ORAL HISTORY 2 TRANSCRIPT

M. P. "PETE" FRANK III
INTERVIEWED BY KEVIN M. RUSNAK
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RUSNAK: Today is December 15, 2000. This interview with Pete Frank 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, assisted by Carol Butler and Tim Farrell.

I'd like to thank you for taking the time out to do this with us today.

FRANK: Oh, well, I'm happy to do it. It's going to be interesting to see what comes out of this.

RUSNAK: I'm interested to hear what comes out of it.

FRANK: Okay.

RUSNAK: If we can begin with how you got involved in the aerospace industry and what these kinds of experiences may have taught you before you went into the space program specifically.

FRANK: Well, just real briefly, I got my bachelor of science engineering degree in aeronautical engineering from University of Texas [Austin, Texas]. After graduation I went into the Marine Corps and flew as a pilot in the Marines for a few years; in fact, just about three years is all. From there, I went to work for an aircraft company in Dallas and spent about two or three years doing that.

But the real thing that got me into working with NASA is when I went to work for the [Glenn L.] Martin Company in Baltimore [Maryland]. My job there was to work on reentry trajectory analysis, studies of trajectories that would be able to come back in from Earth orbit. That was just about the time that NASA was initiating some studies for lunar missions, manned lunar missions, and I got to work on those projects for the Martin Company.

We were doing a lot of original initial investigation of what the trajectory characteristics were for vehicles coming back from as far away as the Moon, which was quite a bit more stressful on a spacecraft than just reentering from Earth orbit. Earth orbit entries were 25,000 feet per second approximately, and coming from the Moon, there was just no way to get it any less than about 36,000 feet per second, which was a major increase in heating and aerodynamic loads. I got to spend a couple [or] three years doing that, and got a lot of understanding of the problems associated with that kind of thing.

So when the contract was awarded to North American [Aviation, Inc.] in [Downey] California and we didn't win (we were bidding on that contract but lost) I applied to come to work for NASA and was accepted. Came to Johnson—well, it was the Manned Spacecraft Center [MSC] then—in October of 1962, and was assigned as a section head for the Reentry Study Section, working under a gentleman named John [P.] Mayer, who had been with the Langley [Research Center, Hampton, Virginia] group at NASA for quite some time before that. He was the Mission Analysis Branch Chief. Chris [Christopher C.] Kraft [Jr.] was our Division Chief (Flight Operations Division).

We had offices on the Gulf Freeway [Interstate 45] at a place called the Houston Petroleum Center. They had a replica of an oil derrick out in their front yard, but we were actually the only organizations in there, operations under Chris Kraft. We were there, I guess at least a year, maybe close to two years before we moved down to the Manned Spacecraft Center down in the Clear Lake area.

That was a really interesting, exploring kind of time, because the Mercury Program was well under way. They were flying Mercury missions throughout this period. I wasn't involved in that at all. That was already in place and happening. We [my section] were concentrating on the Apollo lunar mission, with some work also for the Gemini Programs. As the Reentry Study Section, it was our responsibility for computing the guidance requirements for the reentry portion of the trajectory. I was still learning a lot from that activity.

We had just kind of done the basic things at the Martin Company, and after I got to NASA we were really working on fine-tuning and exploring some of the things, ways we could optimize the solution to the problems about reentry. I wasn't really aware of anybody else that we could turn to, to learn some of these things. We had to use computer programs to do simulations and run analyses of the results, but a lot of the times you would try something on the computer just to see what the results were. You didn't really have a really good way of predicting these things until you'd generated a lot of empirical data.

But that was really interesting. It was just great fun to be working on. The program was scheduled still many years in the future, several years, so it didn't feel that much pressure to get it done right away, and you could spend time really, really working on it. Although we worked a lot of late hours and long [days and nights]. I think we probably worked every weekend during those years, just because there was so much to do. That sounds contrary to think there wasn't much pressure, but it didn't seem like pressure. You got up and came to work because you were really interested in what you were doing that day.

RUSNAK: Can you describe the atmosphere for me at this time, with the center separated in different buildings and these kinds of things, what it was really like to be there?

FRANK: It was a bit awkward. The program offices were at a place called the Farnsworth-Chambers Building, so there was a lot of time spent traveling back and forth around different places in Houston to have meetings and go to meetings. We didn't have a lot of electronic conferencing or anything like that, so you went to these places to get together, to have your meetings.

There was a—how do I put it—kind of a competition between a couple of the organizations. One of them was Chris' Flight Operations and the other was Dr. Faget's, Max [Maxime A.] Faget's Engineering Division. The engineering was responsible for design and building the spacecraft. Of course, Kraft's group was responsible for the operations.

There was a lot of times in a design effort when you're building and doing the initial designs and building a spacecraft, there's a lot of compromises that have to be made between the people that want to operate it, do operate it, the astronauts and the flight controllers, and the engineers who are building the spacecraft. Things that make it easy and really efficient for the engineering sometimes makes it very difficult to operate and vice versa. Things that operators really want give the designers a really tough time. So there was a lot of having to negotiate and work out problems with these other organizations in different buildings around different locations in Houston. There was a lot of effort that went into that kind of a overhead activity, I'd guess you'd call it.

But it was really a very exciting atmosphere. We kind of felt like we were really unique, and that coming into Houston like that… none of us really knew much about Houston before we got here. The city treated NASA, especially the astronauts, but not only the astronauts, any NASA engineer, and so we were really treated like special people and you kind of got the feeling like maybe you were, because they treated you that way so well. But it was just a really fun and interesting place to work.

We had contractors that worked with us. TRW [Thompson Ramo Wooldridge, Inc.] was our primary contractor at the time. They had some very capable engineers that came

into the area and we would meet with them regularly. They were doing some of the supporting work for us and some things on their own that we were always getting together and going over that, comparing results.

One of the big activities was building computer programs, designing them to do the simulations, because nobody had been doing this before. We had to get our own computer programs designed and implemented before we could do a lot of the work. That was a big part of our job during this period.

RUSNAK: What was the state of computing at this time?

FRANK: Well, there were always big IBM machines…. I've forgotten what the number designations were, but you laugh at them now, looking back at what the capabilities were. We used the computer at the University of Houston. They had a computing lab over there and NASA rented time from them. But NASA had their own programmers that would build the programs and then take them over to the University of Houston computer lab.

I spent a lot of time in that lab, because the programs didn't run very fast and there's a lot of computations involved in trajectory work. It's a very iterative kind of problem where if you're going to fly from here to there, you take little bitty steps, computation steps, and the computers were ideal for doing that sort of thing. But even with the computers, it was pretty slow in those days.

RUSNAK: Can you maybe run us through the basics of how you developed one of these profiles? What are the physics behind it that you're looking at and how you translate that into the equations and into a computer language that can run and put this out and give you some meaningful results?

FRANK: Okay. The equations are not closed-form solutions in that you plug in some data and you get an answer. They're the kind that require this step-by-step iteration to get to the answers.

There's two regimes: one is within the atmosphere and there's one that's outside the atmosphere. Outside the atmosphere there were closed-form solutions if you made a few simplifications, which were really primarily the ones we used for analysis, early-on analysis, to get close to a solution. Then you had to switch over and do the non-closed form solutions to get the really tight, accurate answers that you needed. So, lunar return trajectories were a combination of those two, because once you hit the atmosphere, there was nothing that approximated the trajectory in a closed-form solution. The only way to do that was the iterative solutions. That was a big part of the computation problems for this trajectory analysis, was the reentry portion.

Apollo added another level of complexity, not only the speed of entry, but the fact that it used a lifting vehicle instead of just the ballistic Mercury-type capsule. That really complicated things, because now you had the ability to control where you were going to land once you got in the atmosphere. On Mercury you didn't have that. You control where you're going land by when you did the de-orbit and how much of a burn you put in there. Since it was just falling like a rock from there on, it was not a big footprint in which you go looking for it [the entry vehicle's landing spot].

