you're going to use to attempt to fly to that trajectory, but how do you really do it? What targeting do you actually use? Who’s primary for the target? Is it on board or is it ground? In whichever case that is, is the other one backup? How do they backup and monitor that? What are the actual parameters you use for monitoring? How big an envelope can you withstand before you have to change over from primary to backup?" This covered both guidance, navigation, incorporated the flight plan, what the crew's doing, what the ground crew's doing. It really was a systems integration of the entire program at that time. I'm not sure many people realize that that was a very critical, important activity.

Anyway, what I was leading up to is that those meetings sometimes would come out with changes, would have the most significant changes to the trajectory plan, such as breaking into lunar orbit. The initial plan had us going into a circular lunar orbit when it broke into lunar orbit, with one maneuver. But when we got into the mission techniques meetings with the crew there and everybody else, it became clear that that was a pretty dicey thing to do for the first time to the Moon, because you had one burn and you were burning down pretty close to the surface of the Moon.

So we decided, based on the mission techniques, again led by Bill Tindall, to do it in two stages. You had broke the burn down into one that put you into an elliptical orbit, which was quite a bit safer, where if you overburned or something, you still had some maneuver room. You wouldn't crash into the Moon on the front side. You were doing a burn, of course, on the back side of the Moon. So you broke it down into two maneuvers for safety reasons, and that was an example of a fairly significant change that happened from the reference to the operational.

BUTLER: And that was—was that primarily for just the first few missions or did that last for—

BERRY: It lasted pretty much through the entire set.

BUTLER: Seems like certainly an important consideration.

BERRY: Yes. That was just one example. Speaking of lunar orbit insertion, one of the big problems we had for Apollo 8 in converting these planning tools over to the real-time tools, was that we had this massive planning program called the generalized iterator. It was designed to be a general-purpose trajectory planning tool. You could put in any conditions you wanted to meet, and, of course, given enough degrees of freedom that you were willing to change to get to those end conditions, it would eventually find the right trajectory to get to those end conditions.

But it was very slow, and even though we had the fastest computers available at that time, the program was trying to do so much with this generalized approach, be able to solve any maneuver, whether it's a translunar injection or mid-course correction or breaking into lunar orbit or coming back to the Earth, we soon realized it was going to be too slow. So with just a couple of months to go on Apollo 8, we had to go in there and develop a whole new set of schemes, formulation for the real-time system that would solve the time problem. We were still able to use the generalized iterator for maneuvers like mid-course corrections and so on, where we had plenty of time leading up for it to finally find its solution, but for the lunar orbit insertion phase, we were just not going to have that much time from the time of the last mid-course correction leading up to going behind the Moon. So we had to come up with a whole new formulation. That made the last couple of months really something.

BUTLER: I bet it did. Talking about computers, you, throughout your career at NASA, actually, you saw quite an evolution in the abilities of the computers and the speed of them, in their capabilities. Was that—did you ever stop and think about that, and about especially now, looking at a desktop computer, what it's able to do versus what you were dealing with here when you were planning on sending people to the Moon on such a challenging mission?

BERRY: At the time, of course, in hindsight, it's amazing. If we'd only had a desktop. But at the time, we were fighting the capabilities, the constraints of the computer continuously. It wasn't big enough, it wasn't fast enough. Because of that, we had to do a tremendous amount of the work manually, manual iterations, make a run, make a jillion runs in shotgun fashion in order to get the right answer, or to let this generalized iterator run for several days. So that was how we felt about it at the time. It was just a continual battle. Whenever a new computer would come out with a little bit more memory or a little bit faster processor, we would jump right on it.

We were able gradually to more and more automate the tools that we had as we progressed through Apollo and certainly in Shuttle and so on. So it was a continual battle of fighting the computer capacity not being there.

BUTLER: Worked out well enough, anyway, that most things were successful.

BERRY: Right. And it made you appreciate the computer power when you did get it, because you didn't have to do as much manual work. Of course, you learned a lot doing it manually.

BUTLER: I'm sure you did. In fact, that's one of the things some teachers comment nowadays, that kids don't do things enough on their own, that they don't understand it as well.

BERRY: Right. To run one of the early lunar trajectories and associated rendezvous, we were using FORTRAN programming to program the equations of motion and so on, and we had to sit there at a keyboard and punch these little punchcards. I don't know if you've ever even seen one. You probably haven't.

BUTLER: No.

BERRY: Called the old IBM punchcards, full of these little holes. You'd have to sit there and manually punch a card for one instruction, and of course you had thousands of instructions, so you'd end up, to make a computer run, you'd end up with a whole trayful of these cards. You know, for one lunar trajectory, you might have a trayful of cards this thick with these all punched individually. It was quite something.

BUTLER: Quite something. Very different.

BERRY: You'd write out your FORTRAN code and then you'd have to punch it into these IBM cards, and then stack them all together to make a continuous run. Of course it would never work the first time, and you'd have to find which card was wrong in this whole stack. So it was really a bear.

BUTLER: Quite time-consuming.

BERRY: Yes.

BUTLER: Talking about this type of thing and programming the computers and setting things up, and talking about sitting in the meetings and having the discussions on the plans, was there a typical day, or did all of this into—

BERRY: The typical day was that there was no such thing as a typical day. That was the only consistent thing. You would go from—and I'm talking about supervisors as well as the working-level folks, nearly everybody would spend some part of the day doing hands-on technical work. At least I did as a section chief and as a branch chief. So your day would usually be a mixture of doing hands-on technical work, doing schedule analysis, were we on schedule, that kind of thing, having the usual management staff meetings to let everybody know what was going on, but it was usually from a technical or schedule standpoint.

