NASA JOHNSON SPACE CENTER ORAL HISTORY PROJECT
ORAL HISTORY 2 TRANSCRIPT

JACK FUNK
INTERVIEWED BY JENNIFER ROSS-NAZZAL
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ROSS-NAZZAL: Today is November 5th, 2003. This oral history with Jack Funk is being conducted for the Johnson Space Center Oral History Project in Houston, Texas. Jennifer Ross-Nazzal is the interviewer, and she is assisted by Rebecca Wright.

Thank you again for joining us this afternoon. We really appreciate it. I'd like to begin by asking you about your work with the Space Shuttle Program.

FUNK: Well, the Space Shuttle Program, my work started with reviewing the contract evaluation, which we actually went to New Orleans [Louisiana], but the evaluation was at the Michoud [Assembly Facility] test site for Saturn rockets, actually. The contractors, of course, present a contract and a configuration which is based on all the requirements, which are mostly put down by other people up in [NASA] Headquarters [Washington, D.C.] and things like that, and we review it and try to select the best contractor, although usually it's like a toss-up between two or three of them. But we have to put them in order, and they don't always select what we say is the best one, either one.

Then I went back to the Center and continued work on a few things, but the configuration they presented, right away I saw two items that I didn't like. The first one was that they had air-breathing engines in the payload bay, and they weren't piston engines. They were the jet engines in the payload bay, and they were going to just [put] them out in the air after they came through the entry and got back down into flight status and turn them on to use for landing. You know, it just almost looked to me like they were asking for trouble. They're going to open up the payload bay when they're moving at, say, three or four hundred miles an hour. Well, that's going to destroy the aerodynamics, for one thing.

Two, they're going to get awful loads on those things. You know, you put a door out in the middle of all that, and you're going to get awful loads on it. Then they've got to air-start [the engines], and if they don't start both engines at the same time, they're in deep trouble, because they're going to get drag on one side and thrust on the other, and they probably [can't] recover from that.

So when I was flying one day coming home from [a trip], we landed, and I began to think, "You know, I've been flying a lot, and I can't remember once, except when I was flying to Seattle [Washington], that we ever had to go around." So I went to Bill [Howard W.] Tindall's staff meeting, who was the Operations Director, and told him I thought it was a dumb idea.

He said, "Well, the astronauts want it."

I said, "It's still a dumb idea." I told him the X-15, the first airplane to fly faster than the speed of sound, they always did a dead-stick landing. They didn't have any propulsion when [landing]. I suggested that [Bill Tindall] go out there and talk to those astronauts, show them what they're thinking about doing, and check with them about what they think of the idea and what they think of the idea of landing without propulsion. Well, Tindall didn't go out, [I think it was Robert R.] Gilruth, [but I am not sure of who made the trip]. When he came back, the engines were gone.

So the other item that right off the bat looked really not too good was that they had—[because of] the fire on the pad—[Apollo added] solid rockets, two big solid rockets, on either side of the payload bay above the wing that [were] here in case they had trouble on the pad, they could light those rockets off and pull the engine out and go out and ditch in the water. But the structure necessary to hold those [rockets] looked to me like it was going to be horrendous, and they had no other further use. They were going to light them off after they got up [to] a certain speed because the weight that they were holding, they didn't want to take that all the way to orbit, and they were going to fire them to use the propellant rather than staging.

But that's when I started to figure out what could we do to get rid of those things, and I did some work at my desk with drawings and everything like that about putting [oxygen] and hydrogen inside the Orbiter, just small tanks, enough to fire the main engines. [The main engines] could take it off of [the tanks] once they're started and use them in the places of solids.

I gave a presentation on that to Max [Maxime A.] Faget and his Engineering Division and other people. Max didn't like it because of the hydrogen, and I agreed with him, yes, hydrogen is hard to keep from leaking. So, essentially, it got turned thumbs down.

Now, let's see. How did that go? Then I suggested that they could use—no. When did the OMS [Orbital Maneuvering System] engines come along? Oh, what happened is they decided that the big rockets on the side were reliable enough not to have to back it up with; the probabilities of failure of the system they were talking about abort were probably bigger than the probabilities of the side rockets failing, although we did have one fail during *Challenger*. But that was never noticed, so those other rockets would have never been used anyhow. So that's the way that got solved. We just took them off.

