ORAL HISTORY TRANSCRIPT

MELVIN F. BROOKS
INTERVIEWED BY CAROL BUTLER
GLENDALE, ARIZONA – 25 MARCH 2000

BUTLER: Today is March 25, 2000. This oral history with Mel Brooks is being conducted for the Johnson Space Center Oral History Project. Carol Butler is the interviewer and is assisted by Rebecca Wright and Sandra Johnson. We are at Mr. Brooks' home in Glendale, Arizona.

Thank you so much for having us here today.

BROOKS: My pleasure. It's a pleasure to meet you and participate in this. It's a great idea.

BUTLER: Thank you. To begin with, if maybe you could tell us a little bit about your early career and how you decided what you were going to major in in college and how your interest in aviation and aerospace kind of developed.

BROOKS: Okay. Well, I really kind of backed into the aerospace business. My degree at Purdue University was in physics and math, and my interest was in particle physics, you know, atomic physics. I went to Purdue because they had one of the early cyclotrons there. But during the time I was there, my interests changed a bit. Then the Korean War came along and I whisked right out from college to the Army and off to Korea.

Somewhere along the line I had my degree in physics and math, which I carried around with me, and that's what I got all my jobs with, but my interest in that area had sort of diminished. I finally floundered a little bit, ended up working out in California for a company called Aerophysics Development Corporation. They did a lot of work and they did some tests on a wire-guided rocket for an antitank purpose, and they also did some arming

and fusing and reentry stability analysis of a nose cone for an Atlas. We put a payload on top of a Nike booster and carried it up in an airplane and dropped it out, and then the Nike would fire and we'd build it up to speed and then simulate the last 30,000 feet of the reentry of the nose cone and study the stability derivative analysis and all that.

But then I went to work for Lockheed, Lockheed Missile and Space Company, on the X-7A project, which was really a testbed for a ramjet engine, and also developed the wings for the F-104 airplane. I kind of backed into this stuff, and the more I got into it, the more interested I became in it.

Along that route somewhere, Lockheed started the development of the Agena vehicle. I was transferred up to the Sunnyvale [California] plant and worked on the Agena during the early development phases, the engine tests up at Santa Cruz [California] test base and things like that. Then I worked on about the first twenty flights of the Agena.

We transferred down to the Vandenberg [Air Force Base, California] tracking station in California where the launch site was, and the control center was up there. The tracking station was actually like the Cape [Canaveral, Florida]. We did all the final checkout of the vehicle and the pad and the final countdown and the launch, and then we acted as one of the tracking stations during the orbital ops phase.

I was one of the operations directors out there and doing that for Lockheed on the Air Force range, and one day we learned that the John [H.] Glenn [Jr.] flight was going to take place. NASA had people there at Point Magu—Point Arguello [California], actually, right near where our tracking station was, and we communicated with them and we asked them, for example, for the frequency of the air-to-ground loop and all that, but they said, "No, that's classified." But then the next day we got a directive from the range RF control people to stay off those frequencies, so then we could easily figure out which was which. So we put air-to-ground voice and the telemetry data—we didn't understand what it was—we put it on the PA

system in the tracking station, and, wow, that was exciting to me. Take that supersecret payload out of the booster and put a guy in there, and it really got interesting.

I was very, very interested in it and I was just trying to figure out how to get in touch with those people when I read an article or an advertisement in the newspaper that NASA was coming to Santa Barbara to interview people for the project Gemini and Mercury. So I contacted them and I went down the seventy miles away or so, and I was interviewed by, I think, Chris [C.] Critzos and Sullivan. What the heck was his first name? I forget. Both FOD.

About a week or so later, I get a call from [Eugene F.] Kranz, an interview with him, and he made me an offer which I leaped at. I took it right away. No questions asked. I actually took a little cut in pay to go there, but it was worth it to me, because it was really an adventure to get involved with that group.

During the time I was fiddling around getting back into this aerospace stuff, I had to take a lot of courses in high-speed flow, high-speed aerodynamics, compressible flow, and electronics. I learned electricity and electronics with vacuum tubes and stuff and learned all about transistor circuits and so on.

I joined NASA then in May of 1962, and they were just in the process of moving from Langley [Research Center, Hampton, Virginia] to Houston. The center wasn't built yet. We were located in some temporary quarters in Stahl-Myers Building, they called it, along the Gulf Freeway [I-45], right near where Telephone Road intersects the Gulf Freeway. It was right near there. And there were several such places around the area. The flight operations people were there and the Mission Planning and Analysis [Division, MPAD] people were there.

When we actually arrived there, I think the week I arrived there, Jim [James E.] Hannigan came and Cliff [Clifford C.] Charlesworth, and I think one other guy whose name slips me now. But when we arrived there, the flight controllers were all gone. They were

deployed out on the network at the control center at the Cape and around the network for the third from the last Mercury flight. I'll tell you who that was. I have to look it up. I cannot remember all these things. That was the [M.] Scott Carpenter flight, *Aurora 7*. It was just going as we got there, so we had nothing to do. Nobody was there to tell us what to do. We just sat around and listened on the loop and followed the mission and got very excited about it.

Then after the mission, the guys started filtering in, Kranz and all of his team of people and stuff, and it was a huge upheaval in their lives because they were just transferring from Langley, from their homes there, to the Houston area. It was a time of turmoil, but a great time.

When I joined that outfit, I can tell you it was some interesting thing, because if you look on this Del Webb thing—I don't mean Del Webb. This web chart [Brooks displays document], you will see that when I joined the outfit, Chris [Christopher C.] Kraft [Jr.] was the division chief and Kranz was just one of the workers, and John [D.] Hodge was the flight control branch chief. Kranz was one of the section heads. He was section head of the flight ops section, and he had all the flight controllers with him.

Over a period of time we evolved. The reason they were interested in me, obviously, was my knowledge of the Agena, because I had worked on the development of the Agena and I knew the vehicle really well and had participated in a lot of operational flights of the Agena. They were going to use the Agena as the target vehicle for the Gemini.

But there were some more Mercury missions to go yet, so they assigned me in what they call the training section. I became the head of the training section. We conducted the simulations. Gordon [M.] Ferguson was the name of the other fellow I tried to remember. I suppose you've interviewed him.

BUTLER: No, not yet.

BROOKS: He and I planned and ran a bunch of the early—the last two Mercury flights we ran simulations for and we did some innovative things. These had to be canned because we deployed people around the world, so at each remote tracking site, when it was time for their acquisition of the vehicle, they played a tape that we had canned for them. Every time somebody different would play the astronaut from the previous tape, but couldn't help that. But all the telemetry data would reflect certain things. Well, there never, ever was any exercise of those people, the people that worked out at the remote sites, the technicians that ran the ground station and the capcoms and system guys out there. The problems were always with the spacecraft and for exercises with people in the control center. So we started giving them some problems, too, and they weren't prepared for it. We really caught them off guard, but it was really a great exercise.

Another time the people who always escaped the simulation training was the medical people, the doctors. So with the help of one of the medical doctors, we staged a heart attack and actually went up to one of the emergency hospitals, Ben-Taub, I think, or something like that. The doctor hooked them up and taped various people with various stages of heart attacks, and we played this during the mission, and it progressively got worse and worse. A huge debate erupted amongst the doctors whether they should bring the guy right back in immediately and take care of him, or maybe it's better to leave him in that all-oxygen environment where he is now and wait until we get to a proper landing area, where we know we can get at him quickly. It turned out to be a really great exercise. So we had a lot of fun doing that.

One of the things we also discovered is that all the flight controllers were using schematic diagrams, which was their way of analyzing the system, understanding how the system worked, and it was kind of a mess because they were using the drawings provided by the people who built the hardware. They were using from McDonnell-Douglas [McDonnell

Aircraft Corporation, later McDonnell-Douglas Corporation] certain drawings and from some of the other subsystem people certain drawings, and they didn't fit together properly. People used different symbols for different things. There was no standardization.

So we found a lot of errors that people could make just interpreting the drawings. So we inserted a lot of things, and as a result of that, I inherited the task, along with Arnie [Arnold D.] Aldrich and some other guys, to come up with a system of putting together better system drawings. I've been doing that for about thirty years now, I think. We developed the technique for building our own system handbook drawings, functional schematics. We concluded that all these boxes full of drawings that we got from the contractors were valuable, but they didn't serve our purpose. What we needed was something that served our purpose as flight operations people.

Just an example, we were less concerned with which harness the wire was running through and which connector pin it went through and all that than we were in being able to understand the power source and all the controls and telemetry monitor points along the way to the end result, where the crew hit switches or controls all the way to the very end product. And that's what we put in. They were functional schematics. You couldn't design a spacecraft from them, but you could tell how the systems worked.

Over the years those have evolved and gradually grew and grew and grew. I think the book for Shuttle is about two volumes, that thick now. I still have some of the old original Agena books about like that. I showed the Europeans how to do that, too, and most recently the Fokker [Space (a Dutch aerospace company)] engineers on the robotic arm, and we put together a handbook there and some drawings.

Then with the—you want me to just continue talking?

BUTLER: You're doing great.

BROOKS: Do you want to provide me with questions?

BUTLER: I do have some questions, but if you're in a good flow, we can always keep on with that.

BROOKS: I'll lust lay the outline and then you can ask the questions.

As Mercury wound down, then we formed the Agena section, or the Agena branch. I guess it started out as a section. This was as Mercury ended, we ended up forming the Agena section. Let me find it on here [referring to chart]. Hodge was still there, Kranz was here, so I would have been under him. We had it not under flight control, but training yet. Then as Mercury was finishing, we formed an Agena system section and an Apollo section and a Gemini section, under what was called the flight control operations branch. This was still under Kranz. We were separate sections.

We started some of the early planning for that, but then as time went on, we combined the Gemini and Agena into one branch, and I became the branch chief of that. The Apollo stayed as a separate branch, which was broken into the CSM [Command and Service Module] and the LM [Lunar Module] sections. I had the Agena and the Gemini vehicles. It stayed that way, then, for some years as we went into the Gemini flight stage.

I'll just follow this evolution and then it kind of fits the pattern. Then at some point in time we got concerned somewhere we were halfway through Gemini that all of the experience was being accumulated by the Gemini and Agena guys, and the CSM and LM guys just weren't getting any operational training. They were the next guys to take the baton. So we reorganized again and we put the command module and the Gemini in one branch, and Arnie Aldrich had that, and I took the LM in mine. I had the LM and the Agena. So Jim Hannigan, who had the old LM section, he came and joined my branch, and that way we

cross-pollinated and we started putting the LM guys at work on the Agena missions. They actually wore headsets and manned the consoles for us during Gemini.

And it stayed that way for quite some time until we got well into Apollo, and I think the next major development was—well, you pointed out in your questions here, as Apollo was winding down, during the days that we had this organization with the command module and the Gemini in one branch and Agena and LM in another, each one of those branches had an experiment section and they followed all operational aspects of all the experiments that were going on in each program.

As Apollo was winding down, it seemed that we needed to get more emphasis on the experiments, and that's why we pulled those two sections out and I inherited the job of forming a new experiments branch, because they just weren't getting the attention. We had a lot of things in there that weren't really experiment stuff, like the lunar rover vehicle and the deployment and training. How to deploy that thing was kind of tricky. We had the backpacks for the EVA [extravehicular activity], backpacks, the EMUs [extravehicular mobility units] and stuff that weren't really experiments.

We were interested in primarily the operational aspects of the experiments, not the science. We never, ever were in a position that we could pass judgment on which science was more important than another one, or even try to understand what all the science objectives were. Our objective was to make sure that the experiments could be operated, that we had procedures for them, they had power, they had telemetry data, if they needed thermal control, they had that, if there were samples to retrieved, they had procedures for that, and put them in the flight plan and train the crew on them and things like that. So it was more the operational aspects than it was the scientific data. That we didn't judge.

And if they got behind in the time line, for example, for some reason the mission was not going the way it was supposed to and there was a delay and they got behind and they missed some objectives, we would never try to make a judgment about, "Well, okay, go back

and do this experiment or this one." We relied on the users to tell us that. We would tell them, "If you don't give us any inputs, we'll just stay where we are and press on, and all of those are gone, that passed by. So you have to tell us what's most important to do, because we can't judge that." And we only made sure the thing would work operationally.