Very little focus back in those early days on budgetary considerations. We pretty much had a set budget which was adequate, and we didn't have to worry about it, unlike later years where it became 75 percent of your job to work the budget concerns and try to figure out how to do things cheaper and so on.

And another thing we did not have a lot of was people-problem meetings. Everybody was so focused on this one goal and so unified on this one goal of getting to the Moon, that people would let their little petty things go. It was amazing. I can recall very few. I might have one or two people problems in a six-month period or something like that. Again, much different than later years, where people became more concerned about their own situation and so on. So that was what a typical day was like.

BUTLER: That is interesting, that you mentioned the people problems. I guess having such a goal that was such a positive goal really helped with—

BERRY: It works wonders.

BUTLER: Everybody had something good to work for.

BERRY: Right.

BUTLER: That's interesting. During this time you transitioned through from originally as head of the Maneuver Analysis Section to Chief of the Lunar Mission Analysis Branch and then to Chief of MPAD, of Mission Planning and Analysis Division. How did your role change as you were making these—as you were—actually, I'm sorry, I've got myself out of sequence here. You did make that transition, just not immediately.

Before we get there, going back through a couple of the Apollo missions, actually, that you were working through at the time, we talked a little bit about Apollo 8 and then there was Apollo 9 and 10, with the lunar module both in Earth orbit and then going in lunar orbit and then, of course, working toward Apollo 11. Were there any specific details as you were working for any of these missions—obviously for Apollo 11, is the big lunar landing mission—were there specific points that came up along the way as you were planning for them, or did it just move pretty normally, if there was such a thing as normal, through the kind of things you just talked about?

BERRY: I guess you would use the word "normal" for what went for normal back in those days. Everything was on such a frenzied pace that you didn't really have time to stop and think about what was normal or what was not normal. You took each challenge, you just absorbed it and went on, and you found the solution as fast as you could and went on to the next one, regardless of what mission it was in, because I guess Apollo 8 got us into that kind of mode of working, and we just kept going. It finally softened and got more calm later in some of the later missions after Apollo 11 and, of course, on into the subsequent programs. But that was what went for normal in those days.

BUTLER: In planning for Apollo 11, at the time did you think about this being the mission that was going to land on the Moon and the impact of that, and do you remember then the mission itself and what you were doing?

BERRY: Oh yes. Everybody had a very strong sense of the history being made. This added to the excitement. We were excited enough, trying to meet all the schedules, but the sense of history was extremely strong. Everybody felt it, not just for Apollo 11, but Apollo 8 had extremely strong sense of history also, especially for my particular group, because my particular group in the Lunar Mission Analysis Branch, we supported the landing and the ascent and rendezvous, but that was not our major focus. Our major focus was getting to the Moon, getting into orbit, and then getting back. So Apollo 8 was really in a lot of ways our high point and our big sense of history, and when we got to Apollo 11, everybody was very excited because we were really going to be landing and so on, but our group had already done essentially our historic thing, getting the crew to the Moon and into orbit and then back.

I was in the control center again for Apollo 11. I was sitting next to John [P.] Mayer, who was in the staff support room, who was the Chief of MPAD, and we all had our big old headphones on, you know, listening to what was going on, and we all jumped for joy and screamed and everything else when they finally got the thing landed. It was a pretty exciting time, because there were some alarms that went off, as you know, during landing and so on. So it got very exciting. So everybody got very scared at that point.

BUTLER: I can understand that. Certainly some tension there.

BERRY: But we were all over in the control center. A very exciting time.

BUTLER: Moving on from Apollo 11, Apollo 11 was very successful, achieved the goal, landed on the Moon, and Apollo 8 had achieved the goal of getting to the Moon, as you pointed out, but then they wanted to begin to start working toward some of the more precision to things. Apollo 11 hadn't landed quite where it had been planned, so on Apollo 12 they wanted to do more of a pinpoint landing. Were you involved in that at all? I know you mentioned earlier that you physically did the trajectories and not the landing-down or the ascent from the surface, but—

BERRY: We were on the periphery of that, my particular group. One of our sister branches, the Math Physics Branch, that was responsible for the navigation, they were the ones on the front line for that one, because it had become obvious during the first few lunar missions, Apollo 8, 10, and 11, that we did not have the modeling of the gravity of the Moon down right. Of course, neither had JPL [Jet Propulsion Laboratory, Pasadena, California]. They had been there for the early unmanned missions also.

So the Math Physics Branch had to figure out what procedures they could use, because they didn't have time to completely come up with a new gravity model of the Moon, together with the other NASA centers whose responsibility that was, Goddard [Space Flight Center, Greenbelt, Maryland] and JPL in particular, so they had to come up with some way to kludge it or fudge it, to be able to pull off a pinpoint landing.

They came up with a way of when the spacecraft would come from behind the Moon, first visibility with the Earth orbit, they would measure the difference between that first sighting and the actual time, and when they thought, using the old gravity model, at that time the current gravity model, which was incorrect, when that predicted you would first see them, and that was a time difference, so they just came up with a simple time kludge, you know, based on that delta between the time that they actually saw the vehicle. This was before the landing. It would make several revs before the landing, and on those several revs you would come up with this, be able to determine and to refine this kludged delta factor in time. That's how they pulled off that pinpoint landing, was just comparing the actual versus the predicted, coming up with a delta, and putting that into the navigation and guidance programs. That's how it happened.