But we needed lift on Apollo because of the extreme conditions of the entry. The only way you could do a successful entry on a mission like Apollo was to use lifting forces, and that was what was kind of new. It was definitely new, and what we were doing is factoring lift into this equation. It gave you maneuverability, but it also gave you real problems in controlling it. There just wasn't anybody to consult on that. You had to go work at it in the computers and see what would happen. You can make approximations with

closed-form solutions, but that just wasn't accurate enough to rely on. You had to go in and do the detail work.

Some of the people that I first met back when we were working at the Houston Petroleum Center was a fellow named Ron [Ronald L.] Berry. He started working for me in the Entry Section. Really a brilliant young kid, and he has since retired from NASA, but he was a really bright guy and we became very good friends there.

A fellow named Hal [Harold D.] Beck, who had been with NASA all along, and he was fellow section head there when I came in. He's retired, too. Hal Beck is real character kind of person. He was a bachelor, he never got married, but he was a really fine, humorous, party-going-type guy that everybody really had a lot of fun with. I never saw him upset or angry about anything. He could go along with anything that happened.

Ed [Edgar C.] Lineberry was another young fellow who was just getting started and was a really bright guy who really worked out solutions to the rendezvous problems. I don't know if he originated the concepts or whether he started with somebody's idea and then really embellished it and made it really workable. It was a key factor in the Apollo Program, was being able to do rendezvous in lunar orbit. He was the guy that brought all that together, really made that happen.

Carl Huss was another guy who was there at NASA, came from Langley with NASA. He was another character, but he was totally different, very straight, rigid German guy. [Laughter] That's an ethnic bias. But he was also a very capable guy, he worked hard, did everything and really worked his people hard, but they all really liked him, really thought he was a great guy.

He and another character who came from England by way of Canada to work for NASA, was named Morris [V.] Jenkins, he was another very capable guy, but kind of eccentric. He and Carl were quite opposites and they ended up having some personal conflicts once in a while because they would get to encroaching on each other's work area, so

there was a lot of almost unfriendly rivalry, but it was never out of control. They both ended up being branch chiefs when [the organization was expanding and] things were—you know, [in a state of flux]. NASA was hiring like crazy at this point, at this time, and so the work force was increasing and the organization was getting bigger. Then Chris moved up to be a director, and then John Mayer, who was the branch chief, now became a division chief. Morris and Carl [were branch chiefs] and I became section head in [Morris'] branch….

So the organizations under Morris and Carl tended to get kind of bumping against each other, too. There was sort of a split of responsibilities. I always felt like John Mayer did it that way deliberately so that people wouldn't get set in their ways, they'd kind of challenge the other guy to keep things moving. I think Dr. [Robert R.] Gilruth did that, too, with the Manned Spacecraft Center, because he let Chris and Max Faget loosely define their jobs to the point where there was a lot of challenging back and forth there.

I think at the time, at first I thought it was really poor, that it was a really inefficient way to do things, but in the end, I think it helped increase the accuracy and the level of efforts on exploring things different and new. Instead of people getting set in their ways in an organization, there was always a challenge around to keep you on your toes. I have seen that work very well to improve the results of something that was being done, because the two organizations were trying to outdo each other in a particular area and you'd come up with a lot better solution as a result of it.

The period before we moved down to where the center is now, you spent a lot more time in downtown Houston. Then eventually after we moved out here, you kind of got isolated once we came out here. I felt more like a citizen of Houston in those days, even though I was living down in LaPorte. We spent so much time in that area, that you don't feel that now. We don't live in Houston anymore.

So there was a lot more activity involved and nightlife within the city. A lot of the socializing went on in town as opposed to out here in the suburbs. It had a different feel to it

back in those days. There were an awful lot of the people, engineers that we were working with that were single, and that created a lot more social environment also as a result of that. I guess it's just the characteristics of a younger organization that's growing like that.

RUSNAK: How did you see yourself fitting in with everyone else? Were you typical of the other people in your areas?

FRANK: Well, I actually felt, rightly or wrongly, a lot more qualified than a lot of them because of the work I'd done at Martin and had this background. I brought books with me, notebooks, of studies and results and parametric data that we had done, generated at Martin. I just felt like I was a lot better prepared for this than a lot of the people that were working for me at the time and working with me. I felt really good about the job and the fact that I came into this thing not as a longtime NASA person, but was really contributing to the work and to the results and had a significant role in what we were doing here. That was an especially good feeling about it also.

The kids were real young. I had a six-year-old daughter and a four-year-old son, and they were freshly getting started in school. I had never done that before. I didn't travel a whole lot in my job here; it kept me in town most of the time. A lot of the people that I knew and worked with in different areas spent an awful lot of time on the road. It was mostly in California to Rockwell, North American, and later going to Boston, MIT [Massachusetts Institute of Technology, Cambridge, Massachusetts] and Grumman [Aircraft Engineering Corp.] in [Bethpage] Long Island [New York].

I also had friends that lived close to me that were part of the recovery organization, and they spent a lot of time with Gemini and Mercury, both, actually, deploying out for recoveries that would get postponed. The launch would get postponed, and they'd be sitting on a ship for another two weeks or so. That got pretty old for those folks, but it had to be

done, so they were involved. Fortunately, I didn't have that kind of a problem. All the work we were doing was right here.

When we moved down to… the Manned Spacecraft Center… our building was one of the first ones to get built, the one [in which] the Mission Control Center was [located]. So we were down here pretty early compared to some of the other organizations. It was really, really vacant fields everywhere with this Mission Control Center stuck in the middle of it, and the main building 1, the Headquarters Building.

Then there was a building that had a computer for the administrative work, not the Mission Control Center, it had its own separate computer facilities. That was pretty interesting to be in the offices and look outside the window and see buildings going up all around you, under construction.

The Control Center itself was a new concept for me. I hadn't really been involved with mission control at all. It'd all been trajectory analysis and mission planning and things of that sort. So it was pretty exciting for me to get moved next to the Mission Control Center. It was right down the hall from where we were working. Also, our computer trajectory analysis programs were then going to be migrated into and become a part of the Control Center computations. So we then took on this more critical role, if you can say it, probably more critical because it's being used in real time during the mission, not just during the planning. That was a [major] uptick in the involvement with the missions itself, and I really enjoyed that.

In fact, one of our biggest jobs after we pretty well understood how we wanted to fly the missions through the entries [was responsibility for the trajectory to and from the Moon]. My section role got expanded to do guidance work for not only the entry, but also the trajectory to and from the Moon, which was a big change, a big addition to what we were doing. We didn't have any programs that did a really quick analysis of that. It was really

[necessary to] develop your own computer program now that did [this] work…. We had a subcontractor come in and work with us on that.

We were involved developing this program that we could use not only to do the analysis of the lunar trajectories, but also migrate that into the control center to do the targeting for mid-course corrections, both going to and from the Moon. That became a big part of our effort. I spun off the reentry analysis to another section. A good friend of mine I'd worked with at Martin came to NASA and took charge of that section. Claude [A.] Graves [Jr.] is his name. Claude still works at NASA.

So then I concentrated primarily on the lunar trajectories and the final portion of the lunar module landing on the power descent phase…. The section now is called the guidance section, not reentry. We had a lot of interface with the Marshall Space Flight Center [Huntsville, Alabama] because of the Saturn V targeting. We had a lot of work with MIT, because they had responsibility for the guidance systems, the algorithms that go into the computers, on-board computers. Then with both Grumman for the lunar module [LM] and North American—Rockwell at this time—for the Apollo command and service module [CSM].