The next thing that happened was that a note [came] across my desk saying that Bill Tindall didn't like taking the hydrogen tank into orbit and then getting rid of it by firing a little rocket on it and putting it down into the ocean somewhere, because he thought that in order to make that maneuver firing it, that you were going to have to put an attitude control system on that. That's something that could pitch it up and hold it while it was firing. That was not only going to be expensive, but it looked to him like a pretty difficult thing to do, and he sent a note over to Mission Planning and Analysis Division that he thought that we ought to look at some way of doing that, of replacing that particular way of doing it.

Well, I went right back to the idea of the abort system and said that if we could use something like that to suborbital stage the tank into the Indian Ocean, and the reason why you pick the Indian Ocean is because a lot of trajectories, this inclination and that inclination, they crossed right there, so that you could put it down there for almost any flight you were going to make. It was a good place—very few boats, very few tankers coming through there. So I started working on that.

Well, Max didn't like the hydrogen, so I said, "Well, let's use the OMS system. Let's increase the tank size and put them down in the wing roots," where there's area in there that you could hide double sets of tanks on both sides to fire the OMS engine. He didn't like that either, but that would have cleaned up the aerodynamics nicely. The thing flies like a brick.

So, well, I made several presentations on that, and they turned thumbs down on that. Then a little note came across my desk, says, "The OMS requirement for the OMS maneuvering onboard," that's what the OMS is, [Orbital] Maneuvering System, "has been reduced from 1,000 feet per second to 750 feet per second in order to save the weight of the propellant." Right now it was already designed to carry 1,000 feet per second with the propellant.

So I shipped back a note to Tindall, told him, "Hey, that 250 feet per second's enough to suborbital stage the tank." Then you use it for going into orbit, see. You stage the tank, you use the 250 feet per second to go into orbit, and that increases the payload a little bit, plus it picks up the payload, carrying that rocket, the 7,500-pound rocket that they're going to use to retrofire it into orbit, and you get rid of the tank weight sooner. That all added up into better performance.

I said, "It doesn't matter right now. Let them go ahead with what they want. If it doesn't work, we can drop back to the staging of the tank." Well, that put the managers in a tough spot. If they go ahead with going into orbit and bringing it back and it didn't work and they had to go put an attitude control system on there, and at the same time the Martin Corporation in Denver [Colorado], who was building the tank, they come in and made a presentation, said, "Yeah, we will save $70 million on tech [technical] design if you suborbital stage it."

So from then on, they changed over to the suborbital staging, and we did a complete analysis of—we wrote a program to do the launches, stage the tank, put in all the possible errors in the launch. We had error statements that the engine would not have exactly the right characteristics. A lot of other things would not have the right characteristics. We had those all, and we put it into a program that made the launches for all these different characteristics and made a table of the performance, made a drawing of the footprint of the possible errors in causing the impact points to be changed.

Of course, at that time I had a few people that didn't have anything else to do. Apollo was doing other things, and they wrote this program. You took it over and you put it in there and pushed a button, out come the report, to show everybody, that was to demonstrate, in terms of simulation, that we could do this. So that was about all I did for Shuttle. [The contract was given to a company.]

Then came the Skylab. It was already up there. [NASA Headquarters in Washington, D.C.] started a project, $20 million, to design an orbiting vehicle that we'd launch into orbit. It would go up there and grab a hold of the Skylab and push it up back higher so it wouldn't come in. Got a note from Gilruth—[it was a verbal request delivered by division chief]. This project was under Huntsville [Marshall Space Flight Center, Alabama], under [Wernher] von Braun and company. [Von Braun started the Skylab Program. I do not know who was Director of the Marshall Space Flight Center at the time it returned to Earth or who came to JSC to present their analysis of the Skylab trajectory.] Got a note from Gilruth, wanted me to take a look at the project and see what I could do, just keep track of what's going on.

I got a little document, a little paperlike memorandum, that Huntsville had published, that said that they couldn't very well simulate the Skylab with their program. They didn't know any way to take the digital computer and figure out what was going on and things like that. They said they didn't think they could predict the impact with any confidence.