BUTLER: And that certainly worked very successfully.

BERRY: Yes, landed right on a dime.

BUTLER: Right where they were supposed to be, which, of course, made the later missions able to go to some locations that might have been more challenging.

BERRY: Right.

BUTLER: Quite an accomplishment there. Apollo 13 was the next mission, and obviously things started out well, but then quickly several problems developed with the explosion in the oxygen tanks and so forth. You, on the trajectory side of things, were pretty involved with the rescue process or the recovery process. Can you tell us about that whole time, how you first learned of the accident and then how you progressed?

BERRY: Yes. I had been in the control center most of that day and had come home for that evening. The guy that I had transferred over to, a guy by the name of Bob [Robert F.] Wiley, who worked for me in that branch, Lunar Mission Analysis Branch, called me at home and told me they had had a problem, I'd better get back in. So I immediately got back in.

When I got there, things looked pretty bleak, to say the least, because we were just getting the early estimates of how much life support they might have for different situations and they were asking us to support them in determining how much time it would take, what's the shortest time it would take to get them back. Of course, initially there was a pretty large gap in those, a negative gap, which was scary.

So the Director of Flight Operations at that time, Sig [Sigurd A.] Sjoberg, pulled me aside. He said, "I want you to go downstairs. We're going to pull off one of their big computers, and you and your guys can have this computer solely. I want you to run everything you can think of to try to figure out the fastest way back."

So that's what we did. A guy that worked for me at that time, a guy by the name of Bob [Robert S.] Davis, and I went down there and spent most of those first few hours and days running that computer, because even though, back to the point of the computer capacity and processing being very much a limitation to us, even though we had the fastest computers available at that time in the control center, they were not fast enough to have a completely automated abort trajectory determination routine in them. So we had to make all these abort contingency trajectory runs, possible ones, manually.

So we ran literally thousands of possible abort trajectories, both those that would return directly to Earth as well as those that would go around the Moon, and putting in, of course, first of all, we didn't know exactly whether the service propulsion engine would be available and be able to get back on line or not, whether we would have it, or whether we would only have the LM, the Lunar Module engine. So we had to run both those possibilities. And we didn't know how long we would have for either one of those engines. We might only have the service propulsion engine for a certain length of time. We might only have the lunar module engine for a certain length of time because of the consumables problem on board, the shortage thereof. So we had to run everything. Like I say, we literally ran thousands and thousands of trajectories and had a team of folks helping us manually plot the results.

From those thousands of trajectories, of course, the other folks were working on whether the SPS [Service Propulsion System] engine [on the Command and Service Module, CSM] would be available, turned out it was not because of the explosion, and so things were gradually getting more narrow and more defined on the other side, the consumables and what engine we'd have available. So we were able to gradually converge it over those few days in there. Of course, nobody was getting any sleep, which, in hindsight, was a mistake. We should have taken naps, but we were too charged up, too much adrenaline flowing.

So we finally were able to come up with a trajectory which gave us a positive gap with the consumables left, so from then on we were quite happy. The rest of the mission was just monitoring the execution of those maneuvers which resulted from the thousands of scans that we had made, making sure they went okay. Not to say that it wasn't a very nervous time the rest of the mission.

We also had to work on the mid-course corrections coming back, supporting the flight controllers and the crew on coming up with how to make those maneuvers without using the full-up guidance and navigation system, using optical visuals, the Earth and the Moon and so on, using those to align the spacecraft right for the burns and so on. So we still had quite a bit to do.

There was evidently some unknown venting going on in the spacecraft, which kept causing the return trajectory to deviate, so we kept having to make additional mid-course corrections all the way back in till very late. So that made it exciting also.

BUTLER: Very much so. Had you done any planning beforehand of anything like this happening?

BERRY: Yes, we had some basic abort modes, if you will, the return with the big ellipse without going around the Moon, and then going on around the Moon. We had those basic modes in mind, but we, of course, did not have the specific case that occurred, where you had just the lunar module engine and nothing else. But we had done enough pre-flight work so that we were able to limit the number of trajectories we ran to the thousands instead of the millions, which would not have been possible.

BUTLER: On the mid-course corrections, you mentioned using the sun and the Earth as guiding points. Had that been something that was considered before, or was that dealt with—

BERRY: For monitoring, yes. That was one of the reasons that we had designed the mid-course corrections the way we had, and this also was something that came out of those mission techniques meetings that I talked about. If you did the exact mid-course correction that would be required for any particular situation, it would end up with a slightly cockeyed kind of firing direction for the engines, but nearly every time you would determine one, it turned out that it was fairly close to being perpendicular to the line of sight to the Earth. It wouldn't be exact. It would be off a few degrees this time or off another few degrees another time.

But in the mission techniques, Bill Tindall, again, said, "Hey, what if we just fired exactly perpendicular, fired our mid-course corrections exactly perpendicular to the line of sight to the Earth, which would then make it set up a nice crew monitoring, backup monitoring situation for making sure they were aligned properly and the burn was done correctly in the right direction, even though it would not be exactly theoretically the right direction, would it be close enough?" And we did an evaluation of his suggestion and, sure enough, it was.

So the nominal way we ended up making mid-course corrections was that exact perpendicular way anyway, so that set it up pretty nicely to do a manual burn, because you were just really using the backup techniques that we had developed pre-flight, using the Earth, perpendicular to the Earth technique.