We spent many months developing and refining this trajectory program. The problem was, you couldn't get a closed-form solution to get to the [Moon]. We had found that there was a class of trajectory called a free return, and we had thought it just didn't make sense to use anything else but a free return in our targeting. You understand—I think you understood what a free return was.

RUSNAK: Yes. Why don't you go ahead and explain it, though, for the tape.

FRANK: It was a kind of trajectory that when you left the Earth orbit, it would rendezvous with the Moon, [circumnavigate] the Moon… (then the Moon's gravity would, of course,

make that happen) and send it back toward the Earth. It would come back to the Earth and kind of enter the Earth's atmosphere at such an angle that the thing would be captured by the Earth's atmosphere without any further maneuvering. So the Saturn cutoff would send you a trajectory that did that.

Unfortunately, it was so sensitive to [small initial velocity errors] that there was no way you could ever really guarantee you were going to achieve that, because just fractions of a second, of a foot per second of the Saturn cutoff made big differences. But still it was an appropriate way to target. You try to hit that. The reason you could live with that is because you made adjustments or mid-course corrections out on the way to the Moon.

Of course, the purpose of all that was if the main propulsion system of the spacecraft didn't work and you were on this trajectory to the Moon and it didn't work, you had to have some way to get the crew back, and by targeting that way, you could use the small attitude control thrusters to make these fine adjustments to the trajectory, but then you brought it back to the free-return trajectory.

Eventually you're going to use that main engine to break into lunar orbit, and that changes everything, but at least then you know [after using it that] the engine works, because up until that time you hadn't used it at all, you don't know whether [it will work].

So targeting free-return trajectories was something that we introduced into the program and set that criteria with the Marshall Space Flight Center as how we were going to do that. We would give them the targeting conditions that we wanted to achieve, and then they built the system to get the Saturn to do that.

Developing that program, we kind of hedged our bets, because there was two basic ways to go at it, two different approaches to doing this targeting. We spent a lot of time on both systems before we finally got down to where we could discard one and pick one to work with. It was really gratifying on the Apollo 8 mission to see that really work. That was the first time we had ever done it, and everything just clicked off the way it was supposed to.

The mid-course correction techniques that were used all worked fine. Of course, you were sure it was going to before you went on the mission anyway, but it's still not done until you do it.

RUSNAK: A couple of people we've talked to have mentioned some discussions of sending a Gemini capsule around the Moon in this fashion. Did you have any role on that?

FRANK: I wasn't aware anybody was working that, actually. It never got in my area of digging around. I can imagine that we were doing that. There was such a big effort on beating the Russians to it, and, of course, that was the primary reason for the Apollo 8 mission, the way it was, is to get some guys out there and back before the Russians did.

I have talked to some of the Russians since the program has been all over, and it turns out they didn't really have a chance. They were really far behind. But, of course, we didn't know that, and there was a lot of emphasis on it. It worked out that it was really a great concept, because George [M.] Low was a NASA manager whose idea it was to do that. He was another guy that was just an awesome person to work for. NASA had an awful lot of people at that time that were like that. You just really looked up to them as being innovative and imaginative and having enough nerve to take risks, but to also fully understand the risks and know what they were doing and proceed on and get the job done, and George Low was one of those kind of guys.

Let's see. We built the programs, tested them on the computers as much as we could, and then worked with the other organizations to get them installed into the Mission Control Center. I guess it was 1965 or '66 when I was asked to work as a flight director. I was the head of the Mission Analysis Branch at that time and had the responsibility for the Guided Section, the Reentry Section, and the Lunar Trajectory Section. So I jumped at a chance to

do that. I thought that was really great. I had applied to be an astronaut and was not selected for that, so I thought this was at least the second-best job at the center.

That was a whole other direction from this sitting at a desk and doing the analysis and going over and standing around the computer room and watching the trajectory data roll off and trying to analyze that. Then moving into the Mission Control Center, you didn't discard everything you knew, but it didn't do you a whole lot of good in the job you're going into.

But I think when I was selected to work as a flight director, a fellow named Milt [Milton L.] Windler and a fellow named Gerry [Gerald D.] Griffin were also selected. So the three of us started out as freshmen flight directors at the same time. I think part of the reason we were selected is we all three had been military flyers, and I think Kraft felt that had some bearing on doing that job.

But you started out in a whole new organization. Now, I'm not a branch chief anymore, I'm just a flunky flight director over here taking directions from Gene [Eugene F.] Kranz and Glynn [S.] Lunney and Cliff [Clifford] Charlesworth, who had been flight directors on Gemini.

It was a big learning curve, with a lot of time studying books on the spacecraft systems, understanding the details of that. It was a real eye-opener working for Kranz, his personality [was] totally different from mine. I'm really pretty casual and not exactly laid back, but don't get real excited about things and not very intense in dealing with things. Gene is a very intense person. I don't know how well you know him, but you've probably been around him, and you get that message real quick.

I had a little bit of misgivings about coming. When Dr. [Sigurd A.] Sjoberg, he came in my office and asked me one day to ask me to be a flight director, and I told him you know, "I'd probably be really happy to do it, let me think about it, think about it overnight." My thoughts were, can I really put up with Kranz? I had been around him quite a bit and had seen his role as a flight director over there on Gemini and had not really worked with him,

but had seen him and knew his reputation, and I wasn't sure that was going to work out very well, but it was worth a try. And it did, it worked out great, actually. I [have] a lot of respect and admiration for him, and once you get beyond this outward facade that he has, it's not really a facade, he's truly what he says he is, but he's also a really kind, decent person behind all that. He's not just a martinet that he runs by, you wind him up and he does things. He's a real human being.

So that worked really well, and I learned an awful lot from Gene. For quite a while I kind of thought it was going to be jump right in and start doing things, and unfortunately, it wasn't. I spent an awful lot of time working with the various individual flight controllers learning their job and what their problems were, and where the strengths and weaknesses were in their people, and just really had to work my way into being knowledgeable enough to get to sit on that console and make things work out.

There are some kind of funny things that went on. Right after I got assigned there, they were flying one of the Gemini missions, they gave me a headset and told me to go sit in the room over here and plug into the com [communications] loops and listen to what was going on and how they were working back and forth. I plugged in, but I didn't know how to work the console. I pushed one of the buttons and it started flashing and I thought, god, what have I done? [Laughter] I'd punch it again and it kept flashing. I didn't know the fundamentals of how to do that. So somebody helped me out of that okay.

After quite a few weeks and even months, probably, of watching simulations go on, see how that worked, Glynn told me one morning he says, “Look, I've got a simulation to run over here, launch abort simulations, and I've got to a meeting over in Building Two. Go take that over. Take that for me.” Uh-oh, this is not good. But I wasn't about to turn it down, you know. You just don't do that.

I went over there and he says, "There's nothing to it. The guys know all what they're doing. You just respond to their calls. These are launch aborts. They're going to get going. They'll tell you where they are, different places." I knew all the general stuff anyway.

And it was a real baptism, because I really didn't know how to do it. I thought I did from watching them, but until you sit in that chair and you've got to start interacting, rather than just watching the interaction, it just really was a horrible day, but I got through it, and I told Lunney—I didn't tell him right away for a long time and we never really said anything about it, just did it—what terrible trick he played on me doing that. He says, "Yeah, you know," he says, "I thought about it, really I shouldn't have done it." [Laughter]

Because I felt like an idiot and looked like an idiot. Here's these guys that someday you're suppose to be down there running this thing telling them what to do. Here they're seeing you do this and you don't know what you're doing. But by the time I sat down to the console during a mission, it was all worked out and I'd done a lot.

I was surprised at how realistic the simulations were. NASA Flight Operations had come up with really a great way to train the people. These very realistic simulations, you run them in real time, and they were very strictly interpreted to keep it as realistic as possible. You didn't stop in the middle of something and discuss whether you should have done it that way or not; you just went ahead and did it. If you screwed it up, you screwed it up, and the whole thing showed it, and you had to all admit what you had done wrong.

