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ORAL HISTORY TRANSCRIPT

CHARLES S. HARLAN
INTERVIEWED BY KEVIN M. RUSNAK
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RUSNAK: Today is November 14, 2001. This oral history with Charlie Harlan is being conducted in the offices of the Signal Corporation in Houston, Texas, for the Johnson Space Center Oral History Project. The interviewer is Kevin Rusnak, and is assisted by Sandra Johnson and Jennifer Ross-Nazzal.

Thank you again for taking the time out to spend the afternoon with us.

HARLAN: You're welcome.

RUSNAK: If we can start by getting a little bit about your background, maybe what some of your interests were growing up, what may have led you into engineering, and those sorts of things.

HARLAN: A couple of things led me into engineering. I think one was my interest in high school; I liked to work on old cars. Then you could buy an old car for twenty-five or thirty-five dollars that would actually run. I worked on motorcycles a lot. In those days motorcycles were real popular. I grew up in Kentucky. So the interest in mechanical items basically is, I think, part of that reason for engineering.

The other factor that led me to get serious about going to engineering school was the fact that I'm the first person in my family who ever graduated high school. I'm also the first person that ever graduated college. So from that situation, the expectation was typically you get out of high school and you usually go to work. I was fortunate enough to go to work in a concrete block factory, which was a lot of hard work for very little pay, so that helped.

And my father kept pushing. He said, "You don't want to end up like I am. You need to go on to school." So I had an interest in the technical stuff from the things I liked to do with working on cars and motorcycles and things, and then anything mechanical I liked to take apart and fix and so forth. And this prospect of working the rest of my life in a concrete block factory for near starvation wages.

So I had my father promoting it, and, interestingly enough, the guy that owned the concrete block factory, he was on my case about it, too. Even though he had a laborer there, a lot of his laborers were even illiterate. A big part of the workforce couldn't even write their own name. So he kept saying, "Look, you've been to high school. You need to press on," and so forth. So I had some folks, good folks pushing me, and then an interest in the technical end, I guess. So that's why I went to engineering school.

So I went off to University of Kentucky [Lexington, Kentucky] and went to engineering school. In terms of my prospects for the future, I count that as a seminal event in my life, is the education.

Then just to continue, while in engineering school I majored in mechanical engineering, and I got real interested in the aeronautical field. So when it came time to graduate, I was fortunate enough at the time of graduation where every engineering graduate could get as many job offers as they wanted. I happened to take the lowest paying job offer just because of the work content. At that time I didn't have a family, I wasn't married, so money wasn't a high priority in terms of I wanted to go out and grab the job with the most pay. In fact, I took the job with the least pay in the aviation field, working in Navy aviation. I did it because I was interested in the work. Like I say, again, I was fortunate. If I'd had a family and a couple of kids, I might have had to go for the money more.

RUSNAK: Did you find that as someone who was interested in tinkering with cars and that kind of thing, that engineering education turned out to meet your expectations of what engineering was?

HARLAN: Oh, I think so. It struck me at the time that this is what I have an aptitude to do and this is what I like in school. There's a whole lot of other things in school that I wouldn't have liked at the time that I would like to do now. I mean, when you look back on it, I think the technical education—my goal was get an engineering degree and get out of school to where I could get to work and earn a living, so that and I liked the content of the engineering business.

Right now, I keep thinking I think I might like to—this is serious and I'm not pulling your leg because you're a historian, but I read a tremendous amount of history now and I'm thinking to go back and get a degree in history and a Ph.D. in history or something just as a challenge or something. That's a whole different idea. And I still enjoy the engineering, but the problem I think with an engineering degree is—it's a strength and a problem, I guess—you're really focused on the engineering department and the mathematics and the physics and the chemistry and stuff, which was fine at the time because that's what I was really interested in, but it leaves out a lot of other stuff, and you can't go to college forever. So nowadays I look back a little bit. This idea I'd like to broaden a little bit. But maybe that's probably typical of a lot of folks who go into engineering.

RUSNAK: I think nowadays they try to add some interdisciplinary approaches to engineering education, but with what success, I'm not sure.

HARLAN: How long? Well, NASA, back in 1983, sent me on a management training program for a full semester up at Harvard [University, Cambridge, Massachusetts]. I spent, in the Kennedy School of Government, I spent a semester there. Their philosophy—and I guess this is

an Ivy League school kind of philosophy—is you get a four-year degree in sort of a broad set of subjects, more of a liberal arts thing, and then you go to professional school after that. In my mind, that's ideal. But most people, that's way, way too costly, I mean, if you go get a four-year degree and then you went to engineering school after that.

What they look at at Harvard, and I guess the other schools, is you get their four-year program and then you select whether you want to go to business school, law school, med [medical] school, or whatever. It's kind of a nice idea, but again, you take some guy from a small town in Kentucky whose objective clearly had to be to get through this as quickly as possible, and I did get through it in four years. A lot of kids today don't see that, don't have that burning need to get through so where you can get yourself a job. That was the way we were focused then. So I continue my liberal education on my own.

RUSNAK: It's good to see, though, that you do have that broader interest to keep you intellectually stimulated.

HARLAN: Sure.

RUSNAK: What was it about the Navy that particularly appealed to you?

HARLAN: I was interested in aeronautical engineering. Navy carrier aviation just seemed to really be interesting. It was particularly challenging.

So I got a job in the Navy in what they call carrier suitability, the field of carrier suitability, which is sort of the functional area where the airplane and the ship come together. I was working on the airplane side of the interface, and then we had in a division we had folks working on the airplane side at interface and folks working on the ship side of interface, and I'll explain that.

The ship side of interface dealt with catapults and arresting gear, landing aids, and that sort of thing that were basically a part of the ship. We dealt with in the aircraft branch the kind of things that were really a part of the airplane, like the arresting gear, and there was a lot of requirements on landing gear and we went into nose gear tow. We used to do a lot of things with new airplane models, like spotting studies. We had scale model carriers, how to best you can locate airplanes on the ship and best utilize that airplane or a mix of airplanes on a ship.

We were into these navigation aids that the pilots used for landing. In fact, in that time frame, we called it the automatic carrier landing system was being developed, and it's much like the autoland on the—it's implemented differently, but it's kind of like the autoland concept would be on the Space Shuttle. It's interesting to note that the arguments on autoland for landing airplanes on carriers, the arguments for and against it are the exact same arguments for and against autoland on the Space Shuttle. The pros and cons were the same.

It turned out after I left the Navy and went to work for NASA, it took them some years to get that as a part of their embedded operation. It turned out it was a really important feature in carrier aviation in the Vietnam War. When those guys would come back, sometimes shot up and all kind of problems, to have that automatic carrier landing system. The weather was bad. You've got to get down on the ship. You're out of gas or whatever, or close to being out of gas. So it developed over time. So I worked on projects like that.

Then the Navy is one of the more traditional organizations in the world. It's hard to get new ideas there. For instance, we did studies with ships. The way they designed the carriers, they weren't designed very well for making the air flow right over the landing area. They just liked, because it was tradition, to design those islands that stick up the same way. We did studies on that which would show that if you designed them differently, it would make the air flow a lot smoother, it would reduce landing dispersions, a lot of things like that. So that's the kind of work I did there. It was really interesting.

I guess you can see right now, that's where a lot of these air strikes come from, these ships in the current war over in Afghanistan. That technology, I'm sure, has continued to improve.

We developed a nose gear tow system, which before aircraft were launched with a catapult, but they had this big bridle system they used, which was a big cable with these big eyelets on the end. Some of them weighed a couple hundred pounds. You'd hook the aircraft up, the aircraft had the hooks on it, and you'd put these cables around the shuttle on the catapult, launch the airplane. Then what you were trying to do was recover this 200-pound bridle. At the end of the catapult stroke, it might be going 140 or 50 knots, and keep it from tearing the bottom out of the airplane when it broke loose, flailing around, and so forth. So I worked on a lot of projects like that.

Some of our projects would end up going out on a ship. So at the time I was a young engineering and, boy, what more could you ask, until space flight came along, right?

RUSNAK: How far into your career was it until space flight came along?

HARLAN: Let's see. I think I worked for the Navy about three years, and I really was satisfied with what I was doing in terms of interesting work, but that was 1962 is when I went to work for NASA. So all of a sudden—we called it manned space flight then—human space flight became very, very interesting, and it was starting. Who wouldn't want to be a part of that, right?

And I was the right age then. I was just three years into a career, so I had little bit of experience. NASA was at the time hiring everybody they could find. That was another thing. Like I said, when I got out of college you could get a job anywhere, and then when I got interested in going to NASA, they were trying to hire everybody they could. So they were just really starting to develop this whole idea of manned space flight and this sequence of programs,

Mercury, Gemini, Apollo, etc., and so forth and the logic and the strategy for what those programs would do. So who wouldn't want to do that?

RUSNAK: Had you had any interest previously in the beginnings of the space race, after Sputnik, maybe going into a space industry right out of college?

HARLAN: No, I don't think so. I think I got out of college at the time when it wasn't clear to me, at least, where the opportunities were, and this aviation work really interested me. But after about three years, it became clear, hey, this is really exciting. These folks are really serious.

I remember one time I was working on something they called the TFX in those days. It was one of those joint services programs. It was an aircraft, carrier-based, land-based, and everything. It later sort of folded up, but—and worked with some Air Force people and also some NASA people. There were some NASA technical people from Langley [Research Center, Hampton, Virginia] involved in the early end of that, talking to those guys. So the interest developed.

RUSNAK: Did the job come to you, or did you go looking for some involvement with the space program?

HARLAN: Well, there were a lot of folks I worked with in the Navy that within a couple of months had moved over to NASA. So a guy called me, he happened to have been my supervisor in the Navy and says, "Hey, would you like to come over here?"

I said, "You bet. Sounds good to me. I'll say yes on the phone. I don't need an interview."

It turned out that when I went to work, I went to work in NASA Headquarters [Washington, DC], which was the wrong place to go to work for a young guy. NASA

Headquarters is an important place. I'm not degrading it or denigrating NASA Headquarters in any way, but this guy called up. He was over there. He was a lot older than I was. He was in the right place.

So I said, "Sure." So I came to work over there. They had to get a waiver for me because I was the lowest grade-level person, professional in Headquarters when I came over. The guy, Dick Wisnewski [phonetic], had worked for NASA for years and he quit and then he came back and so forth. I've known him longer than any guy that ever worked for NASA. He's the guy that got the waiver for me. It was kind of embarrassing. They said, "We just don't hire folks with that grade level." They had all those big grades up, and I said, "Hey, this is great. There's no end to this."

Then I went to work up there, and after about less than two years, year and a half, I was coming to JSC [Johnson Space Center, Houston, Texas]. The center wasn't here locally, but it was the Manned Spacecraft Center [MSC], and I got to thinking that's where I want to be. That's where I want to be. Headquarters is the wrong—and it is the wrong place for a young fellow like that, but it sounded good on the phone. And it was a way to get started in the program.

I never did have any second thoughts about the time I spent there. I mean, it was good preparation for seeing a part of NASA that has to exist. Those guys are the up and out, deal with Congress, deal with all the other agencies and so forth, so I got a little view of that. It just wasn't technical enough for me. It wasn't my idea of a place to be.

RUSNAK: So what were you doing there exactly?

HARLAN: I worked in a Gemini Program Office in an area that had to do with flight operations. I was really kind of a Headquarters interface with operations people, flight operations people,

down here at JSC, and that's where I went to work. I mean, I pretty quickly got interested in flight control and came down here.