So I looked at that and I wondered what I could do with it. I had this report that was written by Dr. Kaplan from Penn[sylvania] State University [University Park, Pennsylvania] about a method of modeling Skylab in a wind tunnel with just three degrees of freedom of pitching to get some idea. He thought they could predict. Well, they did make a prediction of where it would start tumbling, because when it starts tumbling, the drag goes up, comes in much faster. It was already coming in much faster because of their prediction of what the upper atmosphere at those altitudes would be like was a little low, and it just was coming down faster.

I said, "Well, I can take those equations and then just pick up the orbiting [program] and let it produce all the forces for the orbiting program," so that we could track it, and then it would also show all the motions of the Skylab. So, got the aerodynamics, and we had to put 1,400 points into the table and things like that and model this thing and started running it. And every time I'd run it, it would tumble. I was putting in atmospheric data from the ten-centimeter [radiation from the Sun that JSC was] getting from NOAA [National Oceanic and Atmospheric

Administration] on the solar flares and everything else that [I could think of but it] was always tumbling. I looked and looked and looked for an error in that program and couldn't find it.

Well, one day somebody came in and said, "The Air Force says Skylab is tumbling."

I said, "Oh, my program's not wrong after all." So I said, "The thing for me to do now is to go way back and pick up the Skylab data and get an initial set of conditions to start out the program and figure out where the program says it tumbles." Well, getting the initial set of conditions, the attitude—I had the velocity and the orbital position and everything like that, but I did not have the attitude. But they had recording gyros on there, which they were recording the attitude before it tumbled and during tumbling.

So I went back, and what I did, I started running error coefficients on the position and do a least squares fit to the gyros. And when I got the position that gave the least error in the gyros, that's a normal way of fitting data to curves, been there ever since they invented it back a couple centuries ago to do the initial orbits for the satellites. I mean like Mars and those things. Once I got that and put it in and ran it, then it started. It ran along, and after a while it tumbled. I looked at what I was putting in that made it tumble, and that was when a solar flare [which] increased the temperature and densities of the upper atmosphere. It made it tumble at that time.

So I went over and I told Tindall that—I think he was still—it was Tindall or Ronald [L.] Berry, probably Ronald Berry, that I wanted to make a presentation to Gilruth on what I'd found out. [I do not remember who was where. The task of writing the Skylab dynamic model and adding it to an orbit program was very difficult. I know I made a presentation in Washington, D.C. and suggested that they drop the program to put the Skylab in a higher orbit because it was going to come down before they could build the required system to push it to a higher orbit.]

I made a presentation to [Gilruth] and showed him what I'd found out, and then I said, "This idea of going up there and picking it up, getting something that can hold on to it when it's tumbling or even grab it when it quit tumbling, is pretty—well, you don't have real confidence that you can do that. Even when it wasn't tumbling, you don't have real confidence to do that. The other thing is, it's now coming down so fast that I don't think you can get the system ready to go before it comes in. So the thing to do is to cancel that project, bite the bullet, and let it come down." And they all agreed. So I was there when the impact—and then they did all this. That's the trajectory of it coming down, from the tracking data.

So then I was sitting around, practically nothing to do, and I had thirty-six years of service, thirty-six and a half, and I had one year of health leave I'd never used, and that gets tacked on as a year of service. Thirty-seven years. And at forty years, my retirement income will never go up. You get 2 percent a year, so I was looking at about 6 percent. Inflation is running at 7 and a half percent, which retirees were getting, 7 and a half percent increase in their retirement income. But the people on [civil] service, the president could cut that 7 and a half percent down, and it was usually cut down to about 5 percent.

I looked at that and I said, "Well, if I retire in a couple years, I'll be making more money and I will have more income than if I stay here." So I started looking to put out résumés to companies that were aerospace companies.

Well, Sig [Sigurd A.] Sjoberg had retired, and he was Gilruth's assistant for quite some time. He had taken a job with a company called OAO Corporation, which supported McDonnell Douglas [Corporation], which supported NASA. So I sent my résumé to him. I actually didn't have to send my résumé to him. [Laughs]

He called me up as soon he got it and said, "Come on to work."

I said, "Well, I got to give them two weeks' notice. Ron Berry says I have to give them two weeks' notice."

He says, "No, you don't. I'll make a telephone call." So Sig called Ron Berry and said he wanted me now, right now.

So that's why Ron Berry [came] in and said, "You can retire."