BUTLER: And it all worked out very well.

BERRY: Yes.

BUTLER: The mission came back. I'm sure that was quite a relief for you.

BERRY: Right.

BUTLER: All the training and all the planning had paid off.

BERRY: Right.

BUTLER: As Apollo 14 came along, but then Apollo 15, 16, and 17 were the J missions, extended-duration missions. How did, or did, planning differ for those missions from the earlier ones? Was there any change in focus?

BERRY: Yes. The big change there was in the site selection itself and the type of translunar trajectory we would use. Like Apollo 15 that landed at Hadley Rille was 25 degrees North, and to reach that kind of latitude on the front side of the Moon, we had to consider relaxing some of our trajectory constraints.

The first few Apollo missions, the translunar trajectories were on what's called free-return trajectories. In other words, after you made the translunar injection burn, you were essentially on a trajectory with a mid-course correction capability of circumnavigating the Moon and coming back to the Earth. It's called a free-return trajectory. But when you stayed on that kind of trajectory, it turns out that you cannot go to all places, very many places on the Moon because it took so much to break into lunar orbit. In other words, if you wanted to go way north on the front side of the Moon, like 15 did, you had to make a very large burn, lunar orbit insertion burn, on the back side of the Moon, very much changing the plane of the incoming trajectory. And it took too much propellant to get up there. We couldn't get up there.

So this caused us to go to what's called a non-free-return trajectory, where you would start off on a free-return trajectory, but the first mid-course correction you would make would change it from a free-return trajectory to a non-free-return trajectory, so that you could be coming in at a steeper angle on the back side of the Moon. It was not a trajectory that would automatically return you to Earth if you did not make the lunar orbit insertion burn, but it was one that would minimize the size of the lunar orbit insertion maneuver so you could get to these more extreme landing sites. So that was the biggest change that we saw.

BUTLER: Do you want to take a quick break?

BERRY: Sure. [Tape recorder turned off.]

One thing I failed to mention earlier, which is probably worth mentioning in these lunar missions, it started in Apollo 8 and on through, was there was a very large activity between our group and the sister group at the Marshall Space Flight Center [Huntsville, Alabama]. Marshall was responsible for, of course, the launch and the Earth orbit and the translunar injection burn, and that's where we picked up theoretically at the end of the translunar injection burn. But they had to know where to aim that thing.

So we had to work out what turned out to be a fairly extensive interface activity and work group between ourselves and Marshall, to get all that straight. We had to arrive at a way of targeting that maneuver that would make sense to them, that they could work with. Of course, they were all working in the metric; we were all in the English. Of course, recently, you know, the Mars mission had a problem when you had that kind of changeover, mixture of systems, measurement systems. So we had to watch that as well as the more technical things of how to target those maneuvers. So that was quite a large activity. It required a lot of trips between here and Huntsville and so forth, and those people coming over here.

But in the end, it worked out real well. We arrived at a fairly nice clean set of parameters we could always give them, vectors that they would aim for, and they were able to back that up, take those vectors and back that through their maneuvers, through TLI [trans-lunar injection] and through the orbit on back to the launch site. So it was a smooth fit.

BUTLER: How was—a lot of people have mentioned that sometimes there were interagency almost a rivalry or some challenges in relations between the agencies. Did you experience any of that?

BERRY: No. With the bunch we worked with at Marshall, it was very congenial. Again, it was back to this thing of sharing the common goal. There were instances where we could have got mad at each other or got frustrated, so on and so forth. We really skipped over those pretty rapidly and stayed on plan, stayed on goal, I should say. Again, nothing like a unifying goal.

BUTLER: Absolutely. Talking about interactions with different groups, did you have any interactions with other specific groups here at the Manned Spacecraft Center at the time, like the Missions Operations Group or the astronauts or engineering?

BERRY: All of them, yes. I can't think of a group that we weren't involved with. We were working with nearly everybody, in particular the flight controllers, that group that was originally in the Flight Control Division and then became MOD [Mission Operations Directorate] eventually. With the flight crew, the people that did the crew activity plans or the flight plans, which was a separate activity but very much related and had to work hand in glove with the trajectory design and maneuver design, and the overall time line. So we ended up working very closely with them and the flight crew.

I remember I had to go out before Apollo 8 to the Cape because when we were doing a verification of the onboard software for Apollo 8, we found a fairly major problem with the software that they would use to return themselves if we lost communications, the trans-Earth abort return, software that was on board and that had been done by the MIT Instrumentation Lab people. There was a problem in there causing it to blow up, the software to blow up. So we had to do a quick workaround in the last few weeks, so I had to go to the Cape and explain it all to the backup crew, which was Neil [A.] Armstrong and Buzz [Edwin E.] Aldrin [Jr.] at the time. Then because it was so late, you know, we couldn't get in to see the actual flight crew, so we had to relay everything through the backup crew. It was an example. Prior to that, of course, we could work with the primary crew before they went into isolation.

BUTLER: As—we've talked now in general about Apollo. Were there any, especially toward the later missions which we didn't talk about specifically, each one, were there any events or problems that arose or anything throughout any of the process from the planning to the actual missions itself that you'd like to discuss or—

BERRY: I think we've already covered most of them.