But I had gotten to meet guys like Chris [Christopher C.] Kraft [Jr.] and Gene [Eugene F.] Kranz and people like that. One day when Chris Kraft was up there on a meeting, I kind of got him aside and says, "I'd sure love to come down to MSC and work for you."

He said, "Fine."

So then I got an interview with Gene Kranz and got by that okay, so I went to work for Gene Kranz. So I'd worked about a year and a half there. But mainly what they do there is, what I was doing, it just wasn't technical enough at all for me. I was interacting with folks at the Manned Spacecraft Center mainly for the purpose of collecting all kind of information for whatever they needed it for in Washington, like all kind of progress reports and management reports. So I felt like I wasn't doing anything; I was just collecting information and so forth. But it did give me an opportunity to learn a lot about the flight operations business, where I was interested in, and I knew exactly where I wanted to go. So I mean, I personally got out a lot out of it. The work just wasn't my cup of tea.

RUSNAK: As a person in this interface, what sense did you get of the relationship between MSC and Headquarters?

HARLAN: It was pretty clear then that it's much like it is now. The field centers drive NASA. There's no question about it. The relationship between Headquarters and JSC at that time, Headquarters had even less impact and they lost more of it when guys like George [M.] Low and Joe [Joseph F.] Shea came down here, which those guys were the real horses in the beginning of the program, the whole structure and the architecture of the program. So those guys both decided to come down here where the action was.

I worked for George Low up there. He was like my division chief, and I worked in the Gemini Project Office, which was right under him. We came down here about the same time. But he and Joe Shea, these were the guys that are some of my biggest heroes in the whole program, because very early on there was a big effort at NASA to really determine how to do the lunar landing program. As you're probably aware and talked to a lot of folks here, there were three contending methods there: the direct ascent and the earth orbit rendezvous and the lunar orbit rendezvous.

At this point in my life, these guys had this sort of systems engineering effort there. Shea was head of systems engineering. I think it was Bellcomm [Inc.] he worked for then, before he worked for—or maybe he was working for NASA and Bellcomm was a support contractor. Then George Low was on the other side. He was actually in the program management part.

I just forever thought those guys—I'm telling you, they went through that systematically. None of it had ever been done before. There was tremendous amount of unknown. Today to take a program on with that kind of risk and uncertainty in it, it's really hard to fathom NASA doing and maybe most places in the country, most organizations. But these guys went, I thought at the time, way out on a limb with all the information they had and selected this lunar orbit rendezvous mode. To me, that was one of the seminal events in the whole program when they defined the method and the architecture. After that it was a matter of, okay, we've got the method, we know how we're going to approach it, the architecture, let's build the programs and let's do the development work to fulfill that.

So those guys at that time were really heroes of mine, and still are. Of course, both of them are dead now. But both Shea and Low in their own right were giants in NASA.

I think one of the reasons, to pursue your question about the Headquarters-field center relationship, one of the reasons, those two guys, Low came from NASA, George Low. He was NASA, I think Lewis Research Center [(now Glenn Research Center), Cleveland, Ohio]. Joe

Shea came from industry somewhere. But those guys had a lot of capability, a lot of technical background and so forth.

There's a guy named [D.] Brainerd Holmes that was the head of the Office of Space Flight. He was a fairly strong person. But when you looked around that office up there, wasn't much else in terms of really good technical plus the leadership strength. They hired a lot of guys like me that were really green in this whole business. So the whole Headquarters structure, and then when you go look at a place like the Manned Spacecraft Center and you look at a guy like Max [Maxime A.] Faget and the guys that work for him, you look at, let's see, Walt [Walter C.] Williams was here then and then later on Chris Kraft took over for him, and there were a whole series of guys here that had more knowledge than 98 percent of the people in Headquarters.

Now, I've told you about some of the real leaders up there, and they had all of this knowledge and capability. So the centers had this tremendous core capability and knowledge base and capability to make calculations and so forth. They could look at some approach or problem and do a lot of analysis and so forth. So probably that had a lot to do with the fact that Headquarters and the field centers, particularly JSC, the Headquarters never really, I never felt like, drove the whole thing or managed the whole thing. The field centers look at them like "Get us some money down here. We've got some things we want to do. You guys go get the money."

It hasn't changed a whole lot over the years. It's gone a little bit more in terms of the Headquarters guys have a few more controls, but it hasn't changed much, not much at all. For whatever reason, I don't think NASA Headquarters ever fully got themselves in command of the all of the centers in the agency. And I think that still goes on.

George Low, Joe Shea came to work at JSC, and George Low, I think he started out as the deputy center director and Joe Shea started out in the Apollo Program Office, so they showed up here, so that pretty well gutted a lot of the leadership, the real technical leadership in

Headquarters. Then it focused around the things about schedule and money and so forth up there, more than the technical leadership.

RUSNAK: Did you get a good sense at the time of how their leadership was working, I mean the sort of style that they would use?

HARLAN: I think it was more technical leadership. It was leadership that was based on really analysis of methods and techniques and problems and so forth. By that, it was hands-on involvement. They're right in the middle of it technically, rather than the management model where more of the technical work is done, like the engineering department and different places and it sort of gets integrated somewhere.

So I think early on, and guys like Max Faget, that was his method. He was involved in the technical part of the programs. I think that was very early on the way most of the management was done. Even at JSC when I came here, all of the managers, some of them were pretty awesome and they were awesome because it was a combination of folks that had come from Langley and Lewis and industry, who were very senior in some areas and had a lot of experience and background and they tended to play in the technical stuff.

Probably it was one of the legacies that NASA has not dealt with well. They're in trouble right now, if you read this Young Report stuff, basically poor management and poor cost control and so forth. I think always the NASA managers have liked the technical issues much more than the management issues, and I think that legacy is probably there from these guys early on. They were the best at it, anyway. I mean, they had so much experience and capability and background, so I think that stays with us somewhat today.

RUSNAK: It's interesting that we have this conversation today, because they just announced the candidate for the new NASA administrator [Sean O'Keefe] is someone from the Office of Management and Budget [OMB].

HARLAN: Sure. I think the message is clear there. All the years I worked at NASA, NASA has never really been an institution that managed cost very well, and they still don't do it. They've never done it. They have a budgeting process and you go get budgets, but they don't manage costs or know what things cost very well, nor can they predict what things are going to cost very well.

Nor in human space flight has there ever been any interest at all in efficiency. Efficiency is not something that I've ever seen a big interest in. I work a lot in private industry now. Efficiency is everything out there. Get the cost down, get the cost down, so you can stay in business.

NASA is more like warfare. When you get ready to do a program or you get ready to go have a mission, you've got to win the war or the battle. You've got to win it, so whatever it takes to win the battle in any manner. So that's the way they use resources at NASA. You go attack it with everything you've got. You throw everything in the world at it.

If you'll look out here and if you think about it sometime, there's a whole lot more people out here at JSC than it takes to run these programs. NASA has this big overhead and cost because if they start to get a problem in the battle, they want just in case to have all of this capability to throw at it. And the problem is, it all gets costed to these programs. If there was some way they could get the cost off the programs and get it to some other programs or someone else, but it turns out that I think that's one of the ways—the center has always been oriented toward a single major program and taking a single major program and using all of the resources of the center to support the program.

Example was back early on, I remember Chris Kraft was the center director, and I was in charge of Earth Resources Aircraft Branch and doing that kind of work. Kraft, they were starting the Shuttle program, and Kraft had this book of people working on other projects. Those projects, when the Shuttle Program needed it, he'd get his book out and decide who he wanted to go over there, and it didn't matter the impact to the other programs. What it mattered was, was the support to the main program.

That's kind of always been the model here, to have this tremendous capability. So a lot of it's in reserve. Some of it's being used on a regular basis. So efficiency is not—you wouldn't see this out in the cruel world out in commercial industry. Everybody has got three jobs out there, and then anyone that doesn't have a job they're needed in, they're gone. So it's a little different view. I've tried to think where did that management style come from. Military.

RUSNAK: That was my next question.

HARLAN: Military, I think. It's like winning wars. There's no question about it, if the Department of Defense needs anything right now, they're going to get it. If they needed everybody in the whole government working on that, they'd get it. I think that's a war-fighting kind of mentality or a war-fighting management style, if you will.

So we've always had here access in the human space flight programs, access to whatever we needed. If you need it, they'll get it. It's the resources. So the idea is to be successful. So it's a different management style than you see in a business that's trying to skim off a profit and take it home with them. They don't do that here.

I think there's another thing that probably has affected this management style, is there's no clear customer. With no clear customer, NASA becomes their own customer. If you have a customer out there, and you have, say, an engineering business, and they want you to complete a certain project so you make them a proposal and show them how you'd do this project and all of

the things you would do to make sure and this is what it costs, then they might say, "I don't want that, that, and that. I don't want that analysis. I don't want to pay for it. I don't want to pay for that test."

Well, you don't do it. So they don't have anyone sort of on a real close loop with the way the work is done that's a customer that's looking at it from the standpoint of cost or whatever. It's really big stuff, like they do in Congress.

So I think this management style—I don't know what this gentleman from OMB can do about it. Clearly he's got a mission, and I think we know what it is, and it has to do with cost management, but he's got this huge enterprise that's got forty years of history managing its business the way it is, and he's going to try to reorient that. He's got a big job. He might vector it a little bit one way or the other, but I just can't picture the human space flight ever getting out of what I would choose to call a war-fighting mode, which means we've got to win that battle. If they don't, we lose everything.

So that's kind of mentality, is if we go blow a mission here real bad, we're going to lose. It's like losing the battle and losing the war. I think that's the way it's looked at.

RUSNAK: Did you see this management style as early as your first involvement with the Gemini Program?

HARLAN: It really became clear in the Apollo Program, I think. The Gemini Program, at that time when I started down here as a flight controller, I was working on the Gemini Program real early. The first mission I worked in the control center was down at the Kennedy Space Center [Cape Canaveral, Florida] at the old Mercury Control and before we moved up here, and I was so totally involved in flight control and what I was doing, that I didn't have much interest or insight into program management at all at that point in my career here. I was really interested in the

control center. To me, at that time, I said, "If I can do this the rest of my life, this is what I'll do." I mean, that's where I was. So I pretty excited about it.

I came down here to go work as a flight controller. I went to work as a flight controller for Gene Kranz, and it met all of my expectations, and for several years that's all I thought about. I could really care less about how the programs were managed as long as we kept working in the control center, getting missions to fly.

RUSNAK: What position did you start in?

HARLAN: I started as a Booster Systems Engineer, which was the old Gemini launch vehicle. We started out down at the Kennedy Space Center. There was another guy, maybe you've talked to him, Bill [William E.] Platt and I worked on the booster systems console.

We had two positions there. We had a position for a flight controller and we had a position for an astronaut. The astronaut's job was to look at the tank pressures and monitor the tanks. The way the system worked, it had an autogenous system or you could call it a bootstrap system or whatever. The tanks were pressurized prior to lighting the engines, and then as you draw fuel out of the engines, you had to backfill the pressure. They had a system on the booster there that would mix fuel and oxidizer and generate a gas, and the gas was pumped back into the tanks there in order to keep the pressure up. Otherwise it would collapse. If you draw it out, it's like sucking through a soda straw or something and causing the thing to collapse if you got the end of the soda straw. So they had this system.

Then the tank pressures, the pressure requirements varied during the launch phase depending on the loads on the system, which were somewhat influenced by acceleration as well as the dynamic pressure. So it was a variable. So the concept was to get an astronaut in there so they could start to learn to live in the control center, learn to interact.