So I went over there. He sent me to McDonnell Douglas, and McDonnell Douglas put me to working on doing changes to the SVDS [Space Vehicles Design Simulation] Program, which was run by MPAD [Mission Planning and Analysis Division]. [Laughs] I was right back, as an employee rather than a section head, doing work on trajectory programs for NASA. But I didn't have any trouble. My father taught me, "You do what I tell you, and then when you grow up, you'll learn enough that you can tell other people." [Laughs] And I spent five years there, doing [computer program changes]. I guess you don't want to know anything about that? You want to terminate that?

ROSS-NAZZAL: If you'd like to share some with us, that'd be great.

FUNK: Well, the first problem [I] ran into was being able to run the program. I'd go in there, and it would bomb every time. I said, "Hmm." So I sat down and I said, "I'm going to run all the inputs here one at a time, putting them in one at a time, until I find the minimum number of inputs that makes a program run," because if you can't run it, you can't debug it. Or I mean, you can't [add] anything else to it.

I had a users' guide. It told me all the options and everything else, but it didn't tell me that one thing. So I started writing a users' guide, and I got it to running. My job was to add the program for navigation for the Shuttle from people who had done it, you know, standalone into the program so they could run a simulation of rendezvous with the Shuttle with the radar.

Well, first of all, I just took that program and ran it by itself so I knew that when I hooked it up to the main program, if it didn't run right, it was something to do [with] the hookup, not what was in the program. We hooked it up to the program and, sure enough, it wouldn't run. So we looked and we looked, and I had an assistant and we looked. I finally looked and said, "Well, every time we run this thing, it points the radar in the wrong direction."

So I called the people up who wrote the program. I said, "Come on over here. There's something wrong that's not necessarily in the program."

They came over and they looked at the attitude matrix that we were using to mount the radar in the payload bay. They took one look at that and they said, "Well, that's wrong." So they give us the right numbers, and from then on everything worked.

Well, let's see if any other unusual things—that's about the only significant part of the problem. They did send in Dr. Gottlieb, who came from Huntsville, up to help put in some models of the—was it the OMS system? Yes, into that program. He was working with me. Every time he would come in with a problem that couldn't run, I said, "Well, that's because you don't have the OMS characteristics right." I knew what they were, but somehow he didn't have it. I knew. He did that for about a month or two before he got it written right.

That's why I performed so well. I could read the program. The people you bring in that are program majors, they don't know the system. They also can't read the code. When I see, "ISP," I know that's an engine characteristic. When I see a lot of other things, they [are systems or trajectories]. I was sitting there, looking at a printout one day, and there's six numbers for X, Y, Z, and X.YZ, which is position and velocity for the Shuttle, and there was another set and they weren't the same. Now, first of all, these people wouldn't recognize what it was, what those numbers were, and that they weren't the same. I knew why they weren't the same, that this was computed for a different set of inputs than that one.

I said, "There's only one way that could happen," that the [subroutine] called "WHEREAT" is in [the program] twice. Where is it? The printout for [the computer code is in] notebooks that are about that long [gestures]. Where is it?

Well, I had another assistant, a person that was working with me, that was good with the editor, so I told him to take the whole program [and make a copy]. We had lots of storage then. Put it [on]. It would be our program. They're not going to use it. "I want you to write an editor routine," and this was a good editor, "that takes and puts the subroutine de-bug at the beginning of every subroutine that's in that program. [The editor] can do that automatically, and make [debug] pick up the name of that subroutine [it is in] and print it out, and then it returns to the main program." … [Debug can be programmed to look for errors. When debug finds the errors you know the name of the subroutine that has errors. As an example it found that a program called WHEREAT was called twice in the program and gave different outputs. We deleted one The source code for SVDV required three to four feet of shelf to store the notebooks containing a printout of the code. McDonnell Douglas lost the NASA support contract to UNISYS and that program was lost.]

But that produced an interesting de-bug [technique], which I don't think I've got. I could go into that program, and if I wanted to find out what was going on, I could write a program that would only run when it came to [designated] subprograms and print out all the information I wanted. …

So things went along pretty good until the program got so that it's too big, so they put a segment in, run it and take it out, then put another segment in it, run it, take it out, and they were getting too long. So you have to overlay it and you have to change where the subroutines [are located].