BUTLER: Okay. I always like to give the option in case there's something I missed. As the end of the Apollo Program came up, as it was coming to a close, of course, people were moving on to Skylab and even some discussions, Shuttle at that time. Were there any thoughts about the lunar missions ending? Was that anticipated? Any, I guess—

BERRY: We were all sad to see them end, but I really thought subsequent missions back to the Moon would start back up certainly within five or ten years. I had no idea it would be this long. [Laughter] I think everybody was of the same mind, that it was just going to be a temporary halt. But turned out not to be.

BUTLER: Unfortunately. Hopefully we'll see it at some point going back to the Moon.

BERRY: Yes.

BUTLER: Toward the end of the Apollo Program, you became the Assistant Chief for Mission Design. Did your responsibilities change much from what they had been?

BERRY: Then they encompassed not only the translunar, going into lunar orbit and then coming back, but also picked up the landing maneuver on the Moon, the ascent, and rendezvous, as well as all the abort maneuvers and procedures that went with those different phases of the mission.

BUTLER: So it did expand significantly.

BERRY: Right.

BUTLER: Moving into Skylab and you were in this role then as Assistant Chief for Mission Design, what were your duties in planning for that program, and how did you plan for such a program that was so different from what had come before?

BERRY: Really we had by that time, because we had supported quite a few Earth-orbit missions, even though Marshall was primary, we had to simulate all that in order to give them the right targeting and so on for Earth-orbit missions. So we had essentially all the tools pretty closely ready to go, as well as the techniques for using them to do a rendezvous in Earth orbit. So we had pretty much all the tools, techniques, and procedures down, so that was not a big thing. It was just a matter of executing those in the same successive path, you know, way that we had before.

The new things, we had to come up with a better model of the Earth because of the long-duration orbits. We worked with the various other groups to try to get a better refined way to do long-duration trajectory predictions on an Earth orbit. We had to have that because this fed back into the consumables. How often would you have to make maneuvers to raise the orbit back up after it started decaying and so forth and so on, and to maintain that orbit.

So the two things that really required more work was that gravity model and trajectory projection programs for Earth orbit had to be refined, as well as more emphasis on the consumables for this long-duration mission. We were responsible for coming up with consumables' estimates and managing, essentially establishing budgets and so on for the consumables. So those were the two big changes there, as well as at the end of Skylab we had to support the decay and actual deorbiting the Skylab. I think that was in '79. So after six years up there, it finally had to come down, so we supported the effort in the control center of trying to bring it down in a safe part of the Earth.

BUTLER: That must have had its own unique challenges.

BERRY: Yes.

BUTLER: Luckily that did all come out.

BERRY: It came down in the Indian Ocean and a little bit straight through an isolated part of Australia, a little strip of Australia there that didn't hurt anybody, thank goodness.

BUTLER: Looking at that and just kind of speculating on International Space Station work that's going on right now and that's going to be a larger structure, a lot more pieces, do you have any just thoughts or opinions on how that will ultimately come down, and will it be done in a similar way or—

BERRY: All the planning techniques that evolved all through the previous programs are still being used. They're still being refined and so on. The big change here, more like Skylab but even more so, is there's a much tighter integration between the mission design and the flight plan or crew activity plan, because the real emphasis is in space station, like it was in Skylab, getting there, now what's the crew going to do every minute of every day. So the big shift is over towards the crew activity plan or flight plan side, but still needing to be integrated with the mission or trajectory design. But I think the whole emphasis shifts more so, center of gravity in planning, over to the crew activity planning side.

BUTLER: In looking over my notes, I came across something that mentioned that in 1973 you had been involved with the design of future contractor role for flight operations. Can you expand on that or explain some of what that involved?

BERRY: We were just looking at how we might turn over more of the contractor work on what's called a completion form basis. Up until that point in time, we had used contractors in what's called a level of effort, where you essentially hired them by the hour. They'd come in and you'd say, "Do this and do that." You'd kind of have overall control of what they did sometimes even on a daily basis. They were really like extensions of your civil service force, more so.

Thinking about going to a completion form contract meant that you would contract with them to do total end-to-end complete jobs, more, where they would have more authority to decide what their folks did on a day-to-day basis in order to work for the larger objectives of the contract, what we called then a completion form. I don't know what they call them today. So that was essentially the basis of that effort, to see if it looked like it would hopefully save some money for the government. The budgetary problems, those clouds were starting to arise at that time, as well as give the contractors more a feeling of controlling their own destiny and being able to hopefully have a little bit more enthusiasm and feeling of satisfaction on their side.

BUTLER: Talking about the contractors and kind of going back to the earlier discussion about some of the interaction between the different parts of the agency, how did that work with the contractor role? Was it a pretty comfortable relationship all throughout?

BERRY: Yes. Like I say, it was this level of effort type of contract initially, through the Apollo. It was very comfortable for us, and I think it was fairly comfortable for the contractors, even though it did not have these other advantages from a corporate standpoint that I just mentioned. But from a workers' standpoint, again, they were part of this unified goal thing, and they worked alongside us just like other civil service employees. In fact, a lot of times they brought experience and knowledge that the younger civil service people did not have, so they really taught us in a lot of respects. I remember one guy that worked for TRW, named Bill Lee [phonetic], he was a big help in actually teaching the rest of us things about guidance and maneuver analysis and so on from his experience at TRW unmanned programs. So I think that was a big factor that in the early years, at least, there were so many young kids just coming out of college, working for NASA, that somebody needed to teach them what things needed to be done in what way, and experience in a lot of cases came from the contractors.

BUTLER: Sounds like a pretty valuable relationship.