You remember they also had the thing they called the CapCom, the capsule communicator. So the idea was that was a good way to bring the team together. So we always had a astronaut on the console with us that would monitor the tanks, and then we'd monitor the systems—the flight systems, the engines, the hydraulics system, and electrical system and so forth—during the launch phase.

That's what I started out doing, and I did that most of the Gemini Program, but we did bring in another guy from the Air Force. There were a bunch of Air Force guys that came in during the Gemini Program that were training for the Air Force MOL [Manned Orbiting Laboratory] program. So one of guys was assigned to work on the booster with us, and he worked with us, too. Then they all got transferred back to the Air Force somewhere when the MOL program sort of went by the wayside there.

So that's where I started, and that was a lot of fun.

RUSNAK: What kind of training did you have to learn the position?

HARLAN: It was two kinds, mostly self-taught in terms of learning systems, which meant we didn't have then any real classes on the Gemini launch vehicle, but we had a lot of material, system material. What we would do, we would take this technical material and convert it into functional schematics, and that's how you learned the system.

The functional schematics was, I think, something Gene Kranz invented, because every system area, every area had these systems handbooks, we called them. So you would generate these drawings, and they'd go through a peer review process with everybody that knew anything about it, and then typically you would give a class to other people that were interested in the system using that material. So that was one method.

So that's how you learned the systems, and we got a lot of help from the contractors because they were part of the peer review process. Like Martin Company was responsible for

Gemini launch vehicles, so their people would look at our drawings and basically say whether they were correct or not. But the idea, Gene Kranz's idea was is that you go dig all this stuff out and put it on a drawing some way, and the product was a drawing, but the real product was the knowledge you gained by digging all this stuff out. And they're still doing that now. I mean, that's been a mainstay. Some organizations, not this one, but some organizations might pay someone to deliver them a document like that, but it's also something else to do in between programs, when you got people that you got otherwise not involved in control center operations, you can—.

The other way we trained, of course, was simulations [sims], the integrated simulations. You probably heard a lot about that over in the control center. We used to run launch simulations. When we'd do launch sims, we'd run them all day, and you'd just run days and days of simulations. So you'd get used to seeing the data, reacting to off-nominal data, the situations the simulation people would establish, and working with the team, the flight director and the team.

So that and doing the systems handbook, then we also developed our own flight rules, flight rules and procedures, as far as that goes. So you developed this systems handbook, flight rules and procedures. Flight rules they still use over there, of course, and procedures and system handbooks.

The concept behind the flight rules development is to try to envision every possible situation you could get yourself in and what the action was. Then those would be tested in the simulations to see—sometimes they sound good on paper, but they don't work so well when you implement them.

So you go through that whole process of developing all of those tools. You use the handbooks, the procedures, and the flight rules. So, again, the strength of that was digging it all out and going through the thought process and so forth, really learning the systems. Then the

real good training was the simulations where you actually were presented with those kind of events.

Then I was also in the operations and procedures business. I was in Gene Kranz's branch, and at that time he had operations and procedures, booster systems, and the remote-site CapComs. So I was doing operations and procedures. That's sort of a catchall for all odds and ends around the control center, making sure the data flows right, the ground systems configuration needs are compatible with the spacecraft kind of thing, a lot of data stuff.

We had something called a *Flight Control Operations Handbook*, which was basically a compendium of procedures for the control center. We maintained that. We also maintained the flight rules for the whole organization. We were kind of the owner of the whole process of getting flight rules together. Of course, they were generated by all the different individual participants, but we would organize them and set up rule meetings and get together and talk about them and so forth.

We also worked on launch mission rules at the time, the constraints for launch kind of thing. So that was operation procedures. It was called the Flight Control Operations Branch, and it was the kind of the general planning, odds and ends of every kind. That was where Gene Kranz started.

RUSNAK: Is that how you worked your way into the assistant flight director position?

HARLAN: Yes, that was one of his creations. I worked for Gene in that branch, and Gene wanted to create an assistant flight director position which was sort of a more of what I just described, someone that would—since typically he had a lot of administrative duties, was someone that would take care of a lot of stuff for him.

So an assistant flight director position was created. It was controversial all the time. It was one of those things where the duties weren't very clear. Some of the flight directors felt like

they were being encroached upon by others. So it remained a controversial position the whole time there.

But we had responsibility for *Flight Control Operations Handbook*, flight rules, and a lot of launch rules, a lot of the organization of the stuff, and when the flight director wanted to take a break or go get something to eat, keeping the operation going or whatever, that kind of thing.

RUSNAK: I think it was one of the other assistant flight directors who described it more as assistant to the flight director, rather than the assistant flight director.

HARLAN: That's probably accurate, yes. Right. Exactly. Yes. It was controversial at the time. There was a lot of debate, and Gene Kranz was the guy that promoted it and promoted the idea, and it was under debate. Some of us that got stuck in that position kind of felt like we were in the middle of a big war a lot of times.

I worked with a lot of folks over there, good folks, Chris Kraft and, of course, all the flight directors that were there at the time and so forth. It wasn't viewed as a job that was a stepping stone to anything, and I think it was because of the controversy about it. Gene wanted this thing real bad, and some of the other folks didn't, and they were all equals in the organization, like branch chiefs and so forth. Gene was a branch chief at the time, so he kind of forced it on them. It represented, I think, an encroachment upon their prerogatives and so forth.

We had the INCOs [Instrumentation and Communications Officer], too. The INCO people, they worked in our branch. Over time, I later got to be the chief of Flight Control Operations Branch. Gene moved up and so forth, and that controversy continued, I guess. Gene was the division chief, so he was still going to do it. Gene was a strong-willed—I guess is. I shouldn't say was; is. I know him very well, and he's a strong-willed kind of guy.

It was interesting, I guess. I can't say that if I was the architect of that control center operation, looking back on it, I would have set it up that way, but that's the way it was.

RUSNAK: During the Gemini Program you still had your other job for most of these missions as the Booster controller, right?

HARLAN: Yes. Then, of course, I started getting supervisory jobs, section head, branch chief, and so forth, other jobs like that in the area, in the division.

RUSNAK: Maybe you can describe for us what the Booster console does during a flight—obviously the launch is the critical phase for it—but then what happens after that as well.

HARLAN: Hopefully you don't do anything in the Booster job. We would participate in the countdown in terms of the readiness of the system for launch, and then when they light the fire, you hope you don't have to do anything. You hope you can sit back and everything is going well.

If you have to take some actions in our case, it was bad – all terminate the mission, basically. We would provide information on systems performance, if something was a little drifting off normal but still okay, to the flight director and they'd pass it up by the CapCom. But basically any action we took was abort.

We had a little abort switch on our console, which would light a light that says "abort" in the spacecraft. Now, hopefully they'd see they were in trouble quicker than we would, and this would just be kind of okay, sort of a secondary kind of event information to them. Hopefully they had enough information to see.

We had dual hydraulics, which the Titan II didn't have, and if we were having hydraulic problems, seeing hydraulic pressure drop and so forth in the switchover, seeing the tank pressures deviate a little bit from normally, they didn't have very good displays on this stuff in the spacecraft, so we could give them a little more information on it, but hopefully you didn't

give anything more than information. The action you took was all bad. It was all abort, for both us and the tanks.

We had air-ground on our console, too, so if there was a reason to abort, it was always in a hurry, so we'd flip a switch at the same time, just say "Abort, abort" over the air-ground and give them the signal two ways, one through this electronic command and the other through the air-ground voice.

We never did have but one real serious problem, and so most of the time you just sit back and hope it all works. So there wasn't things to do. I mean it was all hopefully trying to hold it, provide enough information if there was some off-nominal situation to keep going. I mean, that's the way you were oriented. Then if you had to do something, it was bad.

RUSNAK: Why don't you tell us about the one situation that things were pretty serious.

HARLAN: Well, we had a situation one time, and it was Gemini 76. It was a combined mission. This was really a strange situation. This was a rendezvous. We had originally intended to rendezvous with an Atlas Agena target vehicle, and the thing went in the drink on the way up.

So then to salvage the mission, they decided to go into this Gemini 76 mission. One part of the mission was a long-duration mission of like two weeks, which is a long time in a Gemini spacecraft. It's kind of like sitting in one seat in a small car and somebody else sitting in the other seat. You probably get tired of looking at them after a while. [Laughs]

So the first launch came about, and they got the spacecraft in the air. That was the long-duration flight, so it was quite a little bit different operation. It was quite a challenge to go clean the pad up and then bring the other vehicle out that was going to rendezvous with them, get it on the pad, and get it checked out. What they'd done was check it out, take it off the pad, put the other one on, launch it, and then get the other one back and it had less time it had to be on the pad to get checked out.

When we started to launch that, these tanks I told you about, that line, it's called the autogenous line, it goes back and feeds the tanks, this takes a fuel and oxidizer and put it in a little combustion chamber and burned it, and the output gas would go back into the tanks to make up the tank pressure to keep the tank from collapsing as you drew all this fluid out.

It turned out someone had left one of these plugs in the line. So right away as this thing started up, the tank pressure never started to make up. This stuff's got a turbo pump. It's really sucking that stuff out of there. I don't remember the rate, but coming out of there a lot, so if the tank pressure goes negative, you've got a big fireball on the pad because it's going to collapse. All that stuff's going to mix and everything.

The way it happened was, there was another strange event that happened at the same time. Like a lot of things in life, you know, there's not just one thing simple. The tail plug fell out due to the vibration when they started up the engines. When the tail plug comes out, at least in this system, it starts the indication in the spacecraft that you've had liftoff. So you get liftoff, and the clock starts running in the spacecraft. They have mission-elapsed time.

So the crew's hearing all these engines roar and everything and noise and the clock starts running, the idea is we've got liftoff, right? Engine shuts down after liftoff, you've got to get out of there fast, because it's all going to come down in a big fireball. So the idea is to eject fast. They had ejection seats on Gemini. Been difficult to survive that anyway, if you'd bailed out in time, but anyway, that was the system.

So the retrofire officer is the guy that was in charge of the spacecraft clocks in liftoff, so this guy says, "Liftoff! The clocks have started!" and he starts reading the time. I'm sitting there, I know we're on the pad, and it shuts down. So that's the confusion you can get sometime.

This tail plug fell out just soon as the engines lit, real early in this sequence. We're talking a couple of seconds before, and I could see we're still down on the pad. We haven't gotten full thrust and hadn't released from the pad. The idea is the CapCom says, "Liftoff!" to the crew over the radio. So everybody was well trained. Everybody hung in there. The crew

didn't eject. Everybody called it right except the retrofire officer, and he was just calling what he saw, but the time was way off. I mean, he probably should have had a little better feel for that.

But the crew could have taken that information, because if you got to get out of there, if an engine shouts down and it shouts down right after you separate from the pad, you got to get out of there. You're just going to be in a big fireball. But everybody reacted right. There was a lot of confusion.

That's the only real problem we ever had with the Gemini launch vehicle. It was a human error in terms of leaving a plug in. So very quickly they got the plug out, got it all cleaned up, and we got it launched again. It was fine.

RUSNAK: I'm sure that was still quite a surprise for you at the time.

HARLAN: Oh, yeah. It was exciting. Right. That's what you do when you're a Booster systems guy. That's the kind of moments you live for, right, is excitement.

A launch was always, to me, the fun part of a mission because, like I say, once you light the engines and once you lift off from the pad, you don't have all the choices. I used to sit through all of these countdowns on the Shuttle down at Kennedy Space Center, and you've got all the time in the world. If you've got problems, well, you stop and investigate it, go get a whole bunch of people to look at it.