But the data that was presented to the flight controllers is a realistic simulation of what they'll see during a mission. The numbers behave the same way. You put a system failure into the spacecraft and it shows up as those kind of numbers, changed in the right way. So you really learned from the simulations. If you do enough of those simulations along with your studying and background data, you're really prepared for the flights. I think it's shown over the years how often things would happen in a spacecraft, and the flight controllers and the crew just always seem to do the right thing. I hope they keep doing it.

They respond to the problems that come up in a way that maximizes the crew safety and also maximizes the return for the mission. You're getting the most results out of the mission that you possibly can. Once we started flying Apollo, it was like nothing I'd ever been involved in before…. That was truly, those months and few years that we were doing that, was the most dynamic, most interesting, and exciting thing I could possibly do. I don't see how you could have been any better than that, unless you had been in the crew and flying.

But we got to work a lot of missions. The crew would fly a mission and then go away for a long time and come back and fly another mission. We were there mission after mission. Of course, it never got boring, but it never got to be a burden either. The training that you would do would get very intense before a flight and you'd spend a lot of these days and evenings training, practicing different phases of the work until you got it down where it all just seemed to come together right at the right time. It was scheduled out, worked very well with the amount of exercises you had to go through.

There was very little individual rivalries. It was very much a cooperative period. You didn't really see anybody trying to get ahead in the organization. They were always helping each other and making sure that you were doing what was absolutely best for the program and best for the crew. There was just that feeling of the crews' lives rested in your hands and there's no way you could compromise that by trying to get yourself a little more promotion or a little more recognition out of things. People were—at least the ones that were working in mission control anyway, which is really the only ones I had a whole lot of knowledge of, were very oriented toward getting the job done safely and with as much success as you possibly could.

There were a lot of close calls, but [we] were always able to work through them. You'd be in the middle of one of those situations and you'd just [say], “God, why am I here?”

[Laughter] But after it was all over, you felt so great about having worked through it, you really wouldn't do anything else.

I was trying to think about individuals there. Going into flight control opened up a whole new world of characters. There were a lot of people that were flight controllers that were really individualists and had some interesting ways of getting things done or not getting things done. I think some of the more interesting ones I didn't really get that close to because they were out on the remote sites.

Kranz talks a lot about his remote-site capcoms and remote-site systems engineers. A lot of those folks were young guys who were given a small group of people and a mission to go out to a place like Canberra [Australia] and Africa and Guaymas, Mexico, and ships, and setup a little operation there that was supporting the work in the Earth orbit missions. So it fostered an awful lot of initiative and just do things the way you want to do, and it attracted some guys who were really interesting individuals, who were very successful at doing that.

One of the most interesting ones that I did spend a lot of time with was John [S.] Llewellyn [Jr.]. Everybody knows about John because he's so visible. There's probably books that could be written about some of his antics, some good, some not so good. But he was somebody that was really part of the program, did a lot of things that people talk about. He was the subject of a lot of conversations.

RUSNAK: We've had him in that very chair.

FRANK: Good. Then you know all about him. Because what you see is, that's him. He has mellowed a lot, believe me. [Laughter] I don't know when you talked to him, but he's—I guess maybe “matured” is the right word, a little bit better.

There were a lot of celebrations after the missions. There was nearly always an informal one right after a landing, whether it was morning or night. You'd meet somewhere

and relax a little bit, kick back. We got a habit of having these what we called debriefing sessions usually at places down in Dickinson. The Hofbrau was one of the favorite places. The Singing Wheel was another one over here on—it was on Highway 3. Those were places where the crew and the flight controllers would get together and, well, just really a party. But there was a lot of presentations and speeches made back and forth. Those were a lot of fun and they contributed a lot to the camaraderie and the association with it.

My impression of the Mercury Program, the crew and the flight controllers were very much separated. There was very little interaction between them. They didn't really get to know each other very well. That all started evolving, getting better, a more closer relationship, through the Gemini Program. But then Apollo, it really got very, very close there and has evolved even more. Once we got into the Shuttle, there was even more of an interaction and working than it had been before. But Apollo really started that with these debriefing sessions.

RUSNAK: Maybe you can tell us something about how things were for you once you actually got to sit on console for a mission, starting with Apollo 9, I think, was your first.

FRANK: That was the first flight I was actually a flight director on. It was a relatively simple mission for me, and that's the way you do it. First times on the console you're given the night shift when the crew's sleeping and things are not happening very much. But there's always things to be doing, getting prepared for the next day and reviewing and assimilating what happened the previous day. There's a lot of things going on.

But my first shift, the first time I came on, there was a big sign on the console from somebody and it said, “Welcome to flight control.” Then, you know, it was a little bit of a small ceremony there before we got started into things.

But after all the simulations, it was not so different. I felt reasonably comfortable with it after a little while. I mean, the first time I plugged in and got hold of the room and got things started, I was probably a little uptight about that, but before the shift was over, I was feeling pretty comfortable with what was going on. I don't recall anything particularly trying or troublesome on that mission for me.

Now, there was problems there. Rusty [Russell L.] Schweickart got real sick and was practically useless during the mission, and that caused some difficulties, but the main activities of the mission went on pretty well as planned. So it was a pretty easy inauguration into the thing.

The Apollo 10 thing was a lunar rendezvous mission. Did a rendezvous in lunar orbit. There I had the reentry portion of that part of the flight, so that was a big deal. We were really working. The entry trajectory had an entry corridor, we call it, that you had to be within to successfully return, so we were very careful about keeping the trajectory pointed into that corridor. Of course, that wasn't the first time we'd done that; Apollo 8 had been the very first one. That was exciting to be working on the console during that part of the flight.

Again, I really don't remember any particularly difficulties with that. I did not work Apollo 11. Then [I worked] Apollo 12.

RUSNAK: Apollo 10, and, I guess, Apollo 8, a little bit earlier, one of the things it's credited for is helping refine our understanding of these lunar mass concentrations and how that affects gravity.

FRANK: Yes.

RUSNAK: Is that something you had a particular interest in, given your background in mission planning?

FRANK: Yes. Most of our simulations, early on especially, assumed the [Moon's weight was a] point mass, like it was a homogenous sphere. There had been some indications early that that wasn't the case, but nobody knew the magnitude or the exact characteristics of it. So, yes, Apollo 10 spent a quite a bit of time trying to map that just by very carefully tracking the spacecraft, because you'd track it carefully anyway, but what with especially one of seeing what kind of perturbations were happening when, and the magnitude of them and what the directions were, and gathering data that would let you back out from that data influences of what the lunar gravity distribution, mass distribution was like. So that was a big contribution to that.

We had factored that into the way we computed orbits, computed the trajectories from that point on. Every lunar mission after that added a little bit of refinement to that sort of thing. Apollo 10 didn't get you the total story. So you're right, that was one part of that. That's one of the things that I hadn't really remembered.

Apollo 12 with [Charles "Pete"] Conrad [Jr.] and Alan [L.] Bean on the Moon was an interesting flight. Conrad was a real character, and a very bright, very capable person, who just was as casual as you could be. I mean, he was a really fun person to be around, because he's always looking for something to keep it relaxed and keep things on a steady keel. He was really fun to work with, too. But at the same time you had the utmost respect for his ability, because he knew what he was doing and he could do it well.

Apollo 13 was—of course, everybody knows about that, and that was a magnificent effort on that one. I was not working Apollo 13. We were rotating jobs and I [was given] the lead, the primary job for Apollo 14, so I was not working Apollo 13. Of course, once the problem developed, everybody was working Apollo 13 one way or another. We were working off-line with our crew, our team.