BERRY: Oh yes. And a very collegial one also. Like I say, in today's environment, I'm sure trying to work like that side by side, there would be all kinds of frictions, work and so on, but if they did exist, they were overlooked in short order.

BUTLER: You mentioned a little bit earlier, just a little bit before now, that some of the budgetary clouds were starting to roll in with Skylab and into Shuttle. How did you meet those challenges of dealing with those concerns, or did you just kind of take it in stride as part of what had to be done?

BERRY: Well, again back to the computer evolution, that was a big factor, the fact that the tools were coming along to enable us to become much more productive, automating all the systems and knowledge that we had developed during the Apollo and earlier programs. We were able to automate those to a much higher degree, as well as store the knowledge, essentially, of all of our experience in these computer programs, so that when we did change contractors for a better price or so on, we had the knowledge stored. We didn't lose the knowledge. And also experimenting with the completion form contracting helped quite a bit, getting a better price for the product. Plus the fact that our civil service staff was that much more experienced and therefore more productive.

BUTLER: In around about 1976, which is kind of at the end of Skylab and a little bit after Apollo-Soyuz, actually, you transitioned to the role of Chief of the Mission Planning and Analysis Division. How did your duties change with that promotion and—

BERRY: Besides the mission phases that we talked about earlier that I was responsible for, at that point I picked up all the navigation and the rest of the guidance analysis for the other major phases of the mission, like launch, the launch guidance, coming up for Shuttle, and the landing of Shuttle. That phase picked up both the guidance and the navigation. So those were the big things that were picked up with that promotion.

BUTLER: Jumping back as I did, kind of skip over there, Apollo-Soyuz, what—when did you learn of that project and what were some of the challenges of pulling that together, integrating two completely different spacecraft from two different countries and launching them to be able to rendezvous with each other? What were some of the challenges you faced there?

BERRY: Well, of course the big challenge is what you would expect, working with somebody you can't understand. [Laughter]

BUTLER: Yes.

BERRY: And I wasn't up to learning Russian, although I gave it a try, but I just couldn't do it.

BUTLER: It's a hard language.

BERRY: So we had to rely upon the translators for verbal and written. There were some errors made along the way, but they were all corrected in time, and misunderstandings and this, that, and the other. We got to a point of working with the Russians. It was, again, quite collegial and they are just like we are, the same problems. They had the same budgetary clouds, even though more so, I guess. We ended up with quite a good working relationship with them. We worked mainly with them on the orbital phases, the rendezvous. They launched first and then we launched the rendezvous, so we had to work together to determine the best orbit they would go into for us to be able to rendezvous with and so on, and working with us as we did rendezvous. It turned out to be quite a good experience and one I think was beneficial for both countries in the long run. Certainly satisfying for us that worked on it.

BUTLER: That's always a good thing.

BERRY: Yes.

BUTLER: You mentioned that as Chief of Mission Planning Analysis that you began to get involved obviously now for Shuttle and launch and a variety of other aspects to the planning. How different—well, Shuttle was obviously a very different vehicle with a very different mission from Apollo and from Skylab. What—how did you make that transition and what were some of the biggest differences to you from a planning aspect?

BERRY: Well, not just from planning. Planning was the most similar. Trajectory design was the most similar. We'd done similar things. But the bigger challenges were in the guidance phases, guidance and navigation phases of the ascent and landing, because these were very much different kind of vehicles, had very much more stringent constraints. You didn't want to break the wings off and things like that.

The program made a conscious decision for MPAD to provide the guidance formulation for those two phases, rather than having the contractor do it for both ascent and landing, as well as the orbital maneuvers. We were pretty mature in our understanding of how to do orbital maneuvers. So the big challenges there were to develop the guidance scheme for the launch, the guidance and navigation scheme for the launch, the guidance and navigation scheme for the landing. Those took most of the—well, the majority of the focus of the division was getting those two major maneuvers down, because they were both very critical to this new kind of vehicle we were flying, all different kinds of structural and kind of constraints. Marshall had the responsibility for the launch before, but they did not have to worry about wings and things like that, so they were helpful in that transition, but we had to develop quite a bit of new knowledge ourselves in how to do that guidance properly.

BUTLER: During the transition period, basically, between Apollo-Soyuz in '75 and the launch of Shuttle in '81, was it just mostly involved with this planning and developing these new—

BERRY: Right. We started several years ahead for the Shuttle planning and developing the guidance.

BUTLER: As it was coming up time for—oh, actually, were you involved in the planning for any of the [Shuttle] Approach and Landing Tests [ALT], or did that tie in some of that guidance?

BERRY: Yes, because we were testing and utilizing the landing guidance for those approach and landing tests. So we were right in the middle of those.

BUTLER: Building up from those to the first launch and STS-1 going so well and not having major—any major problems itself, what were some of your thoughts as that whole—

BERRY: Very satisfying. The thing went off right. [Laughter] And for a first-time flight of a vehicle like that, that had never been flown before, in hindsight it was pretty amazing everything went as well as it did. The software people that were in another group had a glitch leading up to STS-1, so there were some glitches leading up, but in our particular area it was pretty smooth sailing. And everybody was very nervous and uptight because of the ascent guidance and landing guidance on that first one, but it worked like a charm.

BUTLER: Had you had any thoughts before that of this being the first launch of this vehicle and yet they were putting men on it for the first time, whereas in earlier programs they'd always done some unmanned?