But once you lift off, the flight control is a little different game, and particularly launch phase. Earth orbit is fairly benign, you've got a lot of time, but the launch phase, you can't have a meeting. You can't call a meeting during launch phase to go talk about what's going on. That's why it was so much fun.

So you had to prepare a lot, work hard, prepare a lot, lots of training, and that gave you a feel for it. We'd done so much training that I really had a feel for the timing, too. I'd seen

enough of the stuff where when you light the engine and the thrust buildup, and then I was watching the engines and they started down, the thrust started down. I saw them shut down. It was just crystal clear to me that even though I didn't have a clock reference that it was early, they couldn't have lifted off. So that's the thing. When you train enough, you get—that's the purpose of training, is to get people to where you—and we had good training. Those folks over there in the simulation business were really outstanding.

RUSNAK: Was that particular scenario something that had come up in a simulation, do you recall?

HARLAN: I can't recall whether that exact one had, but I bet we had some pad shutdowns. Let's see. I think I saw a pad shutdown on Gemini II, I think. I think we might have had a pad shutdown on that. It was unmanned. I can't remember. I think we might have had one on that. It may have had something to do with the spacecraft, but it shut down on the pad, I think.

Pad shutdowns are not—you're designed to be able to shut that whole system down. It's not a desirable situation, but obviously there's some failure or some reason you shut the system down, and there's a lot of fuel and heat and pressure and all that stuff around, so it's not desirable, but all of the Shuttle shutdowns have gone well, I think.

RUSNAK: Is there anything else you recall from the Gemini flights that sticks out in your mind?

HARLAN: Yes, I think the most exciting thing about the Gemini Program to me was every flight was different. It was a learning experience.

We had the first EVA [extravehicular activity], and it was a real learning experience, I'll tell you, and quite a challenge. So every flight you had to learn EVA, learn how to do that. You

had to learn docking, rendezvous and docking, do that. Had to get some time under your belt. We had the fourteen-day mission.

I remember this is what they did with assistant flight directors. I remember one time when we docked with the Agena and did our dock program, and then everybody cleared out of the control center to go to the party, and they left me in charge and some other guys, and we burned the Agena and did all that kind of stuff while they were gone. That's what assistant flight directors do. When all the fun's over, everybody leaves and goes and drinks beer and they leave you behind to do all the burns of the Agena and whatever was left. So I mean, that's the kind of thing you ended up doing. That's why it wasn't that great a job, I guess.

RUSNAK: Well, I can understand that. The Booster console is physically part of what they call "The Trench." Were you part of the Trench as the social group or whatever?

HARLAN: Sure. Sure. The Booster—the other thing interesting I think about that, to me, it's always been an interest to me is the evolution of technology. When I started out working down at the control center in Florida, all of the tools we used, the devices were all electromechanical, pretty classical stuff. In the Gemini Program up here, what happened was that they were going to move the control center responsibility to Houston, so we were using the old Mercury control system early on.

So what we did was run the control center here one mission in piggyback, and then there's a group of us—it was running piggyback with the control center in Florida. I think that was probably Gemini III or IV, so in that time frame. Then they decided, "Okay, let's go for real up here."

So there was a group of us went down to Florida, and we were the backup down there. We manned-up the booster and the flight director and the flight dynamics and so forth. So we were the backup down there for here when they finally went live the first time. Then we jumped

in the NASA Gulfstream and came up here and worked a second shift up here. We basically were just backup there in case they had a major failure of the control system, because we'd had a lot of them all along, getting the thing developed and getting it working and so forth. So that's why we were down there.

Then we came back, and all of us worked another shift up here during the rest of the mission. But they ended up after that they shut the place down down at KSC. I guess just before I left NASA, which has been almost five years now, five years at the end of this year, I was down at KSC, and I went over there to visit the old place. I think it's not an open kind of visitors' thing anymore. In fact, they were running a Source Evaluation Board in there, but they let me in, let me look at all that stuff. It could be fixed up, but it was pretty much the displays and all that stuff was still there and so forth. But they were all electromechanical, a whole different technology than you used here.

For instance, that world map, the little spacecraft was on a punch of pulleys and things that pulled it across there. Of course, this is all electronic, and that's evolved tremendously over here over time. The technology changes all the time.

RUSNAK: What did you learn in the Gemini Program that you thought "I really want to make sure we carry this over to Apollo"?

HARLAN: The big lessons I think we were learned in Gemini had to do with environmental control system dealing with these problems with EVA that we really had to tackle in the Gemini Program. It seemed to me that the rendezvous operations went real well, I mean that whole development sequence. They started with a real long sequence, and the last time, the last one we did, I think we called it an M equals zero. M was the orbit number where you actually rendezvoused. We did an M equals zero, I think, finally. That's not a practical thing to do, but it was a demonstration where we launched after the target vehicle and caught them at Australia,

halfway around the world. That's not a practical operational thing. You can do it. So it went through. The whole rendezvous program, seemed like to me that went well.

The EVA thing was really, really a challenge to deal with. That turned out to be some things that they really had to work on, the EVA challenge. The fuel cell really needed a lot of work. We had trouble with fuel cells all the time. Fuel cells, electrical system, electrical power generation, and so forth was a big issue. Navigation was an issue. Of course, there wasn't much in the way of an onboard computational ability, and even Apollo by any kind of standards didn't have much, but it went in to significantly more.

So those were the kind of things we took out of Gemini. The operations techniques, the kind of thing that Gene Kranz championed and the folks in the Flight Control Division seemed to be coming together, to me, pretty well in Gemini for Apollo. That was a different mission. Lunar landing, of course, was a big change from that.

So we learned a lot and I think we practiced it, and we launched about every six weeks with an entirely different flight agenda. It came together fairly well.

RUSNAK: At what point did you begin working on Apollo? Was Gemini still flying then, or did you wait in until the end?

HARLAN: Let's see. Probably there was some overlap, because I can recall working on Apollo real early in kind of little studies about flight operations and so forth, because we had to get prepared for it in defining the control center configuration, the displays and working on systems and so forth. But I didn't do a lot of that early on.

There were a couple of branches in the division already working full time on Apollo in that time frame. There was a CSM [Command and Service Module] branch and they called it the LEM branch, Lunar Excursion Module Branch at that time. So they were already in place. So we would work on it some.

No one really wanted to work on it a lot, because you still wanted to get over to the control center and work on everything. Everybody in Flight Control Division wanted to work on every flight. It was a big problem, it really was, because someone had to work on some other stuff. It was a management challenge for Gene Kranz to get everyone whipped into some kind of shape where they would actually not work every mission, because it was important to keep it going.

I guess the other thing we decided, it was an interesting—we made a decision here at JSC in the booster systems business to turn that over to Marshall [Space Flight Center, Huntsville, Alabama], and it was a deliberate decision. The Marshall Space Flight Center owned the boosters, so they established an office within Flight Control Division and brought their people over to do flight control work. We had decided that we'd recommended that that would be the best way to do. Those guys wanted to do it, (A), and they had good access to the information and so forth. So that responsibility, they reported to the JSC flight operations at least in an operational technical sense, but not in a management sense. So we stepped out of that for Apollo. They really took over the same console we had, they just adapted it. Those consoles in those days were set up to where they were modular and you just changed the modules around, how you configure them.

RUSNAK: How did the higher-ups in flight operations feel about giving up that console to Marshall?

HARLAN: It's hard for me to recall whether there was any controversy over it, but I don't think there was at the time. The reticence was really—the Marshall guys, their management was nervous about it. I recall that. They were really nervous, and the Marshall guys were over here. They always felt like if they had to take some action like an abort, that it would make Marshall look bad and so forth. I mean, I could never see that. I mean, data is data and you do what you

have to do with data, but there was an extreme amount of pressure on those guys, it seemed like, from their management about that, "Don't ever make us look back" kind of stuff and whatever. They were pretty good guys.

I worked with them all the time because I guess I was head of the Flight Control Operations Branch in that early Apollo days. They'd have to get their flight rules done and their procedures done and so forth, and I worked with those guys a lot. But they felt some, I think, unusual and unnecessary pressure from the Marshall management, and they always worried about that. I mean, it was a big worry in their minds.

RUSNAK: Did they keep the astronaut next to that position as well?

HARLAN: No. No. They just turned the whole thing over to them. It worked okay. It would work the other way, too, either way. I think now there's a lot of thought about—on the Space Station Program, some of the experiment support is done over at Marshall, and there's thought about pulling that back over here and consolidating control center operations. Under a different "Here's the way we want to divide up NASA," it might work a different way. But it could have worked either way.

RUSNAK: Since now for these flights where you're a branch chief and you're working the assistant flight director position, how much emphasis was there still on the creation of mission rules and procedures and these sorts of things, and how was that process different for a lunar flight?

HARLAN: The process itself was not different. The rules were different because you added different mission events as well as when you started adding the lunar modules and you started

adding other different equipment like in Earth orbit. It was pretty much, pretty much with the exception of the kind of things that failed and the problems you had, pretty much like Gemini.

But when you go add the lunar part of it, then you've added big mission sequences, big mission events. You've got the issues with launch trying to get yourself on a launch azimuth that you can get to the Moon and so forth. So there's a whole lot of other trajectory-related rules and constraints that made it a major difference. Then we were using different communications, you know, those big dishes that we were using, different communications.

We had lunar module. We had dual vehicle operations and so forth. So it just added more equipment and more mission sequences or mission events, the process being the same, the way we did it. We basically generated the systems handbooks and/or the procedure handbooks and sat down and looked at "What can go wrong?" and "What do I do about it if it goes wrong? What's the best course of action with this?" That's basically the process.

RUSNAK: Maybe you can comment on the value of mission rules as a concept and as a management tool.

HARLAN: I think they're really invaluable, especially coupled with the simulation methodology used by NASA over here, if you take the simulation methodology, which stressed rules. The simulation folks knew as much about our business as we knew about our business, so we'd write a set of mission rules for some scenario, and they'd say, "Doesn't look like it'll work." So they'd set it up in a simulation, and lo and behold, you'd go try to make it work, and it may or may not work. So we had some pretty smart people on the other side generating these simulation scenarios, and we did a lot.

NASA, to this day, is a very rare exception, won't plan anything they don't simulate beforehand. Astronauts over there won't undertake anything knowing in advance they're going to do it while they're on the ground, that they don't train for and simulate in some way. I mean,

they just won't do it without training or simulation. And that's really one of the principles of success of the flight operations of this country as contrasted to that event they had on the Mir, where they were trying to fly the Progress vehicle there and they had the collision. That was an unsimulated, untrained-for event on their side. Now, we'd never do that. So our whole system is founded on some principles, that being one of the most important.

So the rules are ways you make decisions in the calm of the office before you're faced with this all of a sudden happening in your face. You talk about it and you go through reviews, and you get other people to look at it, and you get this big long approval cycle and so forth. Then by the time you think you got something that makes sense, then you turn the simulation guys loose, and some of them are pretty straightforward, pretty simple, nothing to them. They're going to work, I mean. But others, they can pick up the ones that are iffy right away. First thing you know, you're in the middle of sim and that scenario happens and you find out, by golly, it didn't work. So you wring it out that way.

So I think the mission rule, it's like anything. It's like disaster planning, hurricane planning, anything. If you don't plan for it, you've got to do it real-time. I mean, your chances for success are many-fold higher if you plan for these potentialities in advance. So I think the flight rules are really, really important.