Then after a while, Kranz decided—by now he had been head of the flight control division for a long time, and he decided to reorganize the division and break it into two halves. Joe [Jones W.] Roach got the operational half, the flight dynamics people and the mission planning people and all that, and I got all the systems branches. So it stayed that way until I left. The deputy chief, whatever you call it, for systems, and I had like four systems branches under me, all the experiments, the lunar module.

As we went into Shuttle, picked up the Shuttle systems and all of that. But that's about the time, then, it was still in that configuration when I left after Skylab. We had Skylab in there, too. I stayed there through all the Skylab missions. So I was at JSC [Johnson Space Center] for the last two Mercury flights, all the Gemini, all the Apollo, and all the Skylab flights. Then I was sent over to Europe.

Do you want to back up now?

BUTLER: Sure. Now would be a good point to go back over a few details.

BROOKS: Okay.

BUTLER: That was a good overview, though, good introduction. Going back to Mercury, you had mentioned that you were involved in training during those last missions. Did you work on console for any of those?

BROOKS: For the last mission—the group was very small in those days. In fact, I often tell people it was so small that everybody who worked in the control center for the mission would be invited to Chris Kraft's house for the party afterward. Now imagine if he tried that now. [Laughter] He'd need to rent a football stadium or something. But the first mission we didn't actually have any operational position during the mission, but I always complained about that because the sim [simulation] guys learned so much about the systems that they were in awfully good position to contribute during the mission. So for the last mission, I shared the console with Arnie Aldrich on the systems console for the Mercury systems, and I worked on that and I loved it. It was great. That was a wonderful time.

I was back at the Cape for the integration of the experiments into the Spacelab and then the Spacelab into the Orbiter for the Shuttle 9 mission, which is that launch up there. Every day I would drive out to the NASA offices there and I would see this old sign that said the old Mercury control center was down there. One day I just went down there to look at it. I said, "I'll be late," but I went down there and looked, and I was shocked to see it's just a little tiny building all boarded up. Nobody's done anything. There ought to be a shrine of some sort. It was really a very important place. I hope somebody does something one day.

BUTLER: I know I've heard some talk about it, so hopefully someone will be able to make some progress.

BROOKS: I wish they would.

BUTLER: A historical site. Absolutely. Of course, the Mercury control center was quite a bit different than what ended up in Houston.

BROOKS: Oh, yes.

BUTLER: Did you have any involvement with the construction and the organization of the new one?

BROOKS: Yes. Actually, one of the first assignments I had when I got to Johnson Space Center, there was a Source Evaluation Board for the control center design, and I was on the operations panel. They put us in an old hotel downtown. We were like a sequestered jury or something. You weren't allowed out at night to talk to people. But we stayed in this hotel for a week or so, and it was there I met, really got to know Gus [Virgil I.] Grissom, and I discovered that he graduated from Purdue one year ahead of me. I didn't know him there, though. We didn't know that. Yes, I was involved in that, too. Then all through the development and testing of it, always the requirements, operational requirements side of it.

BUTLER: How did you determine what those requirements would be?

BROOKS: Well, just from operating in control centers, I'd done it so much. I'd worked in the control center at Vandenberg Air Force Base and that evolved, too. Incidentally, there we had a contract with Philco [Corporation], it was in those days Philco, which became Ford Aerospace later on, and they did a lot of the flight control work, too. When I got in my Agena section there and I needed to recruit people, I went back to that old network, that old range, and stole away a lot of those people that came to work. Some of them came as Ford Aerospace, some Ford wouldn't release, so we just hired them as NASA people, but they came there, too, guys like Jim [James E.] Saultz and Harry Smith and Hershel [R.] Perkins and Bob [Robert D.] Legler and all these guys. They were from that old group.

BUTLER: Nice that you had that connection to be able to pull from.

BROOKS: Yes, it was really useful. I'd watched the evolution of that control center, and we knew what we needed to find out for the Agena for sure, and then it was easy to apply that to the Gemini stuff as well.

BUTLER: As the Gemini programs were coming up, you were now in this systems role that you were talking about, rather than training. Can you explain what some of your responsibilities were in this? Did you work at the console as a systems person?

BROOKS: More or less, but mostly my job was to provide on launch day a team of flight controllers that were well trained and well simulated and that knew their jobs and had all the right documentation and stuff. So part of it was to determine and ascertain what levels of operational documentation was needed, and then to make sure that we prepared it properly.

For example, one of the reasons for doing our own systems handbooks' drawings was, that was a wonderful tool for learning how the system works. We had each individual engineer to sit down and sketch out his own subsystem, how he wanted to do it, in the drawings. Then we took that to professional draftsmen. Now it's all computerized, but in those days it was all draftsmen who laid it out properly and they would iterate amongst themselves, and only after they were satisfied that it was right. I used to have to break up some arguments once in a while between the professional draftsmen and the engineer. They wanted it different.

But the end product was to get the guys that had all the console procedures, the documents for the console procedures, the crew operating procedures, the time lines, the mission plan, the flight plan, and the mission rules, and the systems handbook. Those were the key documents that we had to produce, and really the value of those documents was in the preparing of them, because when real problems occurred that required instantaneous

reaction by the flight controllers, there wasn't any time for them to go back, even though we had all these books behind the console, there wasn't any time to say, "Okay, let me see. What did we say?" He had to know up here. That's why we simulated and trained, simulate, simulate, simulate until you've gone crazy with it. But that was the main purpose, was to train these guys and get them ready.

Sometimes we used to figure when you brought a new guy in, it would take him maybe a year to be good enough to sit on the front-room console by himself and solo. Then there were exceptions. There were guys coming along, like John [W.] Aaron. You surely have interviewed him.

BUTLER: Yes, we have.

BROOKS: He worked for me. Wow, what a gold mine he was. Guys like him, he was ready in four or five, six months, ready to fly solo on the console. So it varied. Some guys took longer, some guys were faster, but you really were happy when you got a John Aaron in or somebody like that.

BUTLER: Understandably.

BROOKS: He was a super guy.

BUTLER: Very interesting to talk with. In fact, he's just retiring.

BROOKS: Did he? He is retiring now?

BUTLER: I think actually this month, in March.

BROOKS: I'll be darn. Last time I saw him was over at ESRTC [Eurpoean Space Research and Technological Center] in the Netherlands. It was at some meeting, and I saw him in the meeting room. I went in there, broke up the meeting a little bit—

BUTLER: I'm sure everybody understood.

BROOKS: Yes, they didn't mind.

BUTLER: During the missions, what were your specific—you mentioned training the controllers and making sure they were ready, but what did you do during the missions?

BROOKS: Of course, we already talked about Mercury. I just worked one mission there, really, on the console, but for all the Gemini flights, I was the Agena guy on the console. I was the guy who operated the Agena. Sometimes it got to be multi-shift and then I would be on one shift. I usually was on Kranz's shift when he was the lead flight director, like the launch phase, all that stuff.

Then as we got into the later programs, we formed what we called—I can't ever remember exactly when the name changed, but it started out as the SPAN room and later became the FOMA room. FOMA was Flight Ops Management Room. SPAN was Spacecraft Analysis Room.

The idea was this, that when problems occur on the mission, the guys that are on the console in the front room, they don't have time to go offline and analyze things, "Let's see. What led up to this? What did we do wrong? What caused this?" So they could only identify that a problem had occurred and their emphasis was if they could correct it immediately by sending a command or telling the crew to do something and they would do it.

If not, their objective was to get the system in a safe configuration so that it wouldn't further degrade, and then pass this back into the SPAN room, where we were, to where we identified every anomaly or deviation like that, what we called chits.

This would then be farmed out to the various interested people. It might be MIT [Massachusetts Institute of Technology] with the software, or it might be [North American] Rockwell [Corporation] with the hardware or simulator. We would troubleshoot these things and they would do it, and it would be collected back in the SPAN room. There all the managers would sign on it.

It was Kranz's idea. I guess I pushed him on that, but when you're preparing for the mission and you're preparing all these documents for the mission, you reach a certain point in time when you can't change them anymore. If you want to change the flight plan or you want to change the mission rules, you have to go to the Change Control Board. So they come under configuration control.

And when you get to the Change Control Board, you have to stand up in front of all these various departments heads and explain why you want to make this change, and they have to say, "Well, it's an impact to me. It costs me money," or whatever. But the management decides whether they're going to make this change or not, and if they do agree, everybody signs off on it.

Well, during the mission there is no Change Control Board, so that's what the SPAN was for and the FOMA. It was a vehicle for the management to continue this policy of evaluating anomalies, deviations, changes, and approving them. And we had the right people. I was usually the flight ops director representative in there, and there would be somebody from the program office, each program office if more than one was involved. During Skylab, for example, Marshall Space Flight Center was in there. We had people from Rockwell and Grumman [Aerospace Corporation] in there, and management-level guys who could pick up a phone and call people in on Sunday afternoon or Sunday night to run

simulators and stuff. So we were the guys. And after the mission, we had a pile of chits like that that we'd have to process and sometimes justify the decisions we made.

Then along the way there was all these management meetings. Probably the most classic example of that activity was Apollo 13, where we had dozens of parallel activities going on, major, major things. Kranz had gone offline with his team, what was called his Tiger Team, and they were churning stuff out left and right, and the help was very appreciated by everybody. What he would do is, they would document these as chits and send them in to us, and we'd farm them out and get all the right people working them, collect it back together.

Then probably on every shift at least we would meet with Chris Kraft and the other managers and explain to them what we're doing about this problem, "We've looked at this, this, this, and this. Here's the one that looks promising now. By tomorrow we should have an answer, and we're pursuing this." Then they would make a decision on what to do. "We rejected this for this reason or that reason." But it was a lot of people involved in that, and FOMA and SPAN was a place to coordinate all that activity and focus it.

So I did that all the way through Skylab from then on. I wanted to make sure that my initials were on some console position where I had a headset on. No way they were going to get me out of the control center.

BUTLER: Working on the control center and working on the Agena, you said you were in charge of that for each of the flights that had one. The first that was supposed to go and dock was—

BROOKS: Good question, yes. Oh, man. We took it on the chin, I tell you. We had bad press, bad press. The first one was probably one of the most greatest disappointments in my entire life, because I had worked on about twenty launches of the Agena before and never

had any problem. In fact, this launch was the 200th launch of the Agena, and the Air Force had a big publicity campaign ready to let loose with all kind of key chains and T-shirts and stuff. Of course they all went away. It was a very unexpected thing, and it was a state-of-the-art problem at the time.

I don't remember all the details of the history of it. I was involved in the investigation team afterwards, but what I do recall from it is that the problem was a design concept, in that the oxidizer and the fuel for the engine chamber were hypergolic. That means they ignite when they come in contact with each other. But the oxidizer on its way to the combustion chamber circulated through the engine nozzle to cool it before it was injected in. So what happened when the first slug of it hit there, it was fuel-rich. There was too much fuel and it exploded.

That took a long, long, long time and a lot of investigation from experts from all of the aerospace companies in America and the Air Force and everybody to figure that out, but that was the problem. So from then on, they put a slug of something else in the fuel, I think UDMH, something like that, which went through first, and the fuel and oxidizer to hypergolic came at the same time. It had probably never reoccurred, but it was a valuable lesson for a lot of other engine manufacturers that were going to ignite engines in orbit, because nobody had understood that before, and it was a very standard technique in those days. We just happened to be unlucky enough to be the first ones to do it, and it blew up. Terribly, terrible day.

Then you want to know about the next one on the Gemini VIII mission, I think.

BUTLER: Yes, Gemini VIII would be the next. Were you involved, though, actually even before that, as the one that was intended for VI didn't work, were you involved at all in the discussions on how to have VI and VII rendezvous in space?

BROOKS: Yes, somewhat. As part of the team, I was certainly involved in that. My heart wasn't really in it because we'd lost the Agena and we were looking so much forward to that. But, yes, I was involved in that with Kranz and those guys, working on procedures and details. In fact, I had worked on Gemini IV with Arnie Aldrich on the little handheld maneuvering unit to work out the procedures for that and train the crew on that. But, yes, I was in every Agena mission, every Gemini mission I was involved in, in the planning and documenting and stuff like that.