Apollo 14, I was the primary flight director on that one, and had the launch phase and a good bit of the lunar surface activities. We did have some problems. Apollo 14, I guess, was the first time I really had a problem that could have been very critical occur, and that was when we were trying to dock-up with the lunar module. Like all those problems, you're never expecting those, something to happen, you've got a very routine operation going on at the dock, and it didn't capture. "Well, let's back off and do it again." It didn't capture. "Uh-oh. This is—wait a minute now."

We're headed for the Moon, the lunar module is stuck in the Saturn third stage, and we've got to get that thing out of there. It was interesting how quickly the support forces came together and started working at that problem. We were trying to resolve it. Before I could even turn around, we had a model, had a version of the docking system in the control center. They brought it in and we were looking at all the things as the back-room experts were explaining and talking to us about what the various detail features of that system were and why possibly it wasn't working.

As I recall, unless I'm mistaken about this, the final solution, we just hit it harder. There's just not much anybody can do to try to resolve any system problems with that docking latch and probe system. Although Shepard was talking about putting on pressure suits, depressurizing the command module, and then getting the probe out, and trying to work with it. Nobody on the ground wanted to do that, although we had to talk about it. But then it worked, clicked it in.

The other thing that occurred that was worrisome was an abort light that showed up on the lunar module. That's something that I had a very different recollection of how that actually evolved, and after going over the notes and things that Kranz had, I saw that my thoughts on that way back, now current thoughts looking back, were different from the real facts.

I had thought that we were working that problem on the way to the Moon to the extent that we got the software to work around to bypass the switch on the way to the Moon, but we hadn't. …That was done after we got into lunar orbit, at MIT, a young man [came] up with reprogramming the computer to bypass that switch.

That was a good example of how NASA had setup this network of resources to support the mission control, and it worked really great. The thought of reprogramming that computer in-flight was just something people would never [do], you know, touch that computer [program after launch]. You check it out, you debug it and you debug it and you debug it, and once you get it to where you're sure everything in there is working right, you don't get in there again. But this was the only thing you could do, so, okay, let's do it. That saved that landing mission.

RUSNAK: For 14 you said you were the lead flight director. Can you explain what additional responsibilities that is over just being the regular flight director?

FRANK: Normally you have at least three flight directors on a mission, and they take responsibility for different active phases in the lunar missions; that was true. Like launch phase is one, and the guy that does launch phase is usually the lead flight director. He's there for the countdown. In fact, that was always the case. Lead flight director handled the launch phase. But you divide other phases like the lunar surface activities, the lunar rendezvous, breaking into lunar orbit, get those distributed across the three flight directors, so that nobody had responsibility for all of that work.

The lead flight director was overall responsible for the coordination and work in that. He developed the shift schedules, …set the training plan, made the assignments on the mission, and [was] the primary interaction with the flight crew. …[He was] responsible for getting all of that coordinated and pulled together as a package for the mission. The other

flight directors had their phase responsibilities, but for pulling the whole thing together that was the lead flight director. We rotated that job around.

We started toward [the] end of that Apollo Program of bringing on some more flight directors, because we could see (we began to get a good understanding of) what the Skylab Program was going to be like. It was clear there that…[with] Skylab itself… going to fly for eight or nine months, …it just didn't make sense to have three flight directors continually on console for eight or nine months. Also, guys were moving on. Lunney and Charlesworth moved on to other jobs. Kranz, of course, didn't work the consoles anymore. He began to more interact with the higher-level management.

So we did start working and training five new flight directors, and they came in and sat in on part of quiet shifts on the Apollo missions. So there was these other fellows working in on that. I think every one of those people—I started to say they were all ex-flight controllers. When I came in, I was not a flight controller, and neither was Milt Windler. That was the last time that happened. Phil [Philip C.] Shaffer was a mission analysis guy, he was not a flight controller, and he became one of the flight directors.

On Skylab, by that time I was the head of the Flight Director Office. When the Skylab was getting started, then I became the division chief, Flight Control Division Chief, and also ran the Flight Director Offices as a part of that. The flight directors on Skylab were a whole new crew [except for] Milt Windler [who] stayed as a flight director for Skylab. He was the only senior guy…[serving as a flight director on Skylab].

[Skylab] had a whole different character. The mission characteristics were so different, it became one of endurance and keeping the teams up and interested in the job. We had five teams because of that, so we could rotate them off the mission completely for periods of time, and then bring them back in after some period of rest.

The trajectory wasn't a problem anymore; it was [simply] into orbit and circle the Earth forever [or so it seemed]. So all of the emphasis on work and activity was on what

goes on in the Skylab, and it was science oriented. You had a lot of system maintenance and spacecraft maintenance to do and upkeep, system servicing and things of that sort, but the real mission accomplishments were all scientific, where Apollo, it had a certain amount of science to it, but it was mostly just to do things. Do this, get to the Moon, explore it and all that.

It became a big change in the view in how things were done in the control center. Your characteristics of the mission, problems, were quite a bit different. You still had a fundamental concern about crew safety and this hostile environment, but now you were only a few hours away from entry to Earth instead of days, so that changed a lot of thinking about what the team focus was and how it concentrated their efforts in getting work done.

RUSNAK: How much of this had you anticipated before actually starting the program? Obviously you have to set up a rotation, that kind of thing, but in terms of really the effect on controller moral and interest, these kinds of things?

FRANK: Well, actually we had thought quite a bit about it. There was enough thought being given during the latter phases of Apollo, people were set aside to study the Skylab Program from Flight Control Division, to look into it and get prepared for it. The concept of dividing the efforts we came up with, there was a lot of discussion about how to do that. We came up with this idea of there's a planning team, an execution team, and a "what happen[ed]" team that does this.

We first started thinking, well, you plan, you execute, and you look at what the results were. Then you plan, execute, and look at what the results were, like that kind of a sequence. But in planning, the team could come up with something that the execute guys would have a real problem with, there was no time to work that out. They were given a plan here, and they

were expected to execute it. This was long before missions started, we looked at that. Part of the people were saying, "Well, that's tough. That's what you've got to do."

Then we thought, "Why do we have to do that? Let's plan for a day ahead." This team is not planning for that day's activities; they're planning it for the [one] day ahead. Now you've got this time here where people have a chance to look through it and modify it, and fine-tune it, and you got a lot better chance [for it] to work…. There was a lot of resistance to that. That doesn't make sense, you know, you plan, you execute, and you review it. But we ended up putting this time period in there, and it worked out really well.

What we were really surprised at was how disjointed the scientific community was. There [were] four or five disciplines all competing for time on the spacecraft, and we weren't too clever about anticipating the problems that that would cause. This guy's success meant absolutely nothing to this guy over here. In fact, he resented letting this guy have [use of] the crew's time. They were very self-oriented. It was not a teamwork at all. We were not prepared for managing that kind of a thing, and yet we were supposed to. …Being the flight controllers, it was our job to manage all that. We were totally surprised and really were inadequately prepared when we first started simulating and would introduce problems so that today's work didn't get really done the way it was supposed to. [The experimenters would] only [get] half the amount of [crew] time available.

The… arguments that would erupt back in the science planning room about how to [allocate the time when problems interrupted experiments], and we didn't feel qualified to tell these guys what was the most important. So we were really at a loss as to how to handle that. NASA management hadn't anticipated that either, I don't think, because they had us set up like that. It was taken care of by forming a science management team. You had a guru in charge of all of them, and that job was rotated, so that for a while one discipline had the overall responsibility, and they learned to cooperate. …[The science competition] came as a big surprise to [the Flight Directors].

The earlier simulations [did not] involve the scientists—for a good while we didn't do that. We didn't simulate with the scientists, we were just so concerned with operating the spacecraft and making it work properly that we didn't bring the science people in until we had gotten our job pretty well understood. So it came kind of late in the pre-mission preparation that this problem showed up.