The other thing they do, aside from the functionality of having a pre-made course of action or preset course of action that you think is the best, it allows a lot of other people who may have an interest or knowledge, I'd say an interest from a management standpoint or knowledge from a technical standpoint, to buy into that. So that typically the flight control team, once they have a set of rules set down and approved by the program office and all the management over here, they basically have management buy-in on what they're going to do when those events happen.

So it's kind of like covering your tracks a little bit by making sure you have clear understanding if you get into some of these corners, how you're going to get out of them with the

management. So it takes away a lot of the what you could see could clearly happen if you—"I didn't know you were going to do that. I don't agree with you terminating the mission." Well, you know, it's what we had to do. So it gets the management in sync with the guys over here that are faced with the problem. So I think they're sort of invaluable tools, the way NASA does it.

RUSNAK: Actually, that may be a good place to stop so we can take a moment to change out our tape.

HARLAN: Okay.

RUSNAK: When we had stopped, we were talking about mission rules and their utility. I wanted to ask if you thought that that concept could be somehow in some way more generally applicable to industry or other parts of government or just in some field outside of the space program.

HARLAN: Oh, I'm sure it could. Of course, it's been a longstanding process in aviation. You wouldn't want to get on an airplane and the pilot have to figure out what to do if an engine shut down, right? So there's a lot of situations that use that kind of process. But, yes, I'm sure it could.

I mean, all kind of probably applications now that we're considering, responses to terrorist acts, for instance, what do you do? Last couple of days I was over on the [Houston] ship channel working over there at this place, and we were talking about set one of those big tanks off just right, and you could light up the whole ship channel. Twenty-five percent of the nation's refining capacity is right over there. You could set fires, if you did it right, fires that would burn for weeks, probably.

They're starting to think about it. This company said, "We're spending a million dollars in security now." So they're starting to think about things and building fences and trying to protect themselves from that kind of thing. So that's part of that thought. "What happens if" is the next step. They're putting in some security measures, but what happens if. "If" is, we look over there and there's a big hole in the fence, somebody's cut a hole in the fence, what do we do and all that kind of thing. So, yes, I think there's probably all kind of applications for that kind of thinking so that you improve your odds of responding appropriately.

The other thing it allows you to do is once everything you can possibly think of and then something else happens in combination with one of those events, it allows you to think about the thing you didn't think about as opposed to the things you thought about, if you see what I mean. It narrows down what you have to go figure out what to do about—because you're probably not going to think of everything.

RUSNAK: Yes, I think that you can find a couple of examples of that in the Apollo Program.

HARLAN: Sure.

RUSNAK: Maybe we could talk about a couple of the specifics from that program, some of the missions. If we can start, I don't know what involvement you had with the Apollo 1 mission.

HARLAN: I was working with the Apollo 1 mission on mission rules, procedures, and that kind of thing, operations procedures, assistant flight director folks and so forth. It turned out that that event was another seminal event in terms of spacecraft design and how to approach spacecraft design in the program. The design with that oxygen-rich environment was not tolerant of the kind of things that can happen, electrical shorts and whatever. And that whole thing happened.

So, yes, I was, of course, involved in a lot of the planning on how we did business. Very early in those Apollo missions, what we would do at the Mission Planning and Analysis Division [MPAD], all the folks that got together and put together really what the mission was, they would basically define the trajectory in great detail. We'd try to lay out where we wanted the tracking ships and all that sort of thing to support, and it was kind of a team effort to put together a mission.

Then we'd turn all this information over to then it was North American [Aviation, Inc.], became Rockwell [International], and they'd go through and do just tremendous amounts of analysis to see whether the spacecraft, it was acceptable to use a spacecraft in that method. So Glynn [S.] Lunney and I were working a method, and we got them to except it, which was to put together this data book, which really basically defined all of the operating limitations and criteria on the spacecraft so that we could go away and design missions without having them go through all of this analysis. So this was a Spacecraft Operation Data Book, SODB.

So we got the program to do that, and so that started back in Apollo 1, I think. That's when we first came out with that idea of the Spacecraft Operational Data Book. So we talked program into getting them to do that so we could do all of our planning operations and have enough information without violating any of the constraints on a spacecraft, like keeping one side of it in the sun too long or whatever the constraint happened to be like that.

Prior to that, everything we did, we did all of the planning, laid all the mission out, then they'd have to go through and go through it step by step and approve it. That's the kind of stuff we worked on in Flight Control Operations Branch, that kind of flight planning and laying out the ships and the communications and the data flow and so forth.

RUSNAK: As far as changes after the fire, what sort of mission rules or procedures or whatnot had to change because of that due to emphasis on safety or whatever?

HARLAN: Well, if you remember—I'm trying to remember what that did to the flight. I'm sure it changed a lot of detail rules on the environmental control system, because the whole environmental control system sequence of operations were changed.

What they started out with was air on the pad and as you consumed oxygen and lost air through leakage or whatever, you made it all up with oxygen. So eventually you got to this oxygen-enriched environment, and the reason for the oxygen-enriched environment was to facilitate the EVAs because of the low pressure in the suits. The suits are like 4.5 psi, so if you tried to do that with a bunch of nitrogen in the atmosphere, you certainly raise your chances of bends. So the idea was to minimize the chances of bends. So they kept both systems, really.

The Space Shuttle now has basically an air environment the whole time except they do change the oxygen-nitrogen ratio sometime before an EVA. It was set up to do that. But it's still not as drastic. It doesn't change it as much as it was changed there. Everything on the Shuttle is certified in that environment not to be extremely flammable and so forth.

But I'm sure the systems were different. I'm trying to remember. They made a lot of changes on there at that time. Of course, it made the hatch where it opened out instead of in, an explosive hatch. There were a lot of other system changes, and I just don't really recall them all at this point, but we worked on it about two years.

It was kind of like after the Challenger accident. The program was open to a lot of changes. Changes went in the system that were safety-related improvements, that weren't all of them necessarily directly related to the pure oxygen environment, redundancy in some systems and so forth.

RUSNAK: What do you recall of the first manned flight, Apollo 7?

HARLAN: That was an interesting flight. It was successful, of course. It was the first flight we were going to have onboard TV on, I do remember that, and I do remember there being a war between Mr. [Walter M.] Schirra [Jr.] and the Mission Control Center over that television.

The war had to do with they came across the United States and turned the TV on, and we got a whole bunch of noise. I can remember personally talking to George. I was assistant flight director then. Assistant flight director had a lot to do with the data flow and getting data back. So they had it set up to transmit that TV data.

Now, today you can transmit TV data all over this planet in a heartbeat for low cost. It was like big money. We had one shot at it. So Goldstone, California, was where they captured the TV, and they sent the data back here, and it was gibberish. So something was wrong. So we didn't get that.

So I remember talking to George. It was going to be like $20,000 to send the TV again from out there. He's, "Send it."

Okay, we'll send it. So we sent it, but it's still gibberish. They wanted to do the TV again and Schirra balked at that. "I'm not going to do that," blah, blah, blah, blah, blah.

So there become a big war on that flight. That's why that whole crew never got close to a spacecraft again, because not only did his own personal arrogance and ego do him in, and he was probably at the point where he wasn't going to come back anywhere, by the two younger fellows with him, [R. Walter] Cunningham and—I'll think of his name in a minute.

RUSNAK: Donn [F.] Eisele.

HARLAN: Donn Eisele. I can picture his face. Those guys, basically it ruined their career, too.

That war went on the whole time. I can remember Deke [Donald K.] Slayton coming in the control center being so mad he couldn't see about that whole operation. I can remember making tapes of the air-ground voice conversation where Wally Schirra was basically being

defiant of what ground control was telling him to do, and it turned into a big issue. So I remember making all of those tapes of that conversation.

I can't remember the guy's name, he was some general that was in charge of manned space flight up in Washington then, an Air Force general.

RUSNAK: Rip [Carroll H.] Bolender?

HARLAN: I think so. I think that—I remember making him a set of those tapes.

Everybody was mad at the flight crew. I can remember Lunney was—I've known Glynn Lunney a lot. Pretty mild-mannered man. He was not mild-mannered. So the whole thing turned into a mess.

Wally Schirra singularly soured that mission real bad. I know whenever he got returned to the Cape, I think they landed in the Atlantic, Mr. Slayton was over there breathing down his neck. That whole thing was sad.

They finally did get some more TV and demonstrated that the TV would work, but that was the first time we'd ever had in-flight TV, and he didn't want to do it.

I can remember going to a meeting with the man early on. We were involved in a lot of the planning, of course, and going to a meeting on the in-flight TV, since the flight control operations branch was big into communications, data flow, and so forth. It was a design review of the in-flight TV camera. It's like if you look at it, it's kind of like a pistol except that the handle on the pistol wasn't at right angles to the main body of the camera. It was either forward or backward at an angle. I can remember Wally saying, "I won't accept that. I want it the other way," for no good reason. Big deal and he got his way. So they had to change that whole thing.

So you can see at the time the ego and so forth. It didn't make a bit of difference up in flight. I mean, there's no weight, no anything. It's not like anything. It was just astronaut ego. So that sort of prevailed the whole flight.

I also remember going to—I think Gerry [Gerald D.] Griffin was the lead flight director then, and I can remember going to a pre-mission party over here at the Ramada—not the Ramada. The hotel that's right across from Nassau Bay. That's the Ramada now, isn't it? It used be—

ROSS-NAZZAL: Holiday Inn?

HARLAN: No, it's right across the street from the Holiday Inn. But we had a pre-mission party over there and Schirra coming to that. I can remember having a conversation with him, and it was really interesting when you looked at subsequent events, about how in his position he had everything thrown at him, being a celebrity, women, everything else like that, and how it was difficult for him to make good decisions about things and so forth. So having a conversation with a guy like that pre-mission and then you think, well, that guy realizes where he is, right? Then he got in the mission and acted totally out of context. I mean, he totally disregarded directions from the flight control and so forth.

So that whole mission, the spacecraft worked fine. The new systems were proven, the changes that were call that Apollo 7 at the time. That stuff worked well, the mission planning, the flight control, and so forth. Yet here's a guy that soured the whole thing. My belief is the whole astronaut office was mad at him because he created a situation that—it looked bad.

Chris Kraft and the guys like that, they all lined up and says, "Guys, this isn't going to happen again. This is not a way to run a business." As far as I know, we've never had a rebellion like that since. I haven't been involved in the last five years. I don't think anybody is doing that stuff now. But this was just somebody's big ego got in there. But it really soured that whole feeling about it.

There was euphoria. "We got the spacecraft going. We got the program back. It's been a couple of years. We're flying again." Then you got a total jerk, I mean 100 percent jerk, in charge of it. So that's what I remember about that flight.

RUSNAK: It's interesting that it ends up Wally Schirra, who was really the guy in Mercury after [M.] Scott Carpenter's flight that was a little bit mishandled from the astronaut end, Schirra was the guy that came back and flew the perfect mission and wanted to make sure that everything was good there and then now here in Apollo it's almost the opposite.

HARLAN: I can't envision why the man did that, because it's one thing to have something going with someone, but that's pretty public. The NASA management—like I say, I remember making all these voice tapes of a whole bunch of stuff and giving them to this guy in Headquarters. You know, that's uncalled for. Because we taped everything on the air-ground. We taped all the loops inside, so we had all that information. We could just easily go make copies of that.

But that was one of the strangest kind of things where you got all of this work for two years, everybody knowing the program's depending on success, getting the thing back. You had this horrible situation where three people died. Then look what happened. Here's a guy that for most of the flight was a total jerk, and it's interesting he took two guys down with him.