BERRY: Certainly, but we had gotten so good, I guess is the right word, at verifying all of our work, we developed all these checks and counterchecks and verification techniques between us and the software vendors and the overall systems testers, that we felt very confident going in that everything was going to go okay.

BUTLER: As the Apollo—as the Shuttle missions progressed, did your responsibilities or duties change any once the basic planning was down? Did it change much for each mission or did things go—was it pretty much a verification process?

BERRY: Right. There were always some new wrinkles for each kind of mission. Duration was one, where consumables became an issue, again having enough consumables, trying to stretch the flight as long as we could but still be safe from a consumables standpoint. We were always looking at as the configuration changed in terms of weight and this kind of thing, always having to reverify all of our nominal maneuvers as well as abort maneuvers. So they kept us busy.

BUTLER: Certainly would. You became then Director of Mission Support Directorate later on in the Shuttle Program, in fact, '85. Again, was this a more expanded role then building off of—

BERRY: Right. It kept all the planning and the software navigation as well as the guidance and trajectory, but added the control center development support during the missions. It added the development of the flight crew trainers and the support associated with those, as well as the institutional computer support. So it was quite an expanded role at that time.

BUTLER: Mentioning the control center, was this—did it fall under you then some of the redesign when they built the new center?

BERRY: Right. The early stages of that were under the MSD [Mission Support Directorate], the basic architectural change to go to a more distributed system as opposed to the more centralized system we had used up until that time. We did the preliminary work on that for what has become the current Mission Control Center.

BUTLER: I'm guessing a lot of the computer advances that we've talked about a couple of times had a big role.

BERRY: Yes.

BUTLER: Big transition there. As the Shuttle Program was going along and there were obviously a number of missions with different objectives that were all moving along pretty well, with a variety of different glitches here or there, or some more major problems, some less, but then, unfortunately, in 1986 the *Challenger* accident happened. How did that—obviously it impacted everyone to a very big degree. Was there changes then in planning aspects or did your division, department, directorate participate in any of that post-investigation?

BERRY: Our support involved reconstructing all the trajectories involved, that were used by the other investigative arms to determine what really happened and so on. But in terms of changing any of our procedures or ways of doing business, it really did not. That was more on the solid rocket hardware side, of course.

We, of course, went through and evaluated all of our contingency plans, techniques, and so on, to see if there were any that should be changed significantly, but we did not find any. All of our abort modes stood up. Of course, none of them could have handled that particular catastrophe, but for others less significant, we showed that we could handle them fine. The return to launch site abort mode or the continuing on to orbit, and the transition from one of those to the other and so on, they all stayed just about the same.

BUTLER: In fact, there has been a lot that has shown that even if something similar would have happened today, there's still not really a way to recover at that phase of the mission.

BERRY: No.

BUTLER: Unfortunately. It must have been rewarding to see everything get back on track.

BERRY: Oh yes.

BUTLER: Eventually you moved on to be Director of Information Systems Directorate. This seems to be a slightly different area.

BERRY: Right.

BUTLER: How did that come about and—

BERRY: What the center wanted to do with that area was, because of the budgetary clouds that had become severe thunderstorms, the center had to become more productive for budgetary reasons and the fact that the technology was starting to become available to do it and it's the right thing to do anyway. So the job that we were assigned was to attempt to make the entire center more productive through the use of better computer technology, of course, but also moving into the networking era. So our job was to start completely networking the center together with the other centers and with the contractors and so on and so forth. So that's what one of our major challenges was, as well as to provide day-to-day support to everybody at the center for their computer needs.

BUTLER: Certainly is a—

BERRY: And we also wanted to bring on to the center a super computer capability which it had not had up until that point, which we did. During that reorganization we were able to bring in a lot of the people over in the Engineering Directorate that had worked on super computers at other centers for a long time and knew them inside and out, and we were able to use their skill and knowledge to help us acquire and bring on and install and eventually operate the supercomputer, the Cray.

BUTLER: Okay. And is the Cray primarily—is its primary goal for mission support work?

BERRY: No.

BUTLER: Or—

BERRY: No, primarily it's for engineering analysis.

BERRY: Oh, okay. Oh, that's good.

BERRY: Aerodynamics, structural.

BUTLER: And that's still over there?

BERRY: Oh yes.

BUTLER: And operating today. That's great. I hadn't even realized they had one over on-site.

Were you—during any of this, was there any focus on using what you were doing with the idea of space station in the future, of Space Station Freedom or ISS [International Space Station] eventually?

BERRY: Like I say, the whole focus was to make the entire center and its interfaces with other organizations around the country and the world more productive, so obviously, in order to get ready and lean and trim and efficient for this space station era, which was the focus there, we did do quite a bit of work in advanced computer technology development, virtual reality, fuzzy logic, computer-aided computer training and so on, and we did develop some of that and make it available for the flight crew and the ground crew for training for eventual Shuttle-Space Station flights. Virtual reality training is what we call it. We developed quite a nice simulation of the Shuttle-Space Station.

BUTLER: Interesting, you mentioning virtual reality and fuzzy logic, yet here you had started out back in the early days working with the punchcards and taking days to make a run.

BERRY: Right.

BUTLER: In looking at all that, the changes in technology and computers and the growth of the space program, would you ever have imagined where your career would lead you?

BERRY: No, not really. It was amazing, the Information Age kind of snuck up on everybody. In looking back at it, it's just mind-blowing.

BUTLER: It certainly is.

BERRY: Everybody's into it and can't live without it.