So that was a lot of emphasis shifted to an off-line management interaction kind of a task. There was high-level management teams that met daily to review the results of this process. They reviewed the planning that had been done, so that it didn't come down to a bunch of flight controllers deciding what [science] needs to be done…. The mission science planning people laid out priorities and specifics of what they needed to have done, and the [Flight Control team] planners then tried to work that into a meaningful schedule, and then [the scientists] had a chance to review it and criticize it and to work it back and forth. [The Skylab mission] was a big coordination job….

Of course, it started off with a really interesting problem when the meteorite shield came loose and the wing didn't deploy, one of the wings didn't deploy. That was a lot of effort early on to try to get that problem solved. Again, they had Conrad, Pete Conrad, was in charge of the crew of the first mission, and that was a really good deal. They took some very difficult tasks and worked them out and got things going.

Along in there, I'm not sure exactly when, we started getting indications of this Apollo-Soyuz [Test Project, ASTP] mission showing up. Lunney [was by now the Apollo Program Manager] in charge of that…. [A joint mission was agreed to by the US and USSR]. I… got pulled off of doing much with the Skylab after that, and I took over the primary flight director responsibility for the Apollo-Soyuz mission. I still had the division chief job of Flight Control Division and [ran the] Flight Director [Office], so I still got involved to some extent, but primarily the five flight directors who were working Skylab… took… thing over. I didn't get much involved with the day-to-day operations, although Gene and I traded off

times sitting in the control center to help, not as a flight director role, but as a intermediary between the flight directors and the [senior] management….

That was very interesting. I really enjoyed that Apollo-Soyuz mission. It was a real opportunity, I thought, to learn about the Russians and how they did things, not only their space operations, but just the culture as well.

RUSNAK: Tell us about working with the Russians during this time period where we're still in the Cold War, and the race to the Moon, I guess, has just been ended, even though, as you pointed out, from their end they really didn't have much of a chance there.

FRANK: We were all really unsure about how to handle ourselves with the Russians, but we determined… we were going to be as open and congenial and friendly as we could. My first interaction with them was when they came to Houston. There had been one meeting in Moscow where NASA people went over there, but there weren't any flight controller or flight operations people involved in that. But Lunney, being an ex-flight director and in charge of the program office at the time and leading that effort, recognized right off he needed to get some flight ops people involved right away.

So when they came to Houston, that first joint meeting here, we had a proposal for the Russians of a separate working group just for flight operations, and they were totally unprepared for it. They didn't have anybody in their operations organization here, but they assigned some guys to go meet with us, and they were at a real loss for being able to contribute anything. All they could do was take some notes. We had presentations for them, [we told] them what all we thought the ops involvement ought to be. It was pretty frustrating [since couldn’t understand operations issues].

RUSNAK: Actually, this might be good time for us to stop out and change out our tapes and give your voice a rest for a minute. [Tape change]

FRANK: Okay. Working with the Russians turned out to be really frustrating. We had prepared a lot of presentation material and we had an agenda of things that we wanted to cover and get started working on. We essentially didn't get any of that done. I'm not sure how long they were here, but several days, a week or two, and about all we got done was figure out what a big job we had ahead of us just communicating.

But at least we got our point across to them that they had to have some operations people involved with this. It couldn't just be spacecraft designers, and that [operations planning] was going to be a big part of the work. So they were prepared when we went to… the next meeting in Moscow. That was [an] eye-opener again… how crude things were there. The place reminded me of pictures that you'd seen of downtown cities in this country back in the thirties. It just looked old-fashioned and people kind of dressed that way. The telephone system was unreliable. Their ability to do things like make copies of pages, make viewing material for presentations, they just didn't have any of that.

We flight operations people didn't do this, but the program took all this equipment over there with them, copiers and things to do the office work, because some of them had been there before and they knew… that kind of thing was just not available. It was very slow and inefficient, getting things like that done. They relied on us to do the copying for them and to provide them support, administrative kind of support, do all that kind of thing.

Our first impression here was, boy, these guys are really inept, you know, they're not capable of things. What you found out was they were really clever, and in spite of all these handicaps they had, they got the job done. They were very good about doing mission control. They had a grossly different approach to it, and [in] basic things like mathematics and engineering principles… they were as good as anybody in the world. It's just that the

mechanics and details of doing things, they didn't have that kind of infrastructure to help them. But they knew all about these trajectory problems and obviously they'd been flying spacecraft. It wasn't luck. They knew what they were doing, they were just doing it a different way than we did.

The primary difference in the approach was that they didn't plan their missions to very great detail. They would just kind of let things—they… had general plans [of] things that they were going to do, but if something would go wrong [or if] they couldn't complete a step, they might just quit the mission, if they couldn't come up with something in real time to work around it. They didn't spend [much] effort [in contingency analysis]. In Apollo, we probably spent ten times the amount of effort on off-nominal contingency kind of analyses that we did on nominal mission analyses, and they spent very little. So there's a tremendous difference in the amount of effort and work going into preparing for a flight that we did compared to what they did.

We really had to drag them along to get them to do all these things. [Their approach was], "Well, why do all that? If the mission doesn't work out, we'll end it and we'll send another one up." I had a feeling they had a factory turning out these Soyuz spacecraft just one right after another, and if one of them had to cut its mission short, well, we'll catch that next time. That kind of approach. They finally realized that we don't have that. We've got one Apollo we can send and that's it. If we don't do this mission right, then it's a failure, period. They began to feel the pressure from that. They sure as hell didn't want to fail with a joint mission with the U.S. So they began to get the picture [clearly]. [This was a public relations program and you better be successful].

[When we got to Moscow, the Russians were ready with a general plan for the flight]. …They said, "…We want to launch first, and then you… rendezvous with us." It turned out they didn't enough fuel to do a rendezvous to Apollo on the trajectory that we would launch from. So there was really no choice; they had to launch first. But it was also good in that if

they had a problem, they quit that mission before we launched and they'd send up another one. So that contributed to helping them. They didn't have one shot at this thing… If they didn't get up there and become a good viable target, we'd just sit here and let them try to send another one.

[The Russians did not normally] do much training jointly between the crew and the flight controllers. In fact, they did very little. They didn't have anything that let them do integrated simulations where their crew is in a simulator and the flight controllers being in the control center and work with common data. They had no capabilities to do that. A lot of [the] operational [preparation] approach [such as integrated simulations we insisted on], you know, just forced them to do these kind of things, because that was the only way that we were going to operate. I think they were pretty reluctant to go along with it, but in the end they did, and we were all a lot better off for it.

We did joint integrated simulations…[with the Russians] in Moscow and we were here and the crew was in the simulator…. We didn't do very many of those, because it was really hard to keep that operating, but we did some of that just to make sure all of the communications were really going to work.

RUSNAK: In working on issues like this, how restrictive did you find the language barrier, working through translators and such?

FRANK: That was a big problem also. We worked with interpreters all the time. Some of the Russians could speak a little English and, of course, none of us could speak Russian, so we had interpreters that worked with us on any joint meetings. They became a very key part in the planning, because they could really get you messed up if they didn't understand, [if] the interpreters didn't understand, and were explaining the wrong thing to the other side. There was no way to check that until you tried to do something and it didn't come together and that

was because there was some misunderstanding. I mean, we couldn't tell if they were telling the right thing, and the Russians couldn't tell if they were telling them what we told them to tell them. It was a big learning curve on how to work in that environment.

Occasionally you'd get in some disagreement over a particular subject and find that this disagreement was really pretty basic, pretty fundamental, and you couldn't understand how in the world they could want to do what they apparently wanted to do, it just didn't make sense, but they were insisting on doing that. Finally, it came out that that wasn't what they were wanting to do at all. It was being misunderstood and they really didn't disagree on what we wanted to do, it's just that we were telling each other the wrong thing. So anytime there would seem to be something fundamentally wrong, we'd say, "Oh, wait a minute. We've got to translate, work on this translation because something is not right here."