RUSNAK: Well, the next flight, Apollo 8, turned out to be a pretty good way to recover from that.

HARLAN: Right. Exactly. Right. Well, those guys were model American citizens. The only controversy I ever heard over that is from Madeline Murray O'Hare—nobody can find her now—over them reading from Genesis up there. But these guys were as good as it gets for what they did in terms of representing the program, America, their performance. Everything worked fine.

That mission, I think George Low, the gentleman I had talked to you about earlier, had a lot to do. If you went back and read stuff, I know he had his hand a lot in getting that approved and so forth. Because that was an out-of-sequence bold step. In my mind, there were some folks back then that could do things like that, that had good vision, would do things like that.

I don't think NASA could have ever really do things that way anymore. I think they'll risk ever so much, but that was a big risk. There's no question about it. We had one manned flight with the spacecraft. We're going all the way to the Moon on the spacecraft the next time with a system that hadn't done that. You get that big Saturn out and haul off. Wow. To me that was a bold step.

I think that and the success really opened up the rest of the program to proceed in an orderly manner. Had they not done that, and I don't remember all that of the mission sequences, but there were many, many mission sequences over the years more conservative than that, and they just jumped a whole bunch of steps and combined a bunch of objectives in that. It was a bold step and paid off.

RUSNAK: Yes, it sure did. Did you become involved with that at any early stages before maybe it was publicly known?

HARLAN: I can't remember. I can't remember. Probably. I mean, we were all working on that stuff over there.

RUSNAK: It was my understanding, I guess, that a small group of people were brought in initially.

HARLAN: I wasn't working on that team. We all were working several missions. You'd work on several different missions in the planning stage. You didn't just plan them in sequence. So,

early on in the planning sequence, I don't think I was working on that at that time. I may have been working on 9 or 10 or whatever.

RUSNAK: Both of those flights are usually not regarded with as much enthusiasm as some of the big ones like 8 or 11, but 9 and 10 both had very practical objectives, proving the lunar module and then doing the dress rehearsal for the lunar landing.

HARLAN: Yes, 9 really got the lunar module a workout in Earth orbit, and 10 really got us up again very close to a lunar landing into that sequence. We learned a lot there about working with two vehicles and getting the communications right. I remember working with—Gene [Eugene A.] Cernan was a CapCom on that mission. I was always amazed, working with Gene. I was working on communications objectives, and the communications system after that, let's see, must have been after 9, I'm not sure. That's when we created INCO position.

The communications system had a lot of different modes of data, command and voice and television and so forth. You had to get the ground and the spacecraft all configured the same, or you'd have something missing there. You would have a lack of one of those probably capabilities. And it was fairly complicated.

There was a lot of management. The time management of the communications system took a lot of time. So it could be done by ground command, but it was done, I think, on a 9. It was done with the CSM EECOM [Environmental, Electrical, and Communications Officer] and lunar module, one of the lunar module positions. And it was a mess. I remember working with Gene Cernan on some communications tests and trying to get a hold of Gene to systematically get the crew to get the switches in the right configuration and so forth.

He was the CapCom, and we finally, I guess it was after 9, decided to create the INCO position and let one person manage the whole communications system, both the ground system and the flight system. They created that in my branch. So that turned out to be a lot more

efficient. What we did was configure all of that airborne system by ground command, and so it took the crew out of a lot of switch changes and when you went from different communications modes and two vehicles, and it was really a mess. So we created the INCO position, and that worked a lot better, a lot more efficient.

That was some of the things we learned out of—I think we really learned it out of Apollo 9, and then I'm not sure whether we had it in place for 10 or 11, but we finally got it in place, got it all figured out, how to do that, how to consolidate it. It took the crew out of a lot of burden. I mean, the burden was tremendous. I mean, it's just routine stuff. They had more important stuff to do, is what I'm saying. They had really important stuff and then to get distracted by all of this routine switch-throwing that we could do by ground command to try to keep the two in sync.

RUSNAK: We had talked to Ed [Edward I.] Fendell about that.

HARLAN: Yes. Ed was in my branch. What you call a character.

RUSNAK: He was certainly an interesting guy to talk to.

HARLAN: One of a kind.

RUSNAK: I'm struck by how many one-of-a-kind characters there were in flight operations.

HARLAN: Yes. It attracted people like that. It attracted very strong-willed people. Gene Kranz used to tell us that one thing about this job is you can't fade into the woodwork. You've got to get out there and get it done. So people like Ed, who didn't mind—Ed was very competent as well, but didn't mind standing up and getting things done, excelled at this work. He was a little bit of a character.

Did you talk the John [S.] Llewellyn any?

RUSNAK: Yes, we did, several times.

HARLAN: He's a whole lot of a character. [Laughs] We all hope they throw away the mold when they make them like him. He's the guy that hollered "Liftoff" on that Gemini when it hadn't lifted off and got everybody thinking we had liftoff. But John's a character.

RUSNAK: Yes, we certainly get a little bit of sense of this personality in here, but we've heard a lot of stories about him.

HARLAN: Yes. Right.

RUSNAK: As the assistant flight director, you had a chance to work with a lot of the different flight directors very closely. So I was wondering if you could comment on some of their different personalities and styles in terms of how they ran the missions and the shifts, and just provide some sort of comparison for us.

HARLAN: Well, I think the styles are like any kind of variation you find in people. Some people are more into control than others. Others are more into delegating. So there's a whole different set of spectrum of styles you see across people that do work like that.

The ones that are high on control, it seems probably split about fifty-fifty between the ones that are high on control and the ones that are more of delegators. I have good personal friends in both categories, and I think the preferred way—I'll tell you, one of the guys that I always admired, always worked with, always will respect, one of my mentors, one of the guys that I couldn't say enough things about in terms of giving me the opportunities I had over there is

Chris Kraft. He was in the mode of he was the master delegator. He'd let you hang yourself, you know, but he didn't misjudge people. He knew who could do the work, and he let them do the work. He just had a feel for people and so forth. He would push people hard at first, when he didn't know them, just to see what their capabilities were and so forth. Once he had that figured out, he let people do their work.

There were other guys that didn't let anyone hardly do anything, really control. You've seen people like that in every walk of life. They're just different personalities. But Kraft really had a gift. I used to just marvel at the guy.

He was unforgiving, too. I mean, there would be a point, just to show you, when we had the remote sites out there, we always had a picture book of everybody in the remote site, the CapCom we sent out and the systems engineers and so forth. Somebody'd make a goof, he'd say, "Show me the book. Who is that?" He mostly knew everybody. He knew the CapComs, but some of the systems guys he didn't know, and it had a little picture of who they were and everything. The guy may never go out again.

He would let you make mistakes, and if they were honest mistakes and if you 'fessed up to them, fine. If you tried to cover them up or weren't honest about them, you were history. I've seen people just disappear. A lot of people disappear out of flight ops just due to his hand. They went over to work in the program office. That's what he'd do. I've seen him clear a lot of people out of there. We'd get a new program. We'd start getting simulations, people get in. Make an honest mistake, that's okay. Cover it up or keep making it, just showing incompetence, another thing.

But the guy was unforgiving. Yet once he had you figured that you were a square person, he let you do your work. I thought what a gift this guy has. But he also had the power to do something about the people that didn't. What a gift. But he could figure it out.

I remember one time I came over. This might have been something like Apollo 7. It was all the pre-launch mission rules, and we had a lot of it. I had about a ten-page document, and I go over there to his office, and I said, "I need to get you to sign this off."

He says, "Okay." Okay, signs it, just like that. I didn't go over it.

Other guys would have gone over every one. You'd have been there for hours, going over every single one. So he had that gift of categorizing, classifying people with their capabilities and stuff. But some people never learn that. I'm not going to mention names.

RUSNAK: That's okay.

HARLAN: But I mean, some people, they've got to do it all themselves. They've got to see everything. It's a shame, really. When you get into that kind of operation, you don't develop people as well, and you put a big burden on yourself. You become indispensable on every thing.

RUSNAK: I'm surprised by how even though there are a variety of personalities that all of them seem very successful once they got into that position.

HARLAN: Yes.

RUSNAK: At least up through the Apollo Program. I can't comment as much on Shuttle flight directors.

HARLAN: Right. I don't know much about the last bunch of guys in there at all. There was a big war in the organization between Kranz and Kraft over who the Apollo flight directors were. Kranz's view is they all come out of Flight Control Division. Kraft's view was that Flight Control Division was so arrogant and unruly, that he was going to show them that they weren't

the only guys that could run that operation. So they picked, let's see, it was Pete [M. P.] Frank [III] and Milt [Milton L.] Windler and I can't remember who else, but from outside the organization.

Kranz really went to the mat over that with him, and he lost that one. But there was a feeling in the Flight Operations Directorate that the Flight Control Division was a little bit out of control and kind of overran everybody else and so forth in the directorate. So that was done to tame, in part.

Those were good guys, by the way. Windler had come out of, I think, Landing and Recovery, and Pete came out of Mission Planning and Analysis. There was always a little bit of bad blood between those organizations in terms of their view that flight control just rolls over everybody and so forth. Kraft, it was probably the right thing for him to do, but he did make Gene the division chief when he got rid of [John D.] Hodge, and made John Hodge Flight Control Division chief when I first came there. Then Hodge got into trouble with the management. I think that was after GT-9. So he did make Gene the division chief.

I know personally, I've been around Kraft a lot, and he had tremendous respect for Kranz. Even though they had this war going on, he had tremendous respect for him. That didn't interrupt the respect he had for the guy.

RUSNAK: Did you get any sense that this attitude you've been describing within flight control spilled over to the relationships with other directorates like Engineering?

HARLAN: Oh, yes. Oh, yes. I think the whole operations. It sure did. I think there's a long-term resentment in the Engineering Directorate—I have a lot of friends there, too, obviously—about so many of the program management positions, so many of the top positions go to people in operations. "I mean, who are those guys?" That's their view. "We're over here doing this, and no one considers that."

So I think the engineering guys in particular have a—that's a smoldering kind of thing over there. There's a bunch of guys that have been over there a long time and, like I say, they harbor some resentment, like "All the good jobs go to those guys in the flight ops."

I heard a guy, I couldn't believe the guy said this, but the guy has been retired. I ran into him in the grocery store somewhere, and he's still carrying that around, the guy from engineering. He was really—he had resentment. He expressed it to me, resentment for all this publicity Kranz got after *Apollo 13*. This guy was pretty high up over there, and he had resentment for that. I can't understand that. I mean, I just can't understand anybody resenting someone that's been successful at what they're doing doing that. So there's a lot of feelings there. I think they probably go on today and on and on and on.

RUSNAK: Well, since you brought up *Apollo 13*, I think that's a good example of when you were talking earlier about how even though mission rules can't cover every scenario, they can help prepare you for some and then leave you to concentrate on the other ones. So maybe you can give us your version of events that from flight.

HARLAN: Well, I think this is well documented in everybody's book, in Gene Kranz's book, in HBO and all of the movies and everything. I guess the things you can say about it was, is that it represented a significant team effort in dealing with the things that they hadn't predefined like this.

The fact that when you were on a translunar trajectory, that you're going to pick the best method to abort from that translunar trajectory, all of that was mission rule stuff. Like the best time is to wait till they go around the Moon and come back, rather than try to turn the whole stack around. But doing all of the system problem-solving and so forth—and that represents I think something I said earlier about this concept that NASA has, this "in case it happens" management style of having all this capability, they could deal with that.

They've got all of this capability over there in terms of the different skills, knowledges, simulation equipment, and so forth, and know how to bring it to bear in something like that, where a big part of the time, I mean, Shuttle flight after Shuttle flight is just by cookbook flight.