But on Gemini VIII, I remember I got interviewed by Jules Bergman just before the Gemini VIII mission. I'll never forget it, because I was very impressed with the guy anyhow, but he was a strange guy, by the way. He was one of the few newspeople who really understood the technical aspects of what was going on, and it was kind of, therefore, a pleasure to explain things to him because he understood it, whereas most of the other guys didn't.

The biggest problem, though, was that he wanted data, he wanted information, he wanted copies of the flight plans and the mission rules and things like that, and you couldn't give them to him. He was always hounding me for that kind of stuff. You'd get in big trouble if you did it, because he wasn't on the list to get updates. You make a decision in the mission, say, "We've changed that rule." He'd say, "I don't have that." So we didn't ever give it to him.

But I remember that interview, and I remember telling him that going into the Gemini VIII mission, the Agena had to be the most scrutinized and tested vehicle that ever flew in space. It was a DC-3 of the space age, you know. It was a trustworthy vehicle that flew many, many times, hundreds of times, and we weren't asking anything unusual of it in this mission.

So we went into the mission then, and everybody was still gingy from the last one when it had blown up. Everybody was, the flight crew was, Kranz. We couldn't get Kranz

to—Kranz was probably less than most, but a lot of the flight control people and management were still very suspicious of the Agena.

Well, it turned out that there had been planned on that mission to do a firing of the main engine, but that was taken out because of their fear of igniting that big engine. But there still was in there—I still have that flight plan out in my garage somewhere. But there was still a plan in there to light up the secondary propulsion system, the small engine, just to test it out and maneuvering a little bit in orbit. When you did that on the Agena, you had to send—the cutoff for the thrust was an accelerometer which was integrated to calculate delta velocity, and there was a velocity meter in there. We had to put in like a 17-bit word, and you had to send each one with a separate command to set in this velocity.

When we sent this command from the last tracking ship off of South America before they were going to dock, we loaded that velocity meter burn up, the flight controllers out at the site had trouble verifying it. They lost sync on their decom every time they tried to verify it. Send it again, all seventeen commands. I think they did it about three times, and we could never really satisfy ourselves that we had exactly the right number in there because they couldn't verify it.

So we told them, "Don't worry, because it can be easily manually shut down. If it doesn't shut down automatically, we'll do it manually." But when they went over Tananarive [Malagasy Republic], when the Gemini went over Tananarive just before they docked with it, the capcom—I forget who he was now—he told about this problem and he alerted the crew, "There might be some problem with the Agena. If you see any unusual behavior with the Agena, just undock and get off of there." So they were hair-triggered to expect something to go wrong.

If that had occurred, if their docking had occurred and that failure in the Gemini would have occurred over a tracking station where we had telemetry, it would have been solved like that. But because it occurred out of station context and these guys had pre-set in

their mind that there might be something wrong with the Agena, when it started to tumble they could see the Agena thrusters firing and they immediately assumed it was the Agena causing the trouble. What it really was, was an attitude control thruster on the Gemini that was spinning it up and it was coupling from roll of the pitch and started to tumble at very alarming rates, really serious rates.

If they had thought for a minute—I've talked with both the crewmen since then a lot of times, and if they had just thought, thinking back on it, if they looked at the thrust that was firing on the Agena, they could see it was trying to kill off the rotation. It wasn't causing it; it was trying to fight it. But the thruster was so much smaller than the big [Gemini] thruster that it was being overwhelmed by it.

So they assumed it was the Agena and they panicked, they committed their backup ring of RCS [Reaction Control System] fuel to get back in on, and then they undocked. Luckily, by some strange thing, Dave [David R.] Scott—and I've talked to him a lot of times about this—he had somehow the presence of mind, in all of that situation, to go through his normal checklist, and when they undocked and sent all the right commands to the Agena so that we could command it from the ground, because they had locked us out from the ground [after docking]. They didn't want any spurious commands coming in or anything, igniting the engine or something.

So we were able to get control of the Agena again afterward, and after they aborted and brought the crew down safely, luckily, onto an unplanned—well, it was a planned landing area, but not the primary site—they got them okay. We continued to operate the Agena for a long time. They finally ran us out of the control center in Houston, but I got permission to take a team of guys down to Corpus Christi, Texas, and we continued to operate there for a few more days.

We ran that Agena through every test you can imagine, and there, ironically, we found a problem that the other people weren't aware of. The first time we tried to make an

out-of-plane burn—you know the flight path is that way and we tried to make an out-of-plane burn, when we loaded all the parameters for the burn and the velocity meter and all, and we calculated we were going to make a plane change, and when we reacquired the bird, there was very little plane change but a great deal of change in the apogee. The orbit had gone way out of what it should have been.

We had a big witch hunt about that and found out that when the Agena engine lights up, it's a gimbalable engine. You can gimbal it. When it first starts in the buildup cycle of the hydrologic pressure, there's no pressure on the gimbals, on the hydraulics to operate the gimbal, so you don't know where the engine is pointing. As the pressure builds up, then the gimbals move the engine to the center, where it should be.

Well, it turns out that very late in the game—and I've got to be careful here, because I don't want to falsely get Lockheed [Aircraft Corporation] in trouble or anything like that—but my understanding of it is that—the Lockheed engineers and I worked very, very closely, they were my good friends—they discovered in some last-minute testing that right where the joint where the Gemini and Agena come together in the docking adapter, if that gimbal was misaligned and they had built-in software that would make the gimbal damp out just at the wrong frequency, it was the weakest point in the structure, so they didn't want to take a chance on damaging the docking structure. That would have been horrible. And they didn't want to delay the mission, say, "We have a problem we've got to solve. We've got to take six months to solve it."

So what they did is they put a Bandaid on the system. They put a big long delay in what we call the lead light circuits, which is what controls that gimbal so it will overshoot and damp out like that. So they put a big, big delay in it, so it went very slowly. Well, it went so slow, it turned out that the engine ignition, the gimbal was hard over and it came back so slowly to the center point that during the burn it yawed around 70 degrees, and half of the thrust was almost directly in-planed. If it had been the other way, we would have

brought it back in. It would have de-orbited. But lucky it was in-planed, so it just raised the apogee. So we tested that a lot of times, until we decided we couldn't do any more plane changes until that situation got fixed.

Then going into the next mission, we were the ones talking caution. "Hey, look out, guys. We had this problem. We need to really make sure there aren't any more bugs in there. Let's proceed very cautiously and make little-bitty maneuvers, try little-bitty plane change before you do anything." But by now the pendulum had swung the other way and all the managers were saying we overreacted, the Agena was safe, it shouldn't have been the problem anyway in the first place, and so we were now on the other side with "Caution, caution. Let's go a little bit slow on this."

But of course then came the other one you noted, Gemini IX, which again by now everybody was so sick of hearing about Agenas that anytime they heard "Agena," they immediately thought evil thoughts. This was, again, the Agena was a complete victim. They had absolutely no control. It was a failure in the Atlas booster. One of the Vernier thrusters got stuck and it pitched the whole vehicle over. The Agena tried its darnedest, you know. It uncoupled, did the solids burn, and it ignited, but it was by now coming back in. It burned straight in, you know. There was no way it could correct for that. It had been put in a catastrophe position by the Atlas booster. But it still took time for the Agena to get cleared of that.

Now, for all the rest of the missions, the Agena 9, 10, 11, 12, absolutely performed like a champion, like the true champion it is, and it's a wonderful vehicle and it did everything it was supposed to do. It just got off to a rough start. But you ask me what I think about it, I think the Agena is a wonderful vehicle. It got a lot of bad press and it had back luck stacked upon bad luck there, but it did what it was supposed to do.

We flew that thing. Man, we put it through its paces. We would launch the Agena first, and then on the next pass over the launch pad, they would launch the Gemini into that

orbit. Well, we were locked out. We couldn't command. Nobody could send any commands to the Agena then because it was dangerous. You didn't want to disrupt any orbital activity.

One time when the Agena came over the Cape, we could see on our telemetry that somebody was painting the vehicle with the command system. We could see it because we used the old verlark [phonetic] radar system, World War II radar system, as the command uplink. We could see it on the telemetry that somebody was painting our vehicle. Back in the old days when we were flying polar orbits for the Air Force, every time we'd fly over Alaska we'd see the Russians painting it, too. They were checking it out, too.

But somebody over the Cape was sending commands or sending a painting passively to our vehicle. A big witch hunt there, too, and it turns out some guy in Bermuda, I think he was, finally fessed up that he was running some tests with his ground equipment and he was sending some commands very, very low frequency to a dummy receiver on a tower horizontal, and the vehicle was up here. We saw it. So based on that, we tried some experiments with the Agena, and my gosh, that was a delicate receiver. We sent commands. As soon as they acquired, for example, the vehicle over Guaymas, Mexico, which was still out in the ocean, from Corpus Christi, with the antenna pointing straight up, we send commands and it got in, got in the vehicle. We tipped the vehicle upside down so that the receiving antenna was opposite side of the vehicle, they still got in. We'd find all kind of things like that.

We improved the performance of the Agena over what the Air Force was doing, because every time you're going to change the position of the cardinal heading from this one to that one, you set up all the horizon scanners and all that to receive it at the new one, then you tell it's got an error. Your nose is pointing the wrong direction so it fires thrusters to move it, and you wait till it gets around there, then you put the error in the other one. Your nose is around the other way, so it stops firing.

But what we did is we just put in the commands for the new cardinal heading and let it go, and it moved by itself, without any thruster firing. It just moved around very little, just a minuscule thruster firing. We could maneuver it all around, just taking more time but no fuel to use.

So I'm a great proponent of the Agena, as you can tell. It's a great vehicle.

BUTLER: It certainly sounds like it had a lot of successes.

BROOKS: It did. It really performed well.

BUTLER: In fact, on Gemini X, I believe it was, they actually ended up rendezvousing with two of the Agenas, theirs and the one from VIII.

BROOKS: Yes. That was always an objective of the project, was to dock with one and then use it as a propulsion unit to go and rendezvous with another one, perhaps not so much—most of the important objectives were those things that needed to be done for Apollo right away, but also they had a lot of them that were for future programs like Space Station assembly missions and stuff like that, where they were looking at docking with a fuel tank and orbit with thrusters on it that could be used as a tug, space tug. And also the first orbit direct rendezvous was a requirement from Apollo because of the liftoff of the lunar module, and come up and rendezvous and dock with the command module on the first pass. It was no sweat; it was easy to do.

BUTLER: One of the other experiments with the Agena was the tether.

BROOKS: Oh, yes.

BUTLER: What was the objective for that?

BROOKS: That was interesting. There were two objectives, really, that I recall. One of them was to set up this artificial gravity situation by spinning it up, and the other one was to test out what we call gravity gradient stabilization. I remember Buzz [Edwin E.] Aldrin [Jr.] trying to convince all of us how important that was and why it would work and everything. We'd kind of laugh at him, because, see, Buzz was a strange guy. He had a Phi Beta Kappa key in orbital mechanics back when most people didn't even know what that was.

He had this—well, it wasn't all his idea, but he was the one selling it to us, trying to get it, he tried selling it everywhere and finally found some ops people that would listen to him, that if you had a dumbell in orbit and you pointed it toward the center of the Earth, lined it up with the center of the Earth, that the equation for gravity is the product of the masses of the two masses, the Earth and the other piece, divided by the square of the distance between their centers. And since these were physically farther apart, the distance was a little bit greater, that the force would be greater on this one than on that one.

We laughed at him, because those forces he was talking about would be like in the fifteenth decimal place or something like that, and nobody ever believed that that would work, but it did. It certainly did work. It's a routine operations plan now. For example, the Skylab vehicle used controlled moment gyros for attitude control rather than having to carry along heavy propellant gases and all that and fuels, and use these wheels that would spin up and spin down. They were spinning. They were like gyro wheels, and you would control attitude by spinning, increasing the velocity of those things a little bit or something like that. Occasionally you'd want to desaturate them because they'd get spinning, too much energy in them.