But early on, you didn't know them that well to throw that out, you know. Maybe they did want to do this thing that just didn't make sense, and so you had to explore it and find out why they wanted to do it. So that was a learning thing that we went through and it got a lot better working with interpreters after a while, but it always slowed things down. Saying something in Russian seemed to always take twice as long as in English. I don't know if it's because we just have so much jargon and slang that we would substitute a word for maybe two or three sentences sometimes, and they didn't do that, apparently, very widely. So just a simple word like "de-orbit" in Russian might come out to be a phrase like saying "the maneuver that takes the spacecraft out of orbit." So every time you came to that, instead of saying "de-orbit," they would say "the maneuver that takes the spacecraft out of orbit." There must have been thousands of examples like that. It'd get to be funny. Even the Russians would laugh at it, too. It'd be a couple of sentences in English, and then the interpreter would talk for five minutes in Russian. I think that's the biggest thing relative to the technical aspect of it.

[The] flight plans that the [Russian] crew [normally] carried were very general. We had very detailed flight plans, and we ended up using very detailed flight plans on the [ASTP] mission just because we insisted on doing these things and they would end up going along with it.

Other than the technical work, just meeting the people and getting immersed in their society, their social system over there, that was really an education also. They really, really have a different view of things, and having grown up or evolved for centuries in this non-freedom kind of environment, they're very secretive and very reluctant to talk about anything that's the least bit away from the party line in any way. Very reluctant to express personal opinions about things.

It was kind of hard to get one of them to sign a report sometimes, because they didn't really like to get their name on something, because that goes into the files and maybe someday if there's something really bad that happened relative to that, then their name is on it and they get purged. This is speculation; nobody told me that. But it was an explanation, my explanation of why things were like that. Very much not wanting to stand out, just kind of hold back and be part of the group as opposed to being out in front of the group, leading something.

There was one thing in particular that really exemplified the secretiveness of the place. On weekends we would have some kind of social activity, we'd go somewhere out from the city or do something [in Moscow as a group]. One weekend we went on a bus trip to a place outside of town, and going out of town, we went through parts of [Moscow] we'd never been in as part of our work there. We're driving out this big wide road and we passed a complex where they had about a twelve- or fifteen-foot brick wall with barbed wire around it, and at every entrance there were two or three guys with machine guns on their shoulder keeping guard of it. We just all looked at that and wondered what that was. Nobody said anything about it, we didn't want to call attention to it, and they didn't say a word. There

were a lot of Russians on the bus, people that were working with us, the secretaries and engineers and some of the managers. We went on and spent the weekend….

Later on in the week [back in Moscow], they were going to take us to their Mission Control Center, which was in Moscow…. We drove up to [that high-walled, heavily-guarded compound we had passed on the bus the previous Saturday morning]…. It's a big complex, maybe as big as the NASA grounds in the city of Moscow. We went to a building and there's the Mission Control Center. We had passed it three days before and nobody said a word that "That's our Mission Control Center." I wouldn't be surprised if some of the secretaries didn't even know it was the Mission Control Center. It's just the kind of thing that nobody talked [about]. I couldn't believe it when we drove up to that place and this is the Mission Control Center. …We were just here three days [before].

The counterpart, my working group co-chairman, a Russian named [Vladimir A.] Timchenko was, it turned out—I don't remember how [I found out]—I think one of the interpreters told me… he was a colonel in the Russian Army. He never wore his uniform; he was always in civilian clothes. But we socialized quite a bit, and he was really a nice guy, friendly, and very good, conscientious, hard-working guy. You could really count on him working to get things done and get it done right.

We would, on several occasions, go out to dinner or go to something as a group with three or four of us at a time. After… about the second, maybe the third trip that I'd been to Moscow, …we were walking back from some social function through Moscow, and it was at night, probably ten or eleven o'clock at night and there was four or five of us. There's always interpreters with us, and [the Russian group leader] and I were walking side by side, and [the] other [members of our group] were [several steps] ahead of us…. He kind of held me back just a little bit, so I stayed with him. He says, "See, Pete, we're free. We can walk on the streets without anybody bothering us, without any guards." And to him that was a big deal. He knew what we thought about their system, and he was trying to defend it and show me

that they really did have freedom. They could walk on the streets at night without having to worry about guards and stuff. I just felt sorry for him [because] that to him was something he was proud of, that they had that much freedom.

RUSNAK: How did they take to their visits to the United States?

FRANK: Well, a couple of different types of reactions. Some of them just thought it was wonderful, just had a ball. Others kind of resented the facilities and things that we had, the luxuries that we had. I think they felt like we were kind of showing off and trying to put them down. I know a lot of us invited them into our homes and we had dinners and parties at the house with them…. I think they just were intimidated by a lowly engineer living in a two-story home with a big yard and two cars in the garage. I think they kind of felt like we were showing off to them, and some of them did. I think [some of our] people… were doing that, kind of showing off, wanting them to see how great we had it over here, and that was misguided. But I don't think they were trying to make them feel bad, they were kind of proud of what we had, and so it came across as being pushy to some of them. Others, it didn't seem to make any difference at all.

Before they went back, they wanted to go to a store and spend whatever money they could to take things back with them. It was interesting, the kind of things they would get. It would be the most routine things, like windshield wipers for their car. I noticed that all the cars in Moscow didn't have the blades on the windshield wipers. People would take them off and lock them in their car, because it would get stolen. Basic little hardware things they would buy and take back, as opposed to souvenirs and stuff like that. But they loved to go to the big discount stores, just to walk around and [look].

RUSNAK: You mentioned how the Russians were secretive about the things that they did on their end. Were there security concerns from the United States in terms of what technology or information you could share with the Russians?

FRANK: I don't really think there was. There were people who believed that, but I don't really think so. Some people thought we were giving away our operations techniques and how we did things that would help so that it would improve the way they worked. I don't really think that was the case. I think they liked the way they did it. And probably after ASTP, were right back to doing it the way they always had.

I have not been close at all with the Space Station working with the Russians, but I do know that they have not changed their joint simulation activity as much between the crew and the flight controllers. They can do some of that now, but not nearly to the extent that we do. They just don't think it's a big deal.

But as far as engineering and technology, I don't know that we ended up transferring anything to them in that program. It could be in some of the communications things that they got some benefits out of some of that, but I'm really not aware of any of that. I don't think so.

RUSNAK: How did the mission itself go in comparison to the way you had planned for it?

FRANK: It went pretty darn well. It was really going along right on cue, on schedule. They got their first spacecraft off on time and it did the right things. Our launch and rendezvous worked real well. [Thomas P.] Stafford was crew commander, and [Alexei A.] Leonov, the Russian commander, who's a wonderful person, he's really a nice guy and very bright, good humor. I really enjoyed being around him. He's been over here several times since the mission. I was at a couple of things where he was there and he came over and gave me a big hug. He really seemed glad to see people that he'd worked with back then.

But the mission went well. When we opened up the docking module between the two, that module hadn't been opened since I don't know how long before actual launch, so there was a really strange odor in there, and people were wondering what that was. We spent a lot of time to try to hash that out. It just turned out it was outgassing of some of the materials that was in there and it was not harmful or anything, but we had to stop what we were doing and spend some time getting people to analyze what that might be. But that was the only kind of little glitch that I remember.

We had several modes of where the docking system would work several different ways. The crew wanted to try them all out, and the engineers said, "Wait a minute. Let's don't screw around with this. Everything's working great. We've done our job. Let's don't push our luck." But Slayton had practiced docking also. He was the pilot. He really insisted on doing one docking himself, because Stafford had done the one that got the two together. So when it came time to separate, we did separate and he switched to another mode and… [redocked]. Apparently, he got [the alignment] off center, and when they latched up, the Soyuz got swung around…[more than anybody liked] and the Russian crew got really excited about what was going on. [Laughter] But I think other than that, everything just went perfectly on track.