We went to the person that knew most about overlaying and asked him how to do it. Well, he says, "You do it by trial and error, trial and error, and trial and error."

I said, "Well, how long does it usually take you to overlay it, to change the overlays?"

He says, "Oh, maybe a month, maybe two, three months."

So I said to Bob, "That's crazy. We've got to do something about that."

So I called up the machine people, the people that run the computers. It was always bombing out because it would be called a machine program to do something to run the machine the way it's supposed to, and bombing out. So I came over and I had those people come over to us, we sat down and laid out our problem, and they looked and they said, "Well, that program, that program, that program, that program, they've got to all be in the main program. You can't run a machine without those in the main program."

So we sat down and rerun the main program. We rewrote the main program. We went through the whole system with the editor, picked up every one of those [machines] that were in there, and actually made the computer program, put them all in the main program. That worked fine. Then all's we had to do was when we got [the] printout [and] the overlay was too big, we could read how much too big it was right off the end of the printout. It would print out storage locations. All's we needed to do was take enough of these subroutines that were in this segment [that was too long] and see if we couldn't fit them into this overlay down here and some other place and still get the data to run. And, it [only] took us a day or two to keep the overlays from bombing off.

I thought that was a great idea. I mean, from then on, we never had any trouble. But when I left, I would have thought that the company would have been interested in documenting [the technique], but they never used it after that. Maybe they didn't mind charging NASA for all the costs of that big program. [Laughs] Actually, that program cost probably more over the period—they're probably still using [the program]—than what it cost to build the Center.

ROSS-NAZZAL: Oh, goodness. That's expensive. That's very expensive.

FUNK: Oh, the software, all the software probably cost more than all the hardware that was produced.

ROSS-NAZZAL: After you left this company, did you work for any other contractors?

FUNK: Yes. Well, McDonnell Douglas lost their contract. They got the best review, and everybody wanted to keep them. They got it from TRW [Thompson-Ramo-Wooldridge Inc.]. TRW was just as good or better than McDonnell Douglas. McDonnell Douglas lost it to Unisys. Unisys said, "Anybody over there that wants to come over, come on over, and we will hire you."

I went over [to Unisys]. They hired me right on the spot. They put me back into being a section chief, working on the same program, but that was really a problem, the management and the crazy things were happening. They had a different task statement, which increased the paperwork by a hundredfold. It was ridiculous. But we managed to go—and at one stage in—I guess before I went to Unisys, they asked me to write an input subroutine, you know, actually for the users' guide. They were having the same problems I was having. They would send somebody to run a program, and they couldn't get it to run.

That brings up interesting information. While I was working on SVDS, some engineer came into my office and—actually, not an office, but I was sitting out on the floor—and said, "There's an error in that program."

I said, "No, there's no error in this program. We've run it enough that the part that you are running, there might be an error in the part that I'm working with, but there's not any errors in the part you're running. We made too many runs on it."

He said, "Well—." He told me what happened. On a Shuttle flight, they were supposed to come over Hawaii and turn the Shuttle upside down and make some measurements, or the Shuttle's making some measurements to do some kind of experiment onboard the Shuttle, and instead of doing that, it turned it right side up.

Okay. I said, "What units did you put into the program for the altitude?"

He said, "I don't know." He went back and he said, "I put in feet per second." I mean feet.

I said, "Well, the units call for nautical miles." What it did is pointed at the Moon. [Laughs]

So when I was asked to write this input, I sat down and I started out with line inputs. If you know what Windows is, it's not anything like Windows. Have you used a computer with Windows on it?

ROSS-NAZZAL: Oh, yes, yes.

FUNK: This comes up and writes it out. "These inputs are required to run any program," just to get to program one, A, B, C, D, you know, like that. "Now, these are the options for various things that the program can do. Choose one." Or two or three. Depends on how many options that you can run at one time. Well, as soon as they chose an option, then it comes up with, "These are the inputs and the units that you've got to put in to make this option run," and went down for all the options and all the programs like that.

It took me about three or four months to write that and check it all out, but you could sit anybody down to the program. If they had the data, they would not make a mistake unless they put the wrong units in. I didn't write them to check the units, because that would be a little hard to do. Unless they made a mistake in putting in the data, then it would run. You didn't have to know anything about the program.