So what you do is you just put the vehicle so it would go around like this instead of like that [Brooks gestures], and every time it came to one of the gravity gradient points, you just put those things on and it would lock them right up. They would take over attitude control and de-spin the wheels. So gravity gradient stabilization really works. And when they put the tether on and it lined up, it just locked in there. They turned off the attitude control systems and it stayed there.

The spin-up worked a little bit, too, although I don't know if anybody ever followed up. It obviously would. I mean, centrifugal force, so you could generate gravity. But it produced some that way, too. Did some funny results, though. The cable behaved strange. It got funny loops in it and patterns that they couldn't get out of it. When they went around, the pattern just stayed there and stuff. But it was a strange experiment, yes, but an interesting one.

By the way, you asked about relations with the Air Force in the Agena days.

BUTLER: Yes.

BROOKS: Well, you know, when NASA decided to use the Agena for the target vehicle, they couldn't just go to Lockheed and buy one because it was developed and paid for by the Air Force, so the Air Force owned it. So they had to go to the Air Force to buy it, and, of course, the Air Force then injected themselves between the NASA people and the Lockheed people and accompanied them to every meeting they went to. You couldn't ask Lockheed to—it was almost like if you wanted to ask Lockheed a question, you had to ask the Air Force and they would ask them to give you the answer back. It was a little awkward, I can say that. I mean, I knew a lot of these guys from when I worked at Lockheed on the Agena, because I worked with the Air Force range and the Air Force people. But it was difficult sometimes. We wanted to really understand from the Lockheed people who built the thing how it worked and

what they did and what their ideas were on things, and the Air Force guys always intervened in that.

I got in trouble once because we launched the Agena and the handover from the Department of Defense to NASA ops people officially took place when the booster cleared the launch tower. I got on the flight director loop when that happened. I said, "Would you please inform the Air Force that we now own that vehicle?" or something like that. [Laughter] They didn't like that much.

I had some busy times with them, but, you know, one of the guys who was representing the Air Force in those meetings was Buzz Aldrin. He wasn't yet an astronaut; he was, I don't know, a major or something like that, a young guy, strange guy, bright guy, very likeable fellow. I always got along real well with him, had no problems with him.

One time at a meeting I recall—I met Buzz here. He came making a speech and advertising that book he wrote, a science fiction book I have up there, and he was a guest of the Arizona Historical Society. I joined it just so I could go to that meeting and meet him, and they let me go in the back and talk with him a little bit before the meeting. Very typical of this guy, what's he doing when I see him for the first time in twenty years or so? He's standing out in the back with one of these global positioning things and he says, "Mel, stand by. I'm just picking up the third one here. I've got us now pinpointed on three satellites. I know exactly where we are within one meter now." [Laughter] So that's typical of Buzz, you know.

One time when we were at a meeting at Lockheed, he took us all up to San Francisco for a night of carousing around. He was a carouser. When we came out after dozens of bars, none of us knew where in the heck we were, he was the only one who knew his way around, he couldn't find his car. We didn't know where it was. But he said, "Don't worry, I'll get us." And he'd run out in the street and he was shooting on stars, trying to get a bearing on the stars so he could navigate us to the car. [Laughter] He was quite a guy. I like Buzz.

But things with the Air Force were sometimes a little stormy, not always, but we managed to get by. Sometimes we would go to a meeting and they would record it like that, and after we would leave at night we'd see them. We were out drinking beer. They were sitting there listening to that and taking notes and stuff, seeing if we'd stubbed our toe on anything. [Laughter] It was a little difficult. It's almost like dealing with the—you know, within NASA sometimes the project office would inject themselves between the operations people and the ones you really wanted to talk to. They had the contracts with the contractor, Rockwell and all them, and we wanted to talk to those guys. We don't want to talk to the project office; we want to talk to the guy who's designing and building that thing. And it was sometimes not easy to do that, but it's the same kind of thing. Politics. It's one of the unfortunate things about life. You have these political groups in between.

BUTLER: Talking about relations, and having mentioned Buzz Aldrin, how were relations between the controllers and the flight crews?

BROOKS: I think very close. I guess sometimes there were some disagreements, but we always used to say the first thing that happens to a guy when he gets to being an astronaut is he has to get a bigger hat size. They got an awful lot of notoriety and attention, and, frankly, some of them handled it better than others. Some of them, I don't suppose it's any different than if you look into today's world with the young multimillionaire athletes are twenty-three years old and coming from a ghetto, and suddenly they're rich and famous. Some can take it and some can't, you know. Some guys like John [W.] Young, he never wavered a bit. Steady as a rock all the way through there. Guys like Buzz, they kind of went over the brink. Buzz got in all kind of trouble with drinking and carousing. NASA asked the Air Force to take him back, I think, and the Air Force finally got rid of him. But he's doing okay now. He's got his life back in line. He's doing okay. Good guy.

But we got along well. In our opinion, they were part of the ops team. Just happened their console was in the spacecraft. But there was very little authority that they had to make unique decisions that weren't already understood by the people on the ground. For one thing, the people on the ground had access to a lot more information than they did. They could not see, and plus they had no historical data. We had data from yesterday and the whole mission, previous missions to fall back on. We relied on them, they relied on us. We were a team. I think, in general, we got along very, very well with them.

Sometimes relations with other people wasn't that great, because, in my opinion, the flight control people got an awful lot of attention by the press, the news, and all that. We all got to know all of the big news guys, Huntley, [David] Brinkley, [Walter] Cronkite. We always called him Walter Crankcase. And people like that. They didn't go and interview the program office people much; they came to see the flight controllers and the flight crew in the early days. Now it's primarily flight crew and they don't go much above the flight director level anymore. In the old days, they did. You'd walk through the lobby of Building 30 and you had to almost hide your badge because it was full of newspeople in the early days, lights, cameras, and they were running up and shoving microphones in your face.

You had a lot of attention. We had Chris Kraft with his picture on the cover of *Time* magazine, and Ed [Edward I.] Fendell interviewed in *Time*. Our guys got to be famous people. Do you remember the Apollo mission where we photographed the lunar—the roving vehicle had a camera, a TV camera, and they photographed the ascent stage taking off?

BUTLER: Yes.

BROOKS: I've seen it about a million and a half times. Ed Fendell was the guy in the console who sent those commands to do that, and we practiced and practiced and practiced that, because we at first had to position the rover just the right distance from the LM to be able to

get it, because the rate at which this thing could pan couldn't keep up with the rate at which it was going to climb. So you had to start with it way at the bottom of the frame and then you had to pan at the most rapid rate, and just as it pitched over, we got it. It pitched over before it went out of the frame. But you have to remember that there was a second-and-a-half delay in RF transmission time and another second and a half for it to get back with the return signal. So that really took a lot of training, and it worked so perfectly that Ed Fendell was taken to Germany and given what they call the Golden Hand Award. It's kind of like the—I don't know what you'd call it here. For the TV, the best documentary TV or something like that. But it's a hand like that and it's a golden thing. We just called him Goldfinger. We said that's the finger he pushed it with. We call him Goldfinger. Have you interviewed Ed yet?

BUTLER: We haven't, but we're hoping we can.

BROOKS: Ed's a super guy, too. I have to tell you another Ed Fendell story, if I can.

BUTLER: Absolutely.

BROOKS: Ed's a Jewish guy, but, you know, in the control team, they're so closely knit that nobody ever worried about that. He used to call himself "super Jew" and all that stuff. Sy [Seymour A.] Liebergot also, these guys. But nobody had any prejudice about that at all. It was just a joke. But Ed's the kind of guy that was horsing around. One day we were running simulations or something on a Saturday, and I always, by the way, was kidding around with a German accent, even in the simulators. In the simulation days I used to play the pad leader when I needed to inject a delay in the countdown or something and come down in Guenter's [Geunter F. Wendt] German accent. It was LOS [loss of signal] and Kranz was going to go to the bathroom, so he asked Fendell, who was the INCO [Instrumentation and

Communications Officer] on duty, he said, "Would you take over for a minute?" And so he left. Fendell, of course, he started playing flight director, bugging all the console positions. He bugged me in the Agena console for something, and I put on my German accent and I said, "When I was in Peenemünde, we would never have allowed a Jewish technician in our control center." [Laughter] And he said to me—everybody laughed, of course, and he said, "Hey, Brooks, you'd better look back." And I looked back and the viewing room was full of people and they had heard that. They were all laughing like crazy. [Laughter] I didn't know that. But that's Ed Fendell.

BUTLER: You did have quite a camaraderie, as you mentioned, between the whole team.

BROOKS: Such a team it was. Everybody used to say you didn't have your flight control wings until you'd been chewed out by Chris Kraft in a debriefing from a sim, till he brought you to the brink and you screwed up and then you got really chewed out by him. Then you could put your flight control badge on. It was a group, and it was a group therapy session. We used to call that—John [S.] Llewellyn called that a group therapy session, those debriefings after the sims. But they were well designed to bring you to making mistakes, but the thing you always knew about it is that's a mistake you'd never make again. You make it in a simulation and sometimes the simulations would drive you crazy, over and over and over again until you finally got it, until you got it right, until the team functioned as a team. A lot of times I can remember somebody would call from the loop and say, "Flight, INCO, or something, this violation of flight rule such and such." You'd say, "What does the flight rule say?" And he'd look up and say, "It says continue mission." [Laughter] So then you'd get chewed out for that.

There was a camaraderie there. You really were a group. You really, really were understanding what a team is then, because no one guy can cause it to happen. Every guy

there has to do the right thing all the time or it'll collapse. One guy doesn't do it and the whole thing will collapse. You had to have extreme confidence in the people around you. It's almost like when I was in the Army in Korea, in combat, you get to rely on the people around you. When a firefight develops, you don't have time to watch over and see if everybody's shooting in the right direction. You just have to rely on them doing it.

And that's the same in a mission. It requires special talents and capabilities, personality, maybe, or characteristic, character. When you put the headset on and sit on that console, you are taking on some responsibility. You make some decisions that might be right or wrong, and guys' lives can depend on the outcome of your decision. So it kind of puts you in a different light.

People, who, for example—and I don't mean this disrespectful at all, but the people who are in the program office funding the development and riding herd on the contractors, they didn't have to make these kind of decisions in real time. It kind of separated us from them a little bit. It was impossible for it not to. You got so involved with this group of people that you depended on so much, that you really became a very harmonious team.

You asked about an Apollo adventure. I'll tell you one, because John Aaron's name comes up in it. Everybody knows about Apollo 11 and Apollo 13, but most people don't know what happened on Apollo 12. It was the closest we ever came to a powered flight abort. It was a terrible disaster. The whole Saturn V stack got hit by lightning twice, just after liftoff. Do you know about this?

BUTLER: Yes.

BROOKS: Well, it never happened before. Of course, the people observing it could see the lightning hit the top, go all the way down the skin and follow the ionized contrail back to the launch pad on the ground and struck there—twice it happened. When it happened, they lost

all power in the command module. The lights went out, the eight ball was tumbling, all the caution warning lights were flashing like a Christmas tree, and the only thing, the crew had their finger on the button to abort. We've never done an abort during powered flight before, and nobody's sure it would work yet. Nobody ever wanted to be the one to try it, because we're not sure it would work. With seven and a half tons of thrust pushing the thing up, it was too much.

But what saved the day was two things. One is that the IU, or instrumentation unit, for the Saturn booster was the one under control of the Saturn rockets, and it didn't get disturbed by the lightning, so it kept functioning. So the booster kept going. Then John Aaron, who happened to be on the EECOM [Electrical, Environmental, and Communications Officer] console that day, everybody's telemetry data went berserk and they couldn't see anything, just garbage, but John Aaron recognized a pattern that he had seen once before during a test at the Cape. I think it was the Lockheed people at the Cape were in the vehicle, one of them inadvertently hit a circuit breaker and it was for one of the—I don't even remember the name of it—auxiliary power unit or something for the instrumentation buses. But he accidentally bumped that circuit breaker and John Aaron saw this pattern of data and said, "Hey, what happened there?" The guy explained it to him, and he made a note in his log.