We got live television from the Russians as their crew came down to land. It was on parachutes and we were seeing it live. Just as it got real close to the ground, they fire these rockets to slow it down, but I really wasn't thinking along those lines, and this big cloud of dust and dirt came flying up. I thought, "My God, it's blown up." It turned out it was a normal landing.

From then on, I was involved in Shuttle. I mean, that was what we were doing from then on, developing Shuttle. I still had the Flight Control Division [and the Flight Director Office, but]. I never worked on the console anymore [as] a flight director. But when the

flight director's teams [were very much] involved with [planning] the [operation for the] Approach and Landing Tests [ALT] out at Edwards… [and the] Shuttle orbital flights.

Developing the flight control approach to Shuttle was a pretty big effort for a while. We were kind of fighting a trend that said "This is going to be run like an airline operation. We're going to fly sixty flights a year, and there's not going to be all this ground control support required. We're just going to launch them like airplanes, do our mission and come back and land. We don't need this big… elaborate control center operation."

I was really concerned, because I… felt like that wasn't practical to do. It was unrealistic to think that [operations would be so routine], but yet that was the program objective. It was the ultimate goal. So, you know, if that's the ultimate goal, we're going work toward that. But I said, "Well, look, okay, let's say we get there [that routine some day], We're not going to start off, you're not going to fly the first flight like that. So I've got to have a control center to do this, to support [the initial flight tests]."

They didn't want to spend the money on the control center, but there was no way around it. You could not fly those development flights like an airplane. So we went through the whole big deal. It was a very elaborate, very expensive, very costly control center, and it had a lot of capabilities. We had come along way since the Apollo. What I wanted was to get a control center that had the capability to support Shuttle orbital flights.

I said, "We've got to have it to do the development flights. If we don't need it anymore, we'll phase it out and just power down and won't have all these flight controllers, won't have all these systems going, if it turns out that that's reasonable and practical to do." So that's the way it worked out. It was there and it came in pretty handy a lot of times, and we never really were able to power down that control center. That's too bad, really. I mean, it's unfortunate, because its cost makes it a lot more expensive to fly. It certainly would have been a lot better if we hadn't had to do that, but it was not to be.

RUSNAK: Where did you see your role in the space program going as the Shuttle Program came into the operational phase as it was?

FRANK: Well, there was a couple of ways it could have gone. I felt like [we] could have migrated more and more of [mission control] on board the spacecraft, because we were really getting a lot of capability in the Shuttle vehicle. It could be that the ground [could play] less and less a role, [but] how far that [would go] you couldn't really tell. You could see what possibly might be, like you turn into nothing more than an air traffic controller kind of role with the FAA [Federal Aviation Administration]. I didn't… [think we] could ever get away from that.

The other way was that the crew would have [most] of their activities involved in getting the…[on orbit tasks] done. Well, sort of like Skylab, where they [would be] focused on doing things with the Shuttle, with the systems of the Shuttle, that [we] would [do] more and more of the systems management of the Shuttle itself on the ground…. With the links that we had, the continuous tracking in Earth orbit, you could put the…[shuttle systems management] on the ground and operate it remotely. [Then] the crew…[could concentrate on] doing their thing with whatever science or payload support activity was going on. You could even go so far as to do automatic landings. I mean, that's a system that works. It could be done.

So you got these two possibilities that are totally at odds with each other of how it could evolve. It was a matter of what worked [best], which way the system evolved. Of course, there were strong camps on both [sides] of that. I mean, the crew was not about to accept the fact that you were flying the vehicle mostly from the ground. So it seemed to me that where the flight control was going was not obvious to me, that it could have gone either way…. Something in between, which is kind of what happened.

RUSNAK: You did stay with NASA through a few years of the Space Shuttle Program.

FRANK: Yes.

RUSNAK: Why did you choose to leave when you did?

FRANK: I could see the flight control role getting more routine and not as [much new] development. The budgets were getting cut back. There was very little of this exploration kind of mind-set that was getting funded. There were people working that kind of thing and trying to get support for Mars missions and things of that sort, but the budgets just weren't going to support it. It was getting routine enough that it just wasn't that challenging to me anymore.

I saw an opportunity to get involved in developing—IBM offered me a job to work on their proposal for the Air Force. The Air Force was going to build their own Mission Control Center in Colorado Springs [Colorado], and IBM was bidding on that job, and there was a chance to go and develop that control center for the Air Force. It seemed like something still involved with the Shuttle and space operations, but a totally different kind of responsibility, and really different from what I had been doing, because it was not a flight control job so much as it was an overall control center development, prepare operations concepts, and how the Air Force would actually do their mission, which [would have been] a big challenge for the Air Force…. [After we (IBM) won the contract, the Air Force decided it was too big of a job for them]. They… backed off… [and canceled the contract. I think they made the right decision].

…When the Challenger accident occurred, it was just devastating. I really had mixed emotions. One was, "Thank god I wasn't at the control center when that happened," and the other was, "What am I doing out here? I'm not helping. NASA's really suffering and I'm

sitting over here working for some Air Force program." I really felt left out and kind of lost. But that was the way it was.

So that was my career with NASA, in two hours.

RUSNAK: That's right.

FRANK: You were right, it took two hours. I didn't think it would take that long.

RUSNAK: Like I said, people are often surprised at the things they remember.

FRANK: Yes, you get started talking and you just keep going. There's a tremendous detail that's lost. I just don't remember. But it was just a wonderful experience for me. I'm really happy that I was involved in that, got to be a part of it. Just not many jobs like that around to work on.

RUSNAK: That's certainly true. I did want to give both Tim and Carol a chance to ask some questions.

BUTLER: Is there any point during your career at NASA that you consider your biggest accomplishment or something that you're most proud of being involved with?

FRANK: There are several things that I thought were kind of neat that I got to do, but I think [the most satisfying was] being responsible for [dveloping] the trajectory program that was used to get the guidance [parameters] and to get the spacecraft to the Moon and back. Getting that developed, implemented, and seeing it actually [work]… was more of a personal accomplishment or achievement than any of the others. A lot of the rest of it was a team kind

of [effort]—not that the trajectory development wasn't a team effort. It's just that I was in charge of that branch. It was my job to see which of those two programs, if either one of them we were going to use, because other organizations were building similar kind of programs. They weren't focused exclusively for use in Apollo though. Anyway, the fact that that worked so well, I really felt great about that.

Butler: Thank you.

RUSNAK: I wanted to make sure you had a chance for any last remarks, or other stories that may have come to mind, or any other people you want to say something about or describe for us.

FRANK: There's a lot of people I really admire that I worked for and with. I had a great admiration for Dr. Gilruth, even though I didn't work real closely with him. One of the things that I admired about him was that people that I'd worked with that were so admirable had such a great respect for Dr. Gilruth. Chris Kraft thought he was the next thing to God, I think, and I think Kraft was just an outstanding leader at NASA.

George Low was a great gentleman and a brilliant engineer. A lot of the guys, the contemporaries that I worked with, were really capable and worked hard, Ron Berry and Claude Graves. Al Beck, as funny and casual and loose as he was, was really an asset to NASA. I was really impressed with almost all the flight crews, the astronauts. I think if I had to pick one who I was most impressed with, it would be Conrad.

The place was a remarkable collection of dedicated and capable people, and an unique mission and challenge to do something that doesn't come along very often. I guess that's it.

RUSNAK: It's been a pleasure to hear the stories that you've had to offer and your recollections.

FRANK: It was pretty painless. [Laughter]

RUSNAK: Good. We're glad to make it that way for you.

FRANK: Yes, good.

[End of interview]