But should something like this happen again, bang. So they pay a big overhead price for that. Maybe today that's not warranted, but clearly in Apollo days it was warranted. There was so much uncertainty. There's a lot less uncertainty now. In particular with Earth orbit flights, you can get down pretty quick.

But I think that's just a part of that, to bring a team to bear, to bring out all the ideas and have a method to get those guys back okay. It worked fine.

As I say, Hollywood, they jazzed it up a little bit, but I mean the real truth of the matter is that it was good leadership that got the folks together dealing with a real crisis. Turns out they had everything they needed to get it done. It was very impressive, that whole team operation.

RUSNAK: What was your specific involvement with that flight?

HARLAN: I was not assigned as a flight controller that flight. I was in charge of the Flight Control Operations Branch and had several flight controllers over there. As a matter of fact, we really recognized one guy. This guy called up a deep space tracking network. We weren't using it at that point. We weren't far enough out, but right away this guy, this was kind of unplanned, but he did it on his own. He just went out and called up all those big antennas and everything and got everything. That's the war-fighting mentality that we had. So nobody turns around and fusses at the guy. Cost him a whole lot of money, the stuff. The guy had everything up, called up right away. I mean when it happened, bang, he's got everything up and ready to go.

So I helped with them from—not being an active flight controller that mission, not being on the console, but we worked on more of the communication, the data flow kind of stuff, stuff that was in our area.

But the team effort, again, NASA was good at that in those days. I'm not sure it would be as good today. The bureaucracy has spread, and there's more fingers in the pie and more management. I'll give you an example of that. I can't remember which Shuttle flight it was, but they were getting ready for launch, and they had a big hydrogen leak. It was in that seventeen-inch disconnect area, and so they could pick it up on the pad. They ended up canceling the flight. They couldn't find the leak there.

So they established this team of people to go and do problem-solving and find that out. So what it turned out to be was between Headquarters and a program manager over here at the time, the Shuttle program manager, they were all involved in this thing. It turned out to be that some large percentage of the effort was put into making presentations for management, and they were giving briefings to the press on what was going on. In fact, they totally missed the problem. They told them it was something or some glass beads or some kind of thing going on. So Gary Johnson—have you talked to him?

RUSNAK: No, we haven't.

HARLAN: Yes, you need to talk to Gary. Gary was involved, deeply involved, in that whole electrical system back in Apollo and the changes, the investigation. Gary Johnson knows a lot about that. He was on the investigation team, and he was the electrical wiring man for Apollo, so he can really give you some insight into that stuff.

So Gary and I go over to Aaron Cohen then, who's the center director. We say, "Aaron, these guys are never going to get an answer to this problem, what we're doing. This is, problem-solving won't work." It had gone on for three weeks like that. They were having program office meetings, and they weren't problem-solving.

Well, Aaron threw Gary and me right out of his office and says, "Well, I assigned that to the program manager. It's his job," Leonard [S.] Nicholson.

We tell him, "This ain't going to work. Won't work. You'll never get the answer here."

So they went on for about three more weeks. Meanwhile, the Shuttle's not flying, didn't solve the problem. NASA Washington finally decided, "Well, we'd better put together a proper problem-solving team, put the right people together," put them down at Cape where the equipment was. In two weeks they had the answer and had it solved, and we told these guys.

That's what's happening in NASA now. You see all of these infusions of management processes into things like problem-solving processes and so forth. So I would hate to see that happen to something like Apollo 13, if we have something like that again, where all of these guys pile in and pile on and they're spending all of their time giving briefings, not working.

You need strong leadership, and I'm concerned about the leadership, the operations leadership. I don't really see it over there. The Chris Krafts are gone, the Gene Kranzes are gone, and the guys that would really stand up and fight battles and could fight battles and had the clout to do it. I'm not saying those guys can't do it, but I just don't see the leadership anymore that we had when those kind of things were going on, the real leadership that would get there. All the managers would converge.

RUSNAK: Do you think that's a function of the people or the system?

HARLAN: Both. I think the system more than the people, but the people because the system won't let the people exhibit leadership characteristics and traits. It's like there's a difference between management and leadership, and it's management now. It's a management process, a management operation.

The guys that were charismatic leaders, the Chris Krafts, the Walt Williamses, the Max Fagets and those guys were leaders because they had a lot of technical knowledge and a lot of savvy and they were a result of a career of working on all of the predecessor technology that went into what we were doing over there. They had credibility.

You don't see that now. I mean, that's probably one of the biggest weaknesses over there is that you've gone more to this management style of operation as opposed to the leadership style. You don't see the strong leaders in the business anymore. You don't see the leaders sticking out that people follow.

[Former JSC Director] George [W. S.] Abbey was a leader, but he's gone. You could say whether that's good or bad, whether he was a good or bad leader, that's a different question. But George Abbey was a leader. Who's a leader over there? There's no leader over there at the center now.

[Acting JSC Director] Roy [S.] Estess is, of course, just holding the fort. Eventually they'll get someone. If they pick someone from within, they likely won't have a leader. They'll have someone that's a product of the current system. You need real leaders at times, folks that have the credibility and the vision to make changes.

[Former NASA Administrator Daniel S.] Goldin, when he came in, he had some really wonderful ideas what NASA really needed. It turns out he didn't know how to implement them in the system. He was not good down and in, but he had a lot of vision on things that needed to be done, but he just couldn't get them implemented. He had a vision, so he wasn't a great leader. He was a visionary, but not a great leader because he couldn't get them implemented. He tried, and he got a lot of blame for stuff that really he shouldn't be blamed for, some stuff he needed blamed for.

But my point is that here's a guy was a visionary that wasn't a good leader. I don't see any real leaders in the system over there. I mean, there were times when if we were standing on top of Building One over there and Chris Kraft told me to jump off, I'd have jumped off. That was a real leader, right? "Whatever it takes to do the job, Chris, we'll do it." I don't see that.

RUSNAK: Well, it's a shame that it seems to be that way now.

HARLAN: Yes. Leaders don't come around very often, and NASA needs some leadership, someone that not only has a vision and can see what needs to be done to achieve that vision, but can inspire people in a way that they will fulfill that vision, to inspire folks.

Goldin never inspired anybody. George Abbey was a leader, except he just told people what to do. He was a control guy. So he just told people what to do, so you do what he says his way, and that's his modus operandi. So that's not the best leadership model either. NASA really needs that.

I hearken back to guys like Chris Kraft who had this ability to, boy, dig in and take strong stands, but you knew the guy was right. You knew the guy. He's a smart guy. In some of this stuff, a lot of it was back when space flight wasn't routine. We were doing things for the first time. But this guy had just an idea that if we do it this way, we won't get in trouble, and you believed him, and he'd stand up.

We need some folks like that over there and somebody to do program management right, somebody that can take a leadership in that area.

RUSNAK: What effect do you think having these kind of long-running operational programs like Shuttle, or like Station will be when it's completed, has on attracting this kind of leadership?

HARLAN: It's a good point. That's a very good question. Because I think it's a whole different environment than you're talking about in a development situation, and I don't think it would necessarily be a plus in attracting this kind of leadership.

These are just operating programs, routine, very routine, a lot of it, very routine operations. It's pretty much gobbling up the big part of NASA resources to do routine operations. So they've got this big cost, this big operational cost of routine operations that overrides a lot of these other things that NASA really would like to do, the space exploration and the things like that.

So, yes, I would think a different type of person would be attracted to an operations kind of business, something where the business model is mostly pure operations. And there's a need for people like that. There are people that know how to do it, make it efficient, organize it, structure and so forth. But I don't see the visionary leadership that we had before, that we're looking at all these programs and what kind of programs do we need and how we do them. So it's a different kind of thing.

You need good operations leadership, but it's a different kind of person, I think, than you'd get than what I think NASA needs. My view is, they've got to somehow shed themselves of the responsibility of some of these continuing operations if they ever want to get back in and do some development and new programs and so forth. But the burden of these programs are so high, that that's where they're going to be stuck. So it's unlikely to move away from here for a long time. It's an unfortunate situation to be in, I think.

RUSNAK: What was the atmosphere like as the Apollo Program was winding down, where you're ending this developmental program and there's not an immediate follow-on in terms of a lunar program, but then you're going into something like Space Shuttle or you've got the intermediate program with Skylab?

HARLAN: Well, I'll tell you, the atmosphere in flight operations, that's what we do is operations. So you can imagine, it's a fairly big impact on morale and everything to kind of get away from operations, because that's really what we all like to do is that.

So I happened to work for a genius at the time, his name is Gene Kranz, and Gene Kranz decided that his objective at that time, because there was some significant time period between the end of Apollo and the Space Shuttle or the next program, was to involve us in some other activities that were beneficial to the center, (A), and (B), something that we could do that we might learn from and so forth.

So one of the things he did—like I say, one of the things I learned from Gene Kranz is—and there are not very many operations people good at this. Most operations people like to work on the current program, current operations and so forth. Gene always had his eye on what's next, and he always had some people working on it and thinking about it, and when times were slow in terms of current programs and operations, he kept people busy. That guy was a genius at that. Most other people just weren't good at that.

So what he did was he convinced the center that his division ought to take over the Earth Resources Aircraft Program. It turned out I happened to be branch chief of that. He made me the branch chief of that. We put a whole bunch of folks working on that.

It had had a questionable past, so he had some selling points there. At least they could make a case that it hadn't been run very well, the operations part of it, and then if he brought the operations team in on it, we could make it a lot more efficient and operate better. So we started the Aircraft Applications Branch. So I was branch chief of that, so we worked on that.

We basically worked on that until the Space Shuttle started going again, and Chris Kraft got his picture book out, and our pictures were in that book because we were working one of those ancillary programs.

But we had a lot of fun with that. We worked on that through all of the manned Skylab Program. We basically flew a lot of underflight support to the earth resources package that was on Skylab, and we had a P-3V, a C-130. We had a Bell Jet Ranger helicopter. Those three we used. We had two RB-57Fs. We used those two airplanes. Sometimes we brought in a U-2 airplane from Ames [Research Center, Moffett Field, California]. Once in a while we'd strap something on a T-38 or something like that, something of that nature.

So we did a lot of—my job during the manned part of Skylab was to keep the aircraft support there. Anytime they would do an earth resources experiment, sometime we'd have a B-57 at 60,000 feet, and we might have a C-130 at 10,000, a helicopter at 1,000 feet, all lined up

under there taking data and so forth to correlate with the spacecraft instrument. So that's what I did during the Skylab Program, the manned part of it.

It kept a lot of Gene's people busy working on that, and we do think we did a presentable job of managing the program. We do think that. Who knows, but that was the premise under which the flight operations organization would take that. We did all the flight planning, and we had folks that flew on the airplanes. Some of them operated instruments. I had guys that flew the instrument positions on B-57s. I had guys that flew on all the airplanes. Once in a while I'd take a flight or something like that. So we did that. That was one of the ways.

Like I say, Kranz was a genius at keeping people busy between programs. A lot of people wouldn't do that. So that kind of kept the morale up. We were working on Skylab then, too, so I had a number of flight controllers working on Skylab.

When Skylab started, Gene asked me if I wanted to be a flight director on Skylab, and I said no, I did not want to be one. So I decided to opt out of that. I like working on this Earth Resources Aircraft Program better. We did a lot of planning and so forth. I saw working as a flight director in Skylab as kind of like Space Station over here, for months just going to work on shift work, and it just didn't appeal to me. I had been working on it before in terms of the communications system and so forth, so it wasn't anything that I wanted to do.