So when this happened, he recognized that pattern, and while pandemonium was breaking loose in the control center, he's the one that made the call. He said, "Have them go to aux unit two," aux power unit two. They didn't even know what he was talking about. He had to explain, but it turned out that [Jack R.] Lousma—not Lousma, but the second astronaut, the pilot [Alan L. Bean], he knew where this circuit breaker was and he threw it, and immediately they started coming back. Then Aaron talked them back through, bringing the fuel cells back up and configuring the buses to the fuel cells and got the whole thing

restored, and it continued on to a very successful mission. This is what skyrocketed John Aaron into a famous guy. He was never the same after that. [Laughter]

BUTLER: Well, that's certainly quite a call.

BROOKS: Oh, it was. He saved the day.

BUTLER: Looking at Apollo, you had begun to move—at this point you were working with the LM systems as well?

BROOKS: Yes.

BUTLER: Or you had a mix there for a while with the Agena?

BROOKS: What happened, actually, somewhere along the line, of course, in Skylab the experiments were going to be a very big part of what you did. I mean, that's the name of the game in Skylab. We had these little experiment sections in each of the system branches, so what they did is they formed a new branch and called it experiment systems branch. I drew the short straw on that, I guess. I kind of was always Kranz's troubleshooter or put-out-the-fire guy or something like that, so I got the job of pulling that together and we had a lot of the Skylab systems and stuff in there, too. We started working that as Apollo was coming to an end.

Then you mentioned in there something about after I left that branch. I didn't quite understand what you said. I think you're a little mixed up from the orbit chart. You said when I left the experiments division. Well, it was experiments branch.

BUTLER: Okay.

BROOKS: And I went to the payloads systems section. Well, what happened is when we formed this new payloads experiments branch, or whatever it was called, we didn't have a chief for that section yet, so I was both the section head and the branch head for a while there. I was acting. Then later on we put Ted [A.] White in as the system integration branch.

BUTLER: Okay.

BROOKS: Then shortly after that, this is when Kranz reorganized and I became the assistant chief for systems. I had all the systems branches and Roach had all the operations planning branches and stuff. And it stayed that way through the rest of Apollo and until I left.

BUTLER: Looking at the experiments for Apollo, then, you had mentioned earlier that you didn't concern with the science side of it, but more with the operational side and how it would work and what was going on with that. What were some of the key factors in—

BROOKS: Well, I think an important thing we did was we recognized early, as I mentioned, if something went wrong, for some reason you couldn't do all of the experiments that you had planned to do, for whatever reason, you get behind the power curve and now you get that situation fixed and you're ready to start again, but where do you start?

The first couple of times we tried to simulate that, we didn't do it very well, and we irritated all of the users, all of the scientists. So what we decided we needed to do then was to bring in an outside party, which ended up sort of like the mission specialist in the Shuttle flights today, who acts between the operational crew of the spacecraft and the scientists. We used Bob [Robert A. R.] Parker, for example, who is one of the mission specialists. All

through Skylab he conducted these meetings every day, where he would review what science had been achieved, with all the science people. He would review what had been achieved and then they would discuss what needed to be done yet, and these people would decide amongst themselves which one was most important to do.

Within an experiment group, like in Skylab we had the Apollo telescope mount, for example, we came with the idea to call what we called King for a Day, or Queen for a Day, or something like that, where there were five major telescopes involved there, and each with competing objectives. One wanted to look at the LM, one wanted to look at this hot spot, one wanted to look at something else, one wanted to map this area over here, and we couldn't decide what to do, so we agreed with them on the number of hours they would get viewing the sun, but what they did with those hours was up to them. One representative, the lead guy to make the final decision, rotated each day from one of the five experiments. He had to decide what was most important to do that day, and he would get inputs from the other guys. We would block out a block of time, schedule crew it and all that, and then he would come back at the proper time and say, "Here's what we want to do," and then we would schedule the experiments and resources and stuff to do. But it was done like that. We didn't ever get involved in trying—in fact, I used that same experience when I came back.

We'll get into Europe after a while, but I came back for the Shuttle [STS-]9 flight, which was the first flight of the Spacelab. Ulf Merbold, the ESA [European Space Agency] astronaut, flew on that, a good friend of mine. I helped train him a lot. By then I had become an ESA staff member and I was the project manager for the material science double rack, or what we call the verkstaflabor [phonetic] in German, built by MBB. It was a similar situation. There was hopelessly inadequate facilities for the users. There was about, must have been forty different experiments. Had five or six major facilities in there—furnaces and fluid physics modules and things like that, and each one had a dozen of experiments on it,

with their own scientific representatives and all. And where was I going to put all these people in Houston to accommodate them?

I managed to get some space over in Building 17, a room over there, and we put data lines in there and we got them data displays and voice lines and all that so they could talk to us over in what we called the payload users room, POC, the Payload Office Center over there. There we did the same thing. We assigned each day one of the major furnaces would be the boss and he would decide what we were going to do that day. Even within the furnace, we didn't want to do it, because maybe there was a schedule to burn, to put fourteen samples in the furnace, in the isothermal heating facility during this two-day operation. Something happened, we didn't get them down, now we can start running again. Which one shall I put in now? Shall I put in the next one that was scheduled or go back to what we last had? And they had to tell us. We would never decide that.

So the principle worked and it helped us a lot, made it a lot easier. We thought we'd put them in a room with padding on the walls and stuff, soundproofing, let them go. But it worked pretty good.

BUTLER: It all comes down to that teamwork again.

BROOKS: Yes, it did, and it taught them teamwork and they enjoyed it, too. They came to realize what we were doing for them, carrying their battles forward into the operations world and getting astronauts scheduled and all this kind of stuff, and at the same time how we were relying on them to give us the right inputs. It made for a good team, good team.

BUTLER: Always important.

BROOKS: That was quite an adventure, by the way, to come back for that mission, because I worked on that mission for eight years and I'd been away from JSC since 1975. We came back and ran that mission in 1983, I believe, late '83. I was back in the control center now as a payload guy, as a European, and Gerry [Gerald D.] Griffin, who used to work for me one time, he was now center director, and he'd come around every day and see me. And [Charles R.] "Skinny" Lewis was the flight director. I'd go and see him every day and talk to him. Of course, everybody knew I was there and they'd all come back in the science room to see me.

On the last day of the mission, I had to talk on the air-to-ground loop because the people who were doing that, to go to the landing site, and, of course, they put it on the PA system so everybody in the control center heard me talking on the air-to-ground loop, and they all went nuts. "Brooks, we've been here twenty years and we never got to talk on that air-to-ground loop. You come back as a visitor and you get to talk on there." [Laughter]

BUTLER: You had put in your years back previously.

BROOKS: It was fun.

BUTLER: It must have been interesting to see some of the changes around the center.

BROOKS: It was. Every time I would go off shift, I'd go by the FOMA and see what they were doing, what problems they were chasing, and we even helped them once. They had some funny vibrations or sounds in the tunnel between the Orbiter and the Spacelab, and I heard them discussing it. In our material science doubles rack, we had a very sensitive vibration monitor, so we offered to give them some data from that thing if maybe they could help, when it happened, tell us what times they occurred and we'd give them the data. So we even cooperated with them. But it was fun.

One thing I noticed is that those guys were very blasé about this. For me, that mission was a gigantic emotional experience because I had been preparing for it so long. But those guys, they were flying missions every month. It was just one more mission, routine, next one comes next month, you know. It was hard to get used to that.

BUTLER: Very different from the early days you'd been involved with.

We'll go ahead and take a brief break here, change out our tape.

BROOKS: Okay.

BUTLER: ...Apollo and a couple of the missions just in general. Apollo 8 was slightly different than had been originally planned, and many people have said that it was quite a challenge because they were going to go around the Moon, just the command module, and in just a few months after Apollo 7 had proved out that the spacecraft was sound. Did you have any thoughts on the Apollo 8 at the time?

BROOKS: I would say in those days NASA was following an extremely conservative approach, and I think everybody agreed that was the way to go. Verify test it, verify test, verify, simulate, train, and anybody who would challenge that would also challenge the level of simulations we did in the control center. I mean, it would drive you nuts sometimes, but they were all for a purpose. I think every one of those missions was well planned.

I think sometimes as the programs evolved, you get to the point where you have to do some things differently. For example, on the Apollo we had the ALSEP experiment package. You asked me about which one I thought was one of the most difficult. That was probably one, because it was essentially ordinarily that thing would be built as a vacuum tube with a vacuum, with a cover over it and a vacuum put in it because it was designed to operate in a

complete vacuum on the surface of the Moon. What that meant to us is that we saw the equipment the last time many months before it was activated on the lunar surface, because once you couldn't put it in a thermovacuum chamber anymore, you couldn't look at it. You couldn't put power under it. You couldn't look at it anymore. And even when you did, you had to let it sit there for days, outgassing, before you could put power on it.

So everybody was naturally a little bit concerned about the crew handling all this and being around it when we put power on it the first time. It was a concern, and we had to be very careful, not to mention the fact that it had three kilograms of radioactive plutonium in it for heat generation for the thermocouples.

But I felt like the degree of conservatism was right, and whatever possibly should do that, there comes a time when you can't find a thermovac chamber big enough to put a Saturn IV-B in it or something, so you have to take some risks there. But in general, you test everything as many times as you possibly can before you do it, before you put the crew at risk. I always agreed with that.

BUTLER: You mentioned earlier that everybody's heard of Apollo 11 and Apollo 13 because, of course, Apollo 11 was the first one to land on the Moon and then 13 with the accident and explosion and recovery from that. What are some of your thoughts on both of those missions?

BROOKS: On 13 it skyrocketed Mr. Kranz to fame, didn't it?

BUTLER: It certainly did.

BROOKS: To get Ed Harris to play him. You know, the most amazing thing about that to me, though, was when I talked with Kranz about that, I said, "Harris must have spent a lot of time

with you to capture all of your mannerisms and stuff." And he said, "I never met the guy. I never saw him."

BUTLER: Really.

BROOKS: "He never came to see me." That's incredible to me.

BUTLER: That is incredible.

BROOKS: Yes, it is. But Apollo 11, what an adventure. How can you say it? It was the greatest adventure. I mean, I was with a group of guys who were just about as fortunate as you can possibly be. We were in the right place at the right time when the President decided we were going to go to the Moon and put plenty of money in the budget. We set out to do it, and by golly, it was an adventure. And it's probably, I still think, the greatest achievement in mankind's history, what we did on the Moon. What really breaks my heart is that we haven't followed up on it enough. We should have colonies up there now and using that as a lunch base for further missions, and we should be beyond at least to the other planets in our solar system, if not beyond that by now. But nothing, nothing on the drawing boards even. We've taken a gigantic stop in the whole program, and it saddens me that we're not doing more.

But I'm lucky. I'm glad I was around to participate in that big adventure. It was a great, great, great adventure and achievement. My wife still doesn't understand why all the missions were scheduled around Christmastime. [Laughter] It always seemed to happen that way, didn't it.

And Apollo 13, already by the time 13 came, the attention was waning on the program. There wasn't the attention there was. It was the unfortunate but maybe necessary shot in the arm the program needed. It really did. The movie *Apollo 13,* I don't believe that

really happened yet, but Kraft said to me that, "If Kranz had said that, I would have fired him." [Laughter] But the guy who played Kraft, he was awful, wasn't he? He was awful, that guy. He used to play on *Hill Street Blues* or something like that. But he said, "Oh, this is NASA's darkest hour," or something. And Ed Harris said, "No, this is the greatest hour," or something like that. First of all, Kraft would never say anything like that.

Apollo 13 was an incredible thing. When I look back on it, the Europeans always want to talk about it, too, when I'm there, but I tell you, some of the things we pulled off on that mission, I still am not sure how we made that happen, because we had never—well, Hannigan and his guys always had this Pearl Harbor lifeboat filing cabinet full of stuff. They studied it. Kranz had had us all looking at that. It's not that we hadn't ever thought of it before, but it never was a very serious study. And never had anybody thought of firing the lunar module descent engine while it was still attached to the command module. It isn't designed for that. We had to invent new software programs that could fool the computer into thinking it was really descending on the Moon. It really was incredible.