I hope people are not losing something in not having to manually plot things anymore.

BUTLER: It certainly is a question. It certainly is something that I think there's still a lot that people are going to have to learn and adapt to and figure out how much reliance to put on things, technology.

BERRY: Yes. There is, I think, something you do lose, you can lose, if you're not careful, in totally going to automation. There's something about the mind and the hand doing something that causes you to really understand something sometimes.

BUTLER: Absolutely.

BERRY: Or being able to express yourself.

BUTLER: They say one of the best ways to learn something is to teach somebody else. So if you're relying on computers or other instruments and so you don't really even understand it, it's hard to teach someone else and to make that transition. It'll be interesting to see what happens, certainly.

Looking back over your career with NASA, you've mentioned several times a couple different people, and obviously with the program so big and so many aspects to it, it takes a lot of people to make it all happen. Were there any individuals that you worked with that you'd like to comment on, on their impact on your or the space program?

BERRY: Back in the original MPAD days and on through Shuttle, through ASTP and Shuttle and so on, there was a guy named Ed [Edgar C.] Lineberry, who really I consider to be the father of our rendezvous techniques that were used today. He and his group developed the rendezvous techniques. He was doing this in a sister branch to mine in the early days of MPAD. I think people should know about Ed. He has passed away several years ago. But he was a major force, very quiet guy. His way of making presentations, unless you were really into it, could put you to sleep really fast, but, boy, did he know his stuff. He really, like I say, was the primary force, in my opinion, behind the whole rendezvous schemes that are so critical in everything we do today.

BUTLER: Absolutely.

BERRY: There's John Mayer, who was the original Chief of MPAD. He understood the planning process, the significance of it, its tie-in with the guidance and navigation world and how that should be tightly integrated. He made a big impact on the space program.

Of course, our boss at that time above MPAD in the Flight Operations Directorate, Chris [Christopher C.] Kraft [Jr.], was a tremendous force, as everybody knows, but that's no surprise.

Lyn [Lynwood] Dunseith, who was really one of the primary contributors to the early development of the control center and went on to become division chief and then a deputy directorate chief, Data Systems Analysis Directorate when Bill Tindall was the director there. He has passed away also, unfortunately, but he was one of the great minds, I think, and motivators and doers in the whole space program, which owes him a real debt of gratitude.

I mentioned Bill Tindall. I hope I'm not the only one mentioning Bill Tindall.

BUTLER: Certainly not.

BERRY: Bill and his mission techniques work and his famous Tindallgrams. I don't think the space program could have really pulled off what they did without his efforts and his activities.

I failed to mention, when we talked about the expanded responsibilities when I took over MSD, one of the things we picked up was the whole onboard software area at that time, and I think not a particular name, but the whole effort that IBM did and, of course, MIT Instrumentation Labs before them, Draper Labs, but in particular IBM, through the Shuttle, they developed what I consider the closest thing to zero-defect software in the world. Of course, we claim we helped them a little bit, but I think it was primarily IBM and a lot of folks there who deserve a lot of commendation for coming up with the techniques and the disciplines and the strategies for developing not only a state-of-the-art piece of software, but one that had close, like I say, to zero defects. There were a lot of independent studies of that software that they did, and it's still operating today, of course, that gave it the highest rankings of any that they had ever rated. I think they should not be forgotten in all of this.

BUTLER: Certainly not. Sounds like they had quite an impact on things.

BERRY: Yes.

BUTLER: Definitely a lot of good people that have made some good contributions.

BERRY: Right.

BUTLER: In looking back over your career, was there a most challenging point for you?

BERRY: Well, it had to be Apollo 8, probably, for the longer term, like four months. Of course, the four days was Apollo 13, but the four months was Apollo 8. They each had their different kinds of challenges, I guess, but they were both time-critical. Apollo 8 was just continuous. At least Apollo 13 was over with in a little while. But those were the two in terms of the challenges and where I think I made the most contributions to the space program.

BUTLER: Both of those as well.

BERRY: Another guy I forgot to mention was Jim [James C.] McPherson and Emil [R.] Schiesser and Bob [Robert T.] Savely and Paul Pixley, who were in the navigation area of MPAD. I think they were another group of unsung heroes in the whole thing. You talk about your pinpoint landing and all the rest, they were the ones that made that happen with their navigation analysis and techniques. They worked both the ground navigation as well as the onboard navigation.

BUTLER: That's certainly a very vital role.

BERRY: Right.

BUTLER: What do you see, just in your opinion, based on your experiences, for the future of the space program, or what would you like to see, I guess? They're two separate questions.

BERRY: Right. What I'd like to see, of course, is a Mars manned mission. But I think that's going to be a ways off. I think the space station is going to do a lot for the country, the world, as it is an International Space Station. I think it's going to become even more the fabric of our everyday lives, maybe not as glamorous and short-term exciting as some of the previous programs but I think it's going to be every bit or more valuable and influential and significant to our culture, our civilization. I think eventually we will be able to go to Mars, but I don't see it anytime soon.

BUTLER: I want to thank you for coming in today and for—

BERRY: You're very welcome.

BUTLER: —talking with us and sharing your experiences. You've certainly had an interesting time.

BERRY: We did. It was not like a job. A little bit like a job in the later years. In the early years, not like a job.

BUTLER: That's fortunate. That's very fortunate that you had that opportunity. And we're fortunate for you sharing it with us.

BERRY: Thank you very much. Enjoyed it.

[End of Interview]