The aircraft program sounded interesting, and this aircraft job turned into, by the way, a division, because we took over aircraft engineering. They did some combining of flight crew operations and flight operations, and they had some aircraft engineering people out at Ellington [Field], so they put them under me. We made it a division. We had responsibility for the development of the Shuttle training airplanes. So in my mind, that turned into a better job than going over here to control center and working.

By that time I was ready to really do something technically different, rather than just working, boring holes in the sky and that. That's when I got into this aircraft business, aircraft engineering. We worked on the development of the Shuttle Training Aircraft [STA].

That probably came as close to getting me fired as anything I ever did. Very close. I thought I was fired. Chris Kraft said, "I'm considering firing you." He meant it. So that was an exciting program, I must say.

RUSNAK: Maybe you could give us some of the details on that.

HARLAN: Well, we had taken this program over from aircraft operations, and an engineer who was working on it came to work for me as assistant division chief, Charlie [Charles R.] Haines, good, good, good, good aeronautical engineer, fantastic aeronautical engineer. Had a personality about like Genghis Khan or somebody, you know.

George Abbey was our directorate chief. God, George Abbey was mad at us every day. So we started this program. The first thing that happened, it was designed to fly like Space Shuttle. Space Shuttle had never flown before. So it's a moving target. That's okay. You understand, that's a tremendous development problem to make this in-flight simulator fly like another airplane, but, boy, what a challenge. Not a lot of engineers get a chance to work on something like that.

So right after we got the project, they changed the Shuttle cockpit, and, of course, if you look in that airplane, left-hand cockpits is like the left-hand side of the Shuttle cockpit, because that's where it's flown from. So that cost us a million dollars right there in terms of changes to our program, which was a million dollars we didn't have.

Then it went on and on. We ended up after a year or so about $10 million dollars over budget. Our contractor was Grumman, and so we went up there. We did a special investigation. I remember going through every single drawing, everything, trying to figure out where the work was.

So Grumman came in here the first of one month and had a big meeting in front of Kraft. God, he was mad. Ooh, was he mad. They said, "We're a million dollars over budget," and,

boy, he threw them out. He could swear like anybody's sailor, you know, and he was swearing at them.

So that's when we went up to Grumman and started looking at, well, it turned out it wasn't a million, it was 4 million. We came back at the end of the month and it was 4 million. The good thing was, he was madder at Grumman than he was at me and Charlie. But he was really upset when it jumped from 1 million to 4 million dollars. I cannot say in this company what he told them. You will not believe that the director of a center would tell—they had the president of Grumman down here, the president of a big—you wouldn't believe how he talked.

Then he talked to Charlie and me, and he says, "I'm considering firing you guys." Ooh. And he meant it. So I think that's probably the closest I've ever come to getting fired, which we probably deserved it, who knows. But we got it pulled out and working again.

We had an interesting operation because the engineering directorate wouldn't help us. They only wanted to work on the Shuttle. We'd have these big meetings. We'd get Kraft. We'd get the head of the engineering directorate, and he'd agree to Kraft. We needed some control system help, because it's a complicated control system. Say, yes, we'll help and then they wouldn't do it.

We'd go back to see Kraft. He'd swear at them, and they wouldn't help us. So it was one of those kind of things. One day we laid it all out for him what was happening, and we said, "Why are you so mad at us?"

He says, "Because you guys aren't up here pounding on my desk enough."

We said, "Well, we've had all these meetings, we've brought all these people in. You've told them what to do."

He said, "I expect you guys to be up here pounding on my desk."

"Well, gee, boss, you know."

"I'm going to fire you guys."

"Yes, sir."

But we got it going finally and got them delivered. We had a lot of technical problems, tremendous technical problems, so in that sense, for an engineer it was interesting. We had problems making the control system. We called it model following, it actually followed a model of the Space Shuttle. That was a tremendous challenge there and a very complicated system.

Then we had a lot of trouble with because the way the airplane works, you've got to fly it in reverse thrust to get the right glide angle for it during flight, and you fly it at pretty high power settings, like 90 percent or something, and the flaps go up instead of down, and that kills lift on the wings and so forth.

So the first flight we flew where we put it in reverse thrust, the whole cockpit shook so bad they couldn't read the displays, and that went on for a long time, and trying to figure out what was the matter. We knew, of course, when you went in reverse thrust, we knew we were exciting these fundamental modes of the airframe, and it was all showing up in the cockpit there, and they couldn't read the displays, and so you couldn't operate that way, obviously.

So we said, "Well, okay, what are we going to do? Well, we're going to go over here and get the experts at Langley."

Kraft told me go over and talk to Hewitt [William H.] Phillips. He said, "Hewitt Phillips, my old boss over there," he said, "he knows everything there is to know about control systems."

So we went over there to talk to him, and he said, "Well, I need the planes for about two years to do this research program."

We said, "Well, this is a Shuttle trainer. We need to deliver it in six months or something like that. I mean, we've got to train the astronauts."

Then we talked to the Grumman Ph.D's., and they couldn't figure out what to do, but they wanted a research program. We talked to all of these aviation experts around NASA. Finally there was a guy that worked for me who went to the library and sat down and did a little bit of studying, and he figured out. In the meantime, we did a lot of work, like we tufted the back of the airplane so you could see the airflow. We put smoke generators on the engine. We even

found out how to do that. We called up the Thunderbirds and said, "How do you make those engines smoke?" And they told us, so that's what we did.

So this guy figured out the problem, what the solution to the problem was just by—it was incredible. This guy was really smart. He was one of these guys that—his name's Royce [L.] McKinney. He was an aeronautical engineer. He's one of these guys that was way smarter than—he wasn't the guy that you'd go say produce a whole lot of stuff. He's a guy you go use his brain, kind of guy, one of those type of guys.

He sat down and figured this whole thing out. Those Grumman Ph.D's., the guys didn't really believe him much, but he convinced them how to fix the problem, and it took about twenty or twenty-five flights of tweaking this. What he did basically was change the whole outlet configuration of the thrust reverser to where it changed the frequency level of that noise into this exhaust up above the fundamental modes of the airframe. It worked.

Working in that aircraft, to me that was more fun than getting into something like that, than working on Skylab in the control center, although that might have led to something different after that, too. You never know where that would have been. But that's what I ended up doing.

RUSNAK: I think Charlie Haines had mentioned that the STA had the distinction of being the first thing on the Shuttle Program to run over budget.

HARLAN: It could have been. Boy, Charlie's got this—he's a good friend of mine, but he's got this acid personality. We'd have a meeting with George Abbey, he was the directorate chief, every morning at eight o'clock. We had to prepare all these charts and stuff. George would ask us a question, and Charlie would act like "That's a stupid question." He'd show George in every way he could that he asked a stupid question, and it just built a relationship that wasn't a lot of fun. Every morning at eight o'clock I was exposed to this deal for weeks. I'd say, "Charlie, I know it's a stupid question, but he's a boss. Bosses have a right to ask stupid questions. Quit

telling him it's a stupid question. I mean, let him—because he beats us up every day. You go through this thing and tell him it's a stupid question, or you look down your nose at him or send him all kind of signals about that, and we get beat up every single day by this guy. Charlie, when are you going to learn?"

But he never gave up. He was one of these real very, very technically competent guys. If I ever needed an aeronautical engineer, I'd want Charlie around. A lot of experience, a lot of competence. He was good. But he'd get the boss mad at us all the time.

RUSNAK: Were you guys having to deal with the Shuttle Program Office under Bob [Robert F.] Thompson as well?

HARLAN: You know, it's interesting. Bob Thompson was, in my mind, one of the true leaders, too, in the Shuttle Program early on. He had a lot to do with pulling that together.

I remember we went over and talked to him about that, and he says, "I'll help you guys. I'll call Grumman up." We had only so much leverage at our level, and he was the kind of guy, "I'll help you. I'll call Grumman. Give me the information. Give me the facts. We'll get the president down here. We'll talk to him about it." I mean, he very much wanted to be helpful and a part of the solution, rather than beat us up.

Abbey was more the "beat you up" guy and Kraft was, too. Their management style was a little different. But Bob Thompson, he was a very charming man, and right away he picked the phone up, called the president of Grumman, and said, "Let me try to help you with this," and so forth. But, yes, went very well with him.

RUSNAK: How difficult was it to get this aircraft ready to fly like a vehicle where the design is still somewhat fluid in terms of how it's actually going to perform?

HARLAN: Well, what we did was, they had the best engineering simulation is called the SES over here in engineering, Spacecraft Engineer Simulator, whatever they call it. It was a man in a loop engineering simulator of the Shuttle, and that's basically the way we tried to make it fly like that simulator. That had the best engineering input into it.

Then what happened was, when they made those drops out at Edwards Air Force Base [California], they learned some things about some of the coefficients and so forth that updated that simulator, and that's what we used as really our basis for what the Shuttle flew like. So we would use whatever the latest configuration of that was to base the Shuttle aircraft training system.

Charlie and I used to talk about that big orange ball, and it's never happened, thank God, the Shuttle Training Aircraft. The Shuttle Training Aircraft has been going twenty-five years now, and we've never had a big orange ball. But it was one of the things we really worried about because—

RUSNAK: Can you explain that?

HARLAN: Yes. Crash, basically, because of either some form of training incident, error, in terms of that or an aircraft failure, some failure in the system, because they're diving at the ground just like the Shuttle is, at a pretty high rate, and they're doing it time after time after time after time again, and what we did was we set up a safety pilot on the right side and the training pilot's on the left side.

I'll tell you what we did. We went over to flight control to a guy I know, Charley [B.] Parker. I'm not sure Charley's around here now, but he was a guidance officer. We said, "Charley, we need a way, a simple way, to monitor this trajectory by the training pilot, some simple rules," and he was a trajectory guy. He was a part of the whole flight dynamics organization. So we commissioned him to go work on a set of rules that were simple enough to

where the training pilot could take control of the aircraft should it get where it would be difficult to recover it should something go wrong. We call that like a dead man's curve or something.

So what you'd have would be, we had a real simple rule about velocity and rate of descent and so forth that the training pilot could use, and all he had to do to take command of the airplane was grab the yoke and it's theirs. It disengages the simulation. There's also a button on the yoke they can push, and it disengages the simulation. They have control of the airplane.

So the idea was set up this way where if the trainee got the thing in a situation where if you had any kind of thing go wrong you might not recover it, it was the guy would override it and take it out of the simulation, or he would never put you in that dead man's curve. You'd never get in a dead man's curve.

Went back to flight control, developed some simple rules, put the simple rules in, and no one's ever gotten hurt on the thing. I don't know about close calls. It goes on and on and on.

But they terminate the simulation at twenty-five feet above ground level, so that's not very high. What you've got to do is you've got to stow the thrust reversers, make sure that you're in proper climb-out schedule and all that kind of thing, the main gear's down for drag.

RUSNAK: Right.

HARLAN: So you want to suck up the gear. So you've got some things to do there. The airplane is real dirty, so you've got to clean it all up and get it out of there. So you don't want to get where you can't do that. That was the idea. Thank goodness it's never happened. I mean, we just worried about that a lot.

So you talked to old Charlie, huh?

RUSNAK: Yes, we did.

HARLAN: Yes, he's a good guy.

RUSNAK: Yes.

This may be a good place to stop for now because I think we're running a little low on tape and actually it's getting close to five o'clock, too, so.

HARLAN: Okay.

RUSNAK: I don't know how much later we'd want to—

[End of interview]