You know what really gets me when I look back on that whole program is when I think about today's computers, those two computers we had in the command module and the lunar module had 64 kilobytes of memory, and all the while the lunar module was calculating the path to the ground, gimbaling the engine, getting all the radar data, and moving and throttling the engine to land on the target, at the same time it was keeping track of where the command module was and calculating an abort path up there. All at 64 kilobytes. That's why we had those famous alarms and overloads when they were coming down to land and made [Stephen G.] Bales a hero. But everybody understood that would happen.

Yes, every Apollo mission was an extreme challenge. I remember Chris Kraft used to argue that once we did it a few times, it was wasteful to keep doing it. We had to go on to something more important like Mars. And I agreed with him. But he always used to say, "Who remembers the name of the second guy who flew an airplane across the Atlantic?" He

said, "Don't forget Lindbergh carried his back on a ship; he didn't fly it back." I wonder sometimes, too. But I didn't ever argue against it, because I enjoyed those flights so much.

Harrison [H. "Jack"] Schmitt, the science astronaut, he was a real achievement for us, guys like me, because he was the first real scientist that we ever flew on a mission. He was the first real guy with a payload background that flew as a pilot. We called him Dr. Rock always. I'm sure you heard that.

BUTLER: Yes.

BROOKS: But he did get a new name for a while there, as the program was winding down. He and [George W. S.] Abbey drove everybody absolutely berserk with this idea of landing on the far side of the Moon, and they had little teams of people who would meet at Schmitt's house and it was, believe me, a command performance when Abbey said we were going to meet there in the evening. We were mapping out the communication links, how we could time it so that the com [communication] breaks wouldn't be so bad from the lunar module going or the command module going in orbit, and we could relay data back and all. But he was dead serious about that, Schmitt was.

Then he got the name Dr. Farside for a long time. He was one of the good guys, too. I was so proud of him when he got to be a senator, but it didn't surprise me that he only lasted one term, because he was too much of an honest guy to get turned loose in that environment.

Yes, Apollo, what a thing. Everything else in your life led up to that. Skylab was a bit of a setback after that. You know, you had a lot of questions about the experiments and stuff, and I must say that it's obvious, I'm sure, from your research, you understand that within the Johnson Space Center environment the Chris Kraft home team there, the whole purpose of all this was engineering, technological, to prove that we could safely transport them and get them to a landing spot on the Moon and get them back. Science was not the

purpose for doing that. He, I think, many times resisted that. In fact, I found myself sometimes on the other side of him because he felt like the only people who should fly on the Shuttle were astronauts and passengers, and the passengers were people like payloads people, scientists, Arabian princes, schoolteachers, whatever they might be, but they were passengers. They were astronauts, which meant Johnson Space Center astronauts that he paid their salary, or else they were visitors, passengers. He was very tough on that.

When I was in Europe, one of the things I did right off the bat was to help define the requirements for the three astronauts that ESA was going to fly. These were essentially payload operating people, but they were also going to operate a lot of the Spacelab equipment. I argued like crazy with the Europeans that they should define them, call them what you want, but define the requirements according to the mission specialists, because that's the only way you'll ever get them to be considered as astronauts, is if you get them into the Johnson Space Center mission specialist training and get their wings, or Chris Kraft pins wings on them and says, "You are now an astronaut." Otherwise, they will be forever passengers and scientists. I fought like hell to do that for a lot of years.

I think Mr. Abbey's still angry at me about that, but I got crosswise with him a lot of times because he was against it, but I managed to get two of them. I managed to get all three of them into the mission specialist training because we had a delay in the Spacelab flight, and I only succeeded in getting two of them in, because Abbey got the German guy out, I think. But Claude Nicollier is still there. He's still there and he's as integrated into the team as anybody. And Wubbo Ockels was there for a year or so. Did you know him at all?

BUTLER: No.

BROOKS: He's the Dutch astronaut. I worked very hard and was instrumental in getting those guys into that training. Then when I had to make the selection for the flight of the first

Spacelab flight, we had to bring one of them back. Wubbo and Claude decided that Claude should stay, because he was a pilot and more acceptable to the NASA people. But Ulf flew in the first mission, and Wubbo flew in a later Spacelab flight in the Shuttle, and Wubbo's now flown in the Mir station as well, EuroMir, so he's both Shuttle and Mir.

I think this problem with experiments, see, I never understood that for a lot of years myself, but I never understood when on a mission—I had just got there—Scott Carpenter's mission, where he overshot the landing site. You know about that?

BUTLER: Yes.

BROOKS: The reason was that he got too interested in some science objectives and he used up a lot of his attitude control changing the attitude of the spacecraft to get better looks and pictures of whatever he was doing, observing, and so he didn't have enough to control his attitude during the retroburn. I never understood until a long time later that what really they were sore about him, though, was that he elevated this science up to such a high level and it shouldn't have been. Nothing is more important than getting then back in properly. But there was a strong feeling there.

BUTLER: Well, science did become a leading factor in Skylab.

BROOKS: Well, yes, that's why a lot of people were disenfranchised with Skylab. Skylab was kind of boring. I mean, after you'd been to the Moon, what's to sit in low Earth orbit and go around and around and around? We had teams of people looking at Mars missions already, and it would have been a logical next step, would be to put people on that project. Even Space Station is not, to me, that exciting. An expensive hotel for astronauts. I mean, they don't even have enough interest from the science community to make it worthwhile, I

don't think. It's being sold again along the engineering lines, and it is a tremendous engineering challenge to assemble and put that together.

But I don't see—Skylab was boring, sit there day after day after day, three shifts around the clock. For us it wasn't three missions; it was one mission that was a year long. Even when there was no crew there, we still had to operate the systems. Has some interesting things there. I remember the exciting part was when they launched it and ripped off the solar panel and the other ones didn't deploy. Until we could get the crew up to put that little parasol mechanism out and deploy the other solar panel, it was a difficult battle to pick the right attitude for the vehicle because you had the sunlight beating in.

You needed the sun on the remaining solar panel to get electrical power up, and yet you didn't want too much shining in to heat up the interior of the Skylab module. So it got to be, after a while, the electrical guys, once they tilted it down like that so that it would get where the sun wasn't shining to bright on it, then the attitude control guys would lose their control because the gyros weren't being torqued properly by the sun sensors and all of that, and horizon scanners. So they would gradually drift off.

The electrical guys, after a week or so of this, they got very quickly to recognize when that angle was changing a little bit, because they could see the solar cells were charging on the batteries. So it got to be a little game after a while. They loved to call the flight dynamics guys and say, "I think you need to tweak your attitude up a little bit here because we're drifting off," and they couldn't prove it. But there was those kind of little things going on, rivalries.

But when they got to doing the science, it got boring. There were those days where that picture was taken [Brooks points to photo on the wall]. We had to redo the whole flight plan on a short-term notice because the crew happened to look out the window and said, "Hey, the whole northern part of Europe is clear," which is rare. Having lived there for years, I tell you that's rare.

BUTLER: Something to take advantage of.

BROOKS: We had to redo the flight plan. [Owen K.] Garriott took that picture out the galley window. But that doesn't say that it was tedious and boring; it just got to be trying, such long sessions, graveyard shift. And Skylab was not everybody's favorite time.

I might say that it was during those days that I was sort of—I mean, I couldn't see anything coming. They were talking about the Shuttle. Well, first they were talking Space Station, and the Space Station, as part of the Shuttle, whose name was to shuttle back and forth to the Space Station, and the Space Station gradually ran out of money and died, and the Shuttle remained, so then they had to cluge up missions for it to do on its own, in my opinion.

In the place of the Space Station they came with this cabin module that could fit down in the Orbiter payload bay, and at first it started out to be a sortie can or sortie lab or something they called it, that would be carried up into orbit and placed in orbit and with crew in it or something and fly by itself and then rendezvous with it and take it back in. Then it went down to the sortie lab, which remained in the payload bay, and gradually became the name Spacelab.

Marshall Space Flight Center was heading that activity for NASA, but NASA also invited the Europeans to put in a bid for it, the European Space Agency. I was observing that during those long graveyard shifts on Skylab, and when the decision was made to have ESA build this Spacelab, I know the Marshall people were terribly upset with that.

I immediately figured out that NASA would want to have some liaison people in Europe to coordinate the activities, because it had to fit in and mesh with all the things the Shuttle's doing. The most recent job I had at NASA was up—Kenny [Kenneth S.] Kleinknecht was head of mission ops directorate. I think it was still flight ops directorate

then. And Kranz was on his staff as deputy, and I was on his staff as responsible for payloads that went into payload bay. Of course, the Spacelab was one of those. So I was knowledgeable about what was going on there. I contacted Jack Lee [phonetic] at Marshall and asked if they would want anybody over there, and they did. They were sending three people over. One was a flight ops guy from Johnson, a software guy from Marshall, and a ground operations guy from the Cape. I ended up being the flight ops guy, with much promoting and pushing on my part. Kranz wanted me to stay, he wanted me to stay with the flight control division, in fact, but I didn't see nothing more exciting than a Skylab-type thing coming up, and the chance to go to Europe loomed at me, and it seemed I—my wife and my son were anxious about it, so I worked that to happen, and it did.

I went over there. It was a couple-of-years' assignment. I was detailed by NASA to work for the European Space Agency in their operations area. Franco Ameliani [phonetic] was the head of operations then. I worked for a guy named Jochen Graf, who's still my very good friend. He was the flight ops guy. And Billy [William H.] Oyler from the Cape and a guy named Chris Haupf [phonetic] from Huntsville, Alabama, was there. The three of us were the three NASA guys who kind of blended in with the ESA team. It took a long time. I mean, when we first got there, they obviously looked upon us as spies and not there to help them, but to be Chris Kraft's spy into their operation.

I made friends with a lot of the people. I'm still very good friends with them. But I learned sometimes the only way I could—when I saw things that really drastically needed changing, I had two choices. I could write back to Kranz and say, "Gene, this is really screwed up. You need to do something about it." That didn't work too well because it didn't work coming from that direction. So I would go to Jochen Graf and idly get him in a conversation and convince him that, "You know, this really isn't right. We need to do something about this." And if I could convince him, he would carry the ball forward and it would go. So we managed to get some things done that way.

Like I said, they asked me to help with the selection criteria and training criteria for the astronauts, and I got to know all those guys really well. I think somewhere along the line I got crosswise with Abbey over this training of the astronauts, the European astronauts. I don't know. That's my feeling. Because right after I met Mr. [Michael] Bignier, who was the head of ESA, back to the meetings in Houston over the training of these guys, and they were bad meetings. They didn't go very well at all. I felt bad for Mr. Bignier. I was kind of embarrassed because they were crude and cruel to him. But in the end it worked out and we got two of them in the training.

But shortly after that, George [Abbey] called me and said, "We're going to bring you back because we don't need a guy over there. It was obvious they didn't, because what I was working on was really payloads then, and that was Marshall's bailiwick, not Johnson's. And he was right. But I said, "Are you going to replace me here?" He said, "No, we don't feel we need anybody there." I said, "Is Marshall going to replace me there?" He said, "No, NASA doesn't think they need anybody there anymore." I said, "Well, then, okay, I'll take my early out and I'll stay here." And he didn't like that very well, but I decided to do it anyway. This was like 1980 or thereabouts.

I told my ESA boss, and he immediately hired me on the spot. So by this time I had moved down from Nordveik [phonetic], the Netherlands, ESRTC. You know ESRTC? European Space Research and Technology Center or something like that. It's like the program offices. They have testing facilities, testing laboratories, thermovac chambers, vibration tables, and all that stuff. They're the program management people. Then down at Portswein [phonetic] in Germany, which is right outside the Colon-Bonn Airport, there was an organization called SPCE, which was called Spacelab Payload Integration and Checkout in Europe, or something like that. At that point in time they had several Spacelab flights planned as part of their deal with NASA, but ended up being just half of one flight.