Well, later on after some time down the years, they decided to make a Windows-type input for it, and those things are horrible. They put little things up here you're supposed to write the numbers in, write the numbers, doesn't tell you anything about what you should put in there. They spent some $20 million on doing that. They spent six months of my time. Then when they got it done and they were inputting it this time to a program that was now put on one of these big desk-type computers, once they got it done, it would never run on any other type computer.

I went to work, after Unisys, for Muniz Engineering [Inc.], and they gave me that program to work with, and it was horrible. I said, "Why didn't they stay with the line inputs that you can't make any mistakes?" If you want to change it, you just put another line in. To add an option, you just put Option C, D, E, or F, or like that, choose one, and it tells you what to put in. And it runs with any program you can put the compiler on, or the compiler can even put a run program on the machine, and you don't have to worry about transporting it to another machine. But I don't know what they do with it now.

But after McDonnell Douglas, we went to Unisys. Didn't accomplish much over there. It was a problem. What happened, because when they gave the project to Unisys, and that was a subcontract to Lockheed [Aircraft Corporation], who took over the launch facilities, too, and a lot of the people refused to go. A lot of the experienced people refused to go. I had a staff that most of them I had to actually train on how to—and a lot of stuff I did myself, because the schedule they wanted it on was pretty short, and they wanted all this documentation about the changes and things like that.

So I finally—Eagle Engineering [Inc.] came into being, which was a bunch of engineers from NASA who put their own company together to work with NASA and the space industries, launch-vehicle industries, and they wanted me to come over there because they needed launch performance data. It was a problem trying to work with these people who couldn't handle the program. We had three or four that could, but the best one I had of that who could sit down, do the analysis, two to three weeks, write a program, write the documentation and write it up, turn it in, he got snapped up by Boeing [Company].

So I went to work for Eagle doing contract work. I did a performance study for Titan for the contractor that operated Titan rockets, Hercules [Aerospace Corporation]. I did a lot of other studies. That's proprietary information. As a matter of fact, I was doing this work all at home. I said, "Well, it's proprietary. Nobody's going to see this stuff but me." I still have it there. But for the final runs, [that] they were going to put into the contract, they sent somebody there to watch me do it. [Laughs] I said, "Look. I worked for four or five years under top secret for the government." I cleared that up, but they were a little worried.

Let's see. What other happened? Oh, yes. You know, the *Challenger* happened in January. They took that program over in October or November, the one that blew up, and they didn't fly for about two years after that. That saved Lockheed from being [un]able to run this contract. McDonnell Douglas thought sure that they were going to fail, and they said, themselves, that if they hadn't had the *Challenger* accident, they would have been in deep trouble of being able to put together the necessary experienced people to manage and to take care of the contracts.

But [in June 1989], Eagle Engineering got a request from Lockheed. They were reprogramming the Shuttle engineering simulator computer. They were taking the simulation from one computer putting on another one. Now, this is a simulation that the engineering people use to check out different things they're doing with the Shuttle to make sure that it's reasonably going to work before they give to anybody else.

They said they had an error in the program that they couldn't find, because they'd shifted it from one computer to the other, and they [gave] me a three months' contract to come over and see if I could find it. So I went over and learned to run the program, rather than have somebody else run it for me, too much trouble to communicate right, and started running runs. First of all, and I had the requirements documents. First of all, I looked—and somebody at that time said, "Oh, go-to statements are no good." This is what comes up all the time in programming. Some college professor wrote up all this stuff that's no good. What you want to do is "if then, else."

They had this programmer that had put all those "if then, else" in there, and they said there's a mistake in it. I went through it, and I couldn't find a mistake either. I looked and looked, and I couldn't find any mistakes, and so I went to looking at the [instability]. Then engineering came back [to me] again. "Wait a minute. Wait a minute. All's they need is a sine error in the control matrix and it's unstable."

So I did what nobody else there that they'd hired just to do the programming could do. I sat down and read about the control matrix myself. And I looked [at] it and I said, "Yeah, there's a sine error." And I looked at the [requirements] document. "Yeah, there's a sign error in the document. This is a controlled document for Shuttle software for flight that was certified by North American [Rockwell International Corporation] as being run and correct and there's no errors in it."