By this time, Kenny Kleinknecht had been assigned over there to be Mr. Bignier's assistant advisor, and he called me and asked me would I go down there and help them out as a NASA guy. I said I would. My wife agreed, and we went down there. I had been in the Netherlands for three years. We went down there and I ended up staying there thirteen years. After about a couple of years, I left NASA, became an ESA employee, and then immediately became the project manager for the verkstaflabor [phonetic], which was quite an operation. It was a major double rack facility with, as I said, five major experiment facilities in it and about fifty experiments and experimenters. It had so many problems.

It was being developed by the DLR [German Aerospace Research Establishment], which is the German NASA, and they had a direct contract with MBB. But it wasn't working. It wasn't getting off ground. The more I met with the Marshall people, I could see that they were already planning some backup in case this thing doesn't get ready to fly. We don't have time to put another payload in there, but at least we can put some ballast in there so the CG [center of gravity] is right and all that. It finally did go belly-up as far as DLR was concerned, and they turned it over to ESA and said, "If you want to take it over, you can. We don't have the resources to do it anymore."

So ESA picked it up, and I became the project manager of the thing. It was a basket case when it was handed to me, but we managed to get it going. You ask me of all the achievements that I've done in the space program, I would have to put that very near the top because I had never, ever done anything like that before. I'd always been an ops guy with a headset on, planning the operation. This time I was responsible for some flight hardware, very complex flight hardware, state-of-the-art material stuff, that wasn't working right and was on the brink of being scrubbed out of the program. And I had to pull it out of the fire and go through all those gates to get it accepted by NASA and the safety people and all the design reviews.

I mean, this thing, for example, the furnaces had doors that opened up to put samples in. The samples contained highly toxic materials, and the crew had to handle these. Also the furnace had an access to vacuum, so it was possible to vent the whole cabin down at the vacuum through this furnace, so it had everything that the—plus, they heated it up to 1600 degrees Centigrade. So it had everything that would attract the attention of the safety guys, and it was a real challenge to get that developed, qualified to our own satisfaction that it would work, plus to satisfy NASA that we had done it right and all that, and get it accepted.

It gave me, I tell you, tons of pleasure to sit in that control center in Houston and watch that thing perform in orbit. It worked beautifully. They flew it again in the second Spacelab mission, they flew it again on the third mission, and it worked very, very well. I really got a big charge out of that. That was one of the greatest things I ever did, I think.

BUTLER: Certainly you have good reason to feel that way.

BROOKS: Yes, it was really a challenge. I mean, that thing, oh, man, there were so many problems with it. Then we had to train the crew, and some of these furnaces, you couldn't operate in 1G, because the tolerances, you put the sample in the chamber, there was only like half a millimeter clearance around it. So just any 1G sagging or anything would make it bind up, so you had to do it vertically in 1G, had to do it that way, so you had to modify the whole device in order to get the crew trained on it, and that's one of the things I caught onto right away.

When we were training the crew, the scientists would come in there, the PI [principle investigator] for that furnace, or that particular sample, and they would stand right by the guy. When he would get stuck, he'd say, "No, no, wait. You have to move that sample over here. Move it over here. Set that here. Put that—" So I could see that, hey, this guy's not going to fly in orbit. We can't have that.

So we set up a situation there, established again some remote facilities where the PI, the principal investigator, had to sit over and use datalinks and television and voice links, and he couldn't stand next to them. He had to tell them from watching that. It trained them, too. They had to learn how to do it, and it worked in flight. It was really something to watch.

One of the delicate things in the Mir heating facility was to put this silicone rod in there and get the rotation set up and the beam on it so that it would establish a molten zone. Once it established a molten zone, there was a very crucial moment there where if you went too far, you broke it. And if you started to rotate too soon, you broke it. So you had to start it at exactly the right time. So we figured out a way to put a camera on the Mir so the PI on the ground could watch it and he could watch that molten zone develop. He told the crew exactly when to start rotating, and it worked beautifully.

That mission is the first time that ever allowed somebody other than a Capcom to talk on the air-to-ground loop, and we did it routinely throughout that whole mission, having the scientists talk to their people. It was really quite a mission. I enjoyed that.

BUTLER: Certainly a lot of achievement in that mission.

BROOKS: Yes. Oh, it was a great team, too, we put together. I have some pictures from there. The Japanese had a facility in there and they were in the next staff, the users' support room next to us, and they had a big Japanese flag on their wall. So we wanted to get a Bavarian flag to put on the wall, because the MBB is located in Munich, and we finally got one. The guy who was my counterpart for MBB, the project manager, Hans Ugandshuran [phonetic], he went back to Munich one time and brought back a big flag and we put it up there.

We had a logo. There was a close-up pin on the rack. You couldn't have any exposing to the cabin atmosphere because you didn't want to mix the avionics loop with the

cabin loop, so every gap had to have a close-up pin. We had an MBB logo on there and an ESA logo, and they made us take that off. They wouldn't let us fly that.

BUTLER: Going over to Europe, did you have a lot of foreign language background?

BROOKS: No. Well, you know, I told you I played around with a German accent. I studied German in college, Purdue University, but I hadn't used it. At one point I knew it fairly well, but you don't use it for twenty-five years, it kind of goes away. I did pick up the German language fairly well when we lived over there. Dutch I never tried. Dutch is too hard because the Dutch all speak English, first of all, and secondly, you have readily available access to English news, television, radio, from BBC, television and movies, periodicals, newspapers, magazines. So it's very easy to get by there. Plus all the work was in English anyhow.

Germany was different. There we had to learn. My wife picked up a little bit. I got to where I could carry on a conversation pretty good at work sometimes. I got mixed up sometimes. I would receive in German and transmit in English and stuff like that, but we got by always. People always made allowances for me. I know I butchered the grammar a lot of times, but I didn't care about that either. Yes, I got by. I could do it in German. I can still get by in German pretty good.

BUTLER: How was it setting in over there, moving in?

BROOKS: No problem. [Telephone interruption]

BUTLER: …He sounds familiar.

BROOKS: He used to work at NASA, but he joined—I used to work for Hernandez Engineering. You know Hernandez, I think.

BUTLER: Yes.

BROOKS: And he joined that company in Germany. Wow, that's a long time ago. He's still there. He's still in Germany, but he's got his own company now and he works down at GSOC [German Space Operation Center], the German ops center over in Oberpfaffenhofen, outside of Munich. He's here in the States now and he said he'd call me. He's a good friend.

BUTLER: Good.

BROOKS: But it's not hard to settle into Europe. My son graduated from the American High School in The Hague, and he cherishes that year so much. Everything Dutch he's interested in. He's become a soccer fiend and he roots for the Amsterdam team, the IOCS [phonetic] team, and he loves the Netherlands, he loves to go there and visit. He enjoyed it, and during that year he got to visit everywhere, a lot of places in Europe, through the school and through us. We traveled a lot, too. We traveled a lot while we were there.

We never went there with the idea we were going to stay twenty years, but it just happened, you know. I really wasn't ready to quit the space business when I did leave there. It's just that the whole business was drying up. The Space Station was so uncertain. The European contribution is the Columbus module, as you know, and that was in doubt. Nobody was sure that was really going to get built. All the major companies like AIRNOV [phonetic] and DASO [phonetic] were laying off their people. ESA was even encouraging people to take early outs. I was a contractor trying to keep people covered and get work for

them, it got harder and harder and harder to do. It was shrinking, the business, and it wasn't pleasant the last couple of years.

In this country it wasn't any better. You were battling every year in Congress to get your budget, and then they redesigned again the—what was it called? [Space Station] Freedom was redesigned. That was a blow to them over there, too, when that happened. It was not a good time.

I reluctantly agreed it was time for me to step aside and come back, but I got back here and, you know, one of the things that happened, all the while I was there I kept missing out on all these reunions at Houston for all of the Apollo 11 and all the Apollo missions and stuff. There was one there for the Apollo 16 mission after I got back here, and I went over to that. And my golly, that was something. John [W.] Young was there and the guys were just incredible. I didn't even think they would remember me after all this time. Of course, I always see Kranz every time I go there, and he's been my buddy. And guys like Dick [Richard A.] Thorson, poor guy's dead now. And Bob Legler, he's my very good friend. There's a handful of guys like that, Hannigan, that I always kept in touch with. But a lot of them I hadn't seen for twenty years or more.

When I was coming back on the airplane, I asked myself why did I get out of this business. This is what I really love to do. Why am I sitting around doing nothing? I got so bored, I tried my hand at real estate for a while. That's awful. I hated every minute of it. The only fun I had in the real estate business was I advertised myself as the rocket scientist, and every month I would put out a monthly bulletin with some eye-catching picture of the Shuttle or the Saturn booster launching or something like that, and I'd say, "Here's another missile from the rocket scientist," or something like that. Inside there would always be some episode from one of the space missions I worked. That was the fun part. Then some nonsense about real estate. But I only lasted at that about six months or so. To heck with that.

So when my phone rang and my old company called me, would I come back to Europe and help out on another project, I jumped at the chance. My wife and I were ready. We were ready to go back. I went over and worked on the European robotic arm, which was funded by the European Space Agency and developed by Fokker Space company. Actually, the customers, the Russians, Russian Space Agency—actually not the Russian Space Agency, but the Energia company. They will operate it in orbit, the Russian cosmonauts. Well, not necessarily Russian cosmonauts, but whoever the crew is up there at the time will operate it.

Its first purpose is to help assemble the Russian part of the Space Station, and then it's further used for servicing and moving payloads around and that sort of thing, expansion. But it's a nice device. It's about almost 12 meters long, 6 degrees of freedom, and actually 7 degrees, but we lock one, call it 6 degrees of freedom. I had to learn a lot about robotic arms and how they work and all the control laws and stuff with them. It was very fascinating.

My job directly, what they needed help on, was they had published a—it was part of the Fokker contract to publish a flight ops manual, and the one they published was not very well received by ESA. The problem was partly that the ESA people who were working on the project didn't understand what was needed, and the people who did understand weren't involved in the project at all. So Fokker never had a chance to understand it. It wasn't very good, what they put together. I agreed to go over and review it for them. I went over for like a six-month deal. I would review it for them, tell them what needs to be done to fix it, and after the six months was up, they asked me to stay another six months and then another six months, then another six months. Until finally we published a book. We got it out. And I'm quite proud of what we did, actually, when you consider the people we had working on it.

But this is it [referring to book]. This is my baby. I want to show you just for a moment a couple of the things, probably the most significant aspect, because one more time I had to teach people how to do functional schematics. What we came up with is darn good.

These guys had never done this in their life before, and I had to show them how to do it. But we built them. This is what it looks like, and we built these darn schematics. Look at that.

BUTLER: Wow.

BROOKS: They're beautiful, these things. They're beautiful. They're up to the latest requirements based from the Space Station flight ops datafile requirements specs. We only deviated a little bit where we had to. But I'll tell you, I found a guy with a mind like a sponge to pick this up. We made all these mechanical drawings and stuff, too. It was incredible what we did. And, you know, I think probably NASA's got a team of 100 people working on their ops manual, and we did this with like three or four people. Three or four people and in a year. My God, it's amazing. It's really good what we did.

BUTLER: That's great.

BROOKS: I look back on the two years I spent there as a real gift. What a break, to have a chance to do that. My gosh, that was something.

BUTLER: You essentially came full circle.

BROOKS: Yes. In fact, it was sad to leave. I had to leave. I just didn't want to—I still am not ready. I told Kranz, "I don't know how you can give up." I told both Kranz and Hannigan—this guy who just called me has a budget for some consulting work, and I told Kranz about it. I said, "You can pick up some extra bucks, get a tour to Europe, go over and study some documents back here, go over there and present the results, sit in on a couple of their meetings." "No," he said, "I'm out of the business. Don't want to do it anymore." But I

don't understand how they can walk away from it. Of course, he's got this now [referring to Kranz' book *Failure is Not an Option*].

BUTLER: Yes, he's been reliving it in a way.

BROOKS: Oh, yes, absolutely. I'm really looking forward to that. I can't thank you enough for that, and Kranz, too. I'll send him an email.

BUTLER: We're glad that we could courier it here for you.

BROOKS: I was going to ask you if you could find out for me, if I need to get it through Houston, Barnes and Noble, I'd do it.

BUTLER: We're glad that we could help out with that.

BROOKS: It's wonderful.

BUTLER: For both of you.

BROOKS: Yes. It's great, yes. He's the guy I first talked to that hired me, and he's been my friend ever since.

BUTLER: He was very glad to hear that we were coming to talk to you.

BROOKS: I bet he was. He's a good guy. You only meet one guy like him in your lifetime. There's not very many. I used to say if you had to name the ten people who contributed, who

made the manned space program successful, Kranz's name would be on that list. Guys like [Robert R.] Gilruth and George [M.] Low and people like that would also be on it, but Kranz would be on that list. He might even make the top five in my book, because it wouldn't have happened without him. Sometimes he would drive you absolutely nuts because he would never let anybody relax, let their guard down. If you got too relaxed, he was worried. "Something's wrong here. We've got to keep these guys busy." So on some of those missions, like Spacelab where those boring LOS [loss of signal] periods would be forty-five minutes long or something, you'd think, "Well, at least now I'll go out and read a magazine or something." No, no, not with Kranz. "You can run a simulation. We're going to simulate now." He kept the torch lit under everybody all the time.

You know Milt [Milton L.] Windler?

BUTLER: Yes.

BROOKS: He's a good guy, too. He was also with Hernandez Engineering when I was, and he was down at the Alena [phonetic] Company in Toreno. He did some outstanding work for them out there. I went down there and had some meetings with him and visited with him. He's a super guy.

BUTLER: Certainly there were a lot of unique people and people with special talents that made all this happen.

BROOKS: Griffin, you know, those two guys, when I was working at the Vandenburg tracking station, Gerry and Larry [Griffin, brothers] were both Air Force officers up at—what did we call the thing? DICE [phonetic] or something like that? It was an Air Force headquarters control center up in Sunnyvale. We were down at Vandenberg tracking station,

and they were coordinating it all. I knew him from those days. I think he was one of the youngest majors in the Air Force. I don't know what he was. I don't remember that. But he was one of the guys that went after when we were building up the Agena thing, because he knew the Agena quite well. He came to work in my section for a little while, but then he went over to the Gemini when we split that off. He stayed with Arnie Aldrich in the Gemini, and he skyrocketed to fame, too. Yes, he was quite a guy.

Every splashdown party, Larry would show up and they would change jackets and stuff. You couldn't—unless you really had a trained eye, you couldn't tell who was who. Getting mixed up all the time.

BUTLER: That's pretty good. You certainly had a lot of—

BROOKS: And I saw him—I was watching the movie, what's the one with Jodie Foster in it?

BUTLER: *Contact*?

BROOKS: *Contact*. And this control center scene, and there's Gerry Griffin sitting there. He was in it. Did you see the movie?

BUTLER: Yes.

BROOKS: He's in it. He even had a speaking part in it. Amazing.

BUTLER: I hadn't realized that. I missed that when I saw it.

BROOKS: I heard he was hired as an advisor on that movie, but he was there, he was in it, and I saw him when he walked in with the flight director, all excited and everything. He sat down at the console and he had a speaking part in it.

BUTLER: That's great.

BROOKS: It was. It was amazing.

BUTLER: From flight controller to actor.

BROOKS: Yes.

BUTLER: That's good.

BROOKS: I lose track of these guys and don't know where they are anymore. Also another guy, Ed [Edward G.] Gibson. Where is he know? Do you know anything about him?

BUTLER: I believe he's in Florida.

BROOKS: Florida? Last I heard, he was in California at some museum or institute or something like that.

BUTLER: We haven't gotten in contact with him yet, but we are hoping to this year.

BROOKS: NASA assigned him as—no, I don't think it was NASA. I think he did it on his own. He took a leave of absence from NASA, but he worked at the Arinau [phonetic] plant

in Bremen, Germany, for, I don't know, better than a year or so. I in those days was working at ESRTC and used to travel to Bremen all the time, so Ed and I got to be very good friends. In fact, it was the 1976 [American] Bicentennial when the ambassador—I was attached always to the embassy, to the Council for Scientific and Technological Affairs, was under the umbrella of the embassy, and he was trying to promote a big deal for the Bicentennial, and he wanted to set up a NASA exhibit. So I got Ed to join in. Nobody had gotten him yet, so I got him to come over. I would introduce him every day and he would show the films from his Skylab mission. Then we had an exhibit set up. I managed to capture all kind of stuff that happened to be floating around in Europe from NASA. Even a space suit we had. We had a really nice exhibit set up there.

Ed came over, and he and I would go out afterward and answer all the questions and stuff. So Ed and I got to be pretty good friends, but I lost track of him after he came back here.

BUTLER: That's one of the things we hope that through this project that we're able to do. In fact, we'll send you this, when we send you the final transcript, we send also a little note asking if it's all right to share your address with other participants of the project.

BROOKS: Sure. That's great.

BUTLER: And we don't give it to anyone outside, but then once a year we're going to start trying to send then all of you that participated a list of each other's addresses so that you can get back in contact.

BROOKS: That's wonderful. There's one anecdote I wanted to tell you about that leads into one of the reasons why I went to Europe. It takes only a minute. I don't remember how it

came up, but somewhere along the line, it was the first anniversary of Apollo 12 ALSEP [Apollo Lunar Surface Experiment Package] deployment and I think it was Bendix Corporation who built it, was going to have a big exhibit or a big ceremony out in the Sam Rayburn House Office Building in Washington [DC]. They asked us, NASA, if we could provide some display of data from the Moon or something like that. I ended up with that little task, which I didn't mind doing. I kluged up a rack of gear that had a receiver and discriminator in it, and we leased some voice data lines from Goddard [Space Flight Center, Greenbelt, Maryland] and we interfaced with the network. We had a little printer and we decommutated. We didn't decommutate; we singled out the channel that had the commutator wave train on it. We prepared a stamp and we'd print out data from the Moon, and a little wave train, we'd stamp it "Data compliments of NASA and Bendix," and all this stuff on it.

We went out and set that up in the Sam Rayburn House Office Building and it was a boondoggle, but a very nice one for a few days and I enjoyed it. But one of the guys who came around to look at it was from the Atomic Energy Commission, and he said, "We're going to have an exhibit in Geneva, Switzerland," for the fourth something on peaceful uses of atomic energy. ALSEP used this hot plutonium as a power source for the RTGs [Radioisotope Thermoelectric Generator], so it was on the candidate list. He said, "Could you set up a rack like this over there?" I said, "Could I? Just make sure you ask for me by name." So we went over and set that up. I was there about three weeks or so for the exhibit. It was very popular. My wife joined me the last week and then we toured all around Europe. We decided that would be a nice place to live for a while.

BUTLER: That's interesting.

BROOKS: Also I meant to mention to you, on Apollo 13 there was an episode that didn't get an awful lot of attention and wasn't even mentioned in the movie, but this RTG was in the

lunar module and had to be brought back in to the Earth's atmosphere. I personally spent a lot of time. There was an Atomic Energy Commission guy in the FOMA or SPAN, whatever it was called, and we had to show him what our targeting capabilities were, where we could target this thing to reenter. He picked out a deep trench in the Pacific Ocean the first target, it was a big one, but we had to then cluge up the lunar module again, firing the descent stage engine to decelerate so it would burn up in the atmosphere. Then they put Air Force planes all around this trench and watched it come in and photographed it, to prove that we had got it in the deep trench, which we did do. But that was going on the whole time, too.

BUTLER: So many little pieces—

BROOKS: Part of Kranz's fire brigade that I always ended up on was this—you mentioned it in there, too. I forgot to mention it, the sim bay. We cleared out one bay of the service module and put all kind of scientific instruments in it. I managed to get myself involved in that from the operations side again, and again from the systems side, making sure that power was available and what kind of power each instrumented needed, and the data requirements and commands in and out, and temperature heat rejection, and all this kind of stuff. So I was part of that design team. That was absolutely incredible, what that team of people achieved in eighteen months from the time they were told to do it, they flew the first mission and allocated all that space and got everything out of there, and it worked. It worked fine.

BUTLER: So much that came together to make it all successful.

BROOKS: Yes. I was part of that team. By then we really had a team on the ground. Man, oh, man, there was nothing we couldn't do. Nothing we couldn't do. We could have been to

Mars a long time ago if they just had given us the direction to do it. We'd have been there. It's terrible that we haven't done that.

BUTLER: Hopefully we'll be able to see that without too many more years going by.

BROOKS: I'm skeptical. I wish I could agree with you. I'd like to see it, but I'm skeptical. I don't think there's a will there. In order to achieve Space Station, everything else had to go away. There's not enough money to do more than that. I don't see where Space Station is that much of an achievement, other than to build it and assemble it. Then what are you going to do with it for thirty years?

BUTLER: Unfortunately, they're even having problems getting it built.

BROOKS: Yes. I've kind of lost track of that. I need to log on to some of the NASA sites and see what that assembly sequence is. I don't even know—when is the service module scheduled to go now?

BUTLER: I think it's scheduled for July, but I think they're having some questions about whether they will be able.

BROOKS: Jeez. July. My God, it was due a year ago. Jochen still owes me twenty gilders on that, because he was convinced it would go in September of last year. I have to remind him of that.

BUTLER: That's right. [Laughter] Well, you have certainly had a lot of interesting experiences.

BROOKS: I sure have. You know I've got cancer now. But I tell you what, I've had a heck of a life.

BUTLER: Yes, you have.

BROOKS: My life has been one huge adventure.

BUTLER: It certainly has been, and we thank you so much for sharing it with us.

BROOKS: I appreciate it. You get me started talking on this stuff, and I can't quit.

BUTLER: Oh, we would love to continue listening.

BROOKS: When I was sending out those news bulletins, I never sold a house as a result of that, but I used to run into my neighbors around here where I sent them, say, "Hey, when are you going to send us another one? We look forward to that." [Laughter]

BUTLER: That's neat. That's really neat. People are very interested in the space program.

BROOKS: I mentioned to you I was—I may still some day get involved with this Challenger Center. If they got it going, I would be involved with it now. I went in a shopping mall up here a couple of years ago and they had a storefront there, and they were selling stuff. I wondered, "What is that?" I went in there and met some of the people and talked with them and learned about it. They learned about my background and immediately wanted to suck me into their world of activity. I didn't mind doing it. I got involved with it and I got

involved in some of the fund-raising. I was still in the real estate business, so I went around twisting the arms of the title companies and the lending companies to buy these tiles that will be in the entrance hall with their names on and stuff, donate money. I'd come to $100-a-plate meals that weren't very good and stuff. [Laughter]

But at that time they were talking about having it going a year and a half ago, but they had severe funding problems. What they're building is very elaborate. It's probably the most elaborate one of any around. The one down in Tucson is at the Pima Air [and Space] Museum, is an old hangar that the Air Force let them have, but these guys are building a whole new building, very nice architecture, very state of the art. I like the idea of it, to work with the kids.

BUTLER: It's a great idea.

BROOKS: The Civil Air Patrol was involved a lot helping with this, and they got me traveling around making speeches to the young people in the Civil Air Patrol. I found myself enjoying that. I'd drag out my models. I even got hold of an Agena and Gemini model. Not many people have that.

BUTLER: That's neat.

BROOKS: And in the background [referring to a photograph] you can see the group I worked with at ESA, and that's the tip of the arm. You can see the robotic arm in the thermovac chamber at ESRTC. They were getting ready to run tests on it. And over here is my Skylab model. Behind the door.

BUTLER: Sure enough. Very nice. I'm sure the kids got a kick out of all that.

BROOKS: They did. I always take stuff like these flags that have been to the surface of the Moon and stuff, and they were really impressed with all of that. It was fun, trying to inspire a little bit of interest for them. That's what I like about the Challenger Center.

BUTLER: Absolutely.

BROOKS: If my health allows, I might get involved with it. I don't know.

BUTLER: We'll certainly hope that all that does come through.

BROOKS: Thank you. I hope so.

BUTLER: And you are able to remain healthy and to help all of that work out.

BROOKS: Okay. Are we finished, then?

BUTLER: Yes. Thank you very much.

[End of Interview]