So I went in to the guy that was running it, and I said, "Change this sine." I think it had to be either plus to minus, but I think it was a minus. Yes, I think it was a plus to a minus. "And run it."

He came in and said, "Yeah, everything works fine." So I sat down and wrote this up. Well, I said, "North American has sent you a document that wasn't checked out. There's no way they could run that and make it work unless somebody fudged it just to make schedules."

So they called North American and they said, "Oh, yeah, we found that error, and we're going to—," and they thought, "Oh, yeah?" It only takes an hour or two to go in and change that sine. We told them where it was.

So the poor girl that did this program, she came down, sat down by my desk—she was about in tears—said, "They're about to fire me."

I said, "Why?"

"Because of those 'if, then, else' statements."

I said, "They violated the—who told you that?"

She said, "Somebody over at NASA."

I said, “They violated, telling you to do that. They should have run that through the control board and get authority to do it, because this is a controlled document. That program should have never been programmed that way.”

She said, “Well, we’re getting a new one in, you know. They’re getting a new one.”

I said, “I’ll tell you what to do. You go through that controlled document and put down everything it says to do in there just like it says to do. And if you want to, write all the text in there, so that when you print it out, it prints a controlled document, and get it to run and everything runs right. Then if this guy says he wants ‘if, then’ statements in it, you say, ‘Well, I’ll do that. You just send me a letter saying do it.’” I said, “He’s not going to send you that letter.”

So that’s about the last thing I think I’ve done.

ROSS-NAZZAL: Well, you’ve had quite an interesting career.

FUNK: Except all those studies I did. I’ve got lots of simulations. I can run the Shuttle trajectory just as well as they can, right into orbit. I did the Hercules. Oh, I did a lot of things for some contractors. We worked with Hercules and Eagle Engineering to develop a set of modular rockets. They were all solid rockets that could be used to put up a lot of different payloads, but we couldn’t get NASA to buy it. They didn’t have to build it. They just had to buy it.

ROSS-NAZZAL: Let me ask you just two questions before we close out today. Looking back over your career with NASA and with NACA [National Advisory Committee for Aeronautics], what do you think was your most significant accomplishment?

FUNK: Most success. Oh, you mean for NASA?

ROSS-NAZZAL: For NASA or with NACA.

FUNK: For NASA, the most significant accomplishment was that trajectory program, that trajectory program, for NASA and for the [Johnson] Space Center over here, because there was a big controversy. I see in this list of people that were interviewed that a guy named [Joseph F.] Shea was interviewed. He did come down to work here, but he tried to get that program to go to Headquarters. That was the most significant one. It was more [significant] to the work I did for Apollo and Shuttle, because they impacted programs. The other ones, like the lateral stability aircraft due to high altitude, that's just technical documentation to educate designers, and there was no real input into projects.

ROSS-NAZZAL: What do you think was your biggest challenge?

FUNK: The Skylab Program. [I did the Skylab Program myself. Tom [Thomas F.] Gibson and Ellis Henry did the Apollo Mission Planning Program.] That was a challenge, but we knew how to do it. Tom Gibson and Ellis Henry were just fantastic about completing it in three or four months. [Tom was not with me when Skylab came in, and Ellis was working on trajectories to

Mars. Ellis published MSC Internal Note No. 70-FM-89 "Round-Trip Mars Orbital Missions in the 1980s".] I would guess that maybe it was less than six months, and they were probably the only two persons in the organization who could have done that in that time.

ROSS-NAZZAL: Let me ask Rebecca if she has any questions for you today. No?

Do you think there's anything we've overlooked? I mean, you did a fantastic job of giving us a sense of your career with NASA and with NACA.

FUNK: Oh yes, a postscript, postscript. You can use this or you can cut it out if you want to.

During the programming of the guidance computer, Dr. [Richard H.] Battin and I were up at Washington, D.C., giving a progress report on the progress of the guidance computer program, always it comes up, arguments about schedules and everything and questions about schedule. Dr. Battin looked out over the audience and—I quote—he said, "NASA's idea of a crash program is to get [a woman] pregnant and hope for a baby in one month." [Laughter]

ROSS-NAZZAL: That's a great joke.

FUNK: Oh, I had to laugh. That stunned the whole audience. That's the saying of the decade, I think.

ROSS-NAZZAL: Well, you certainly have a lot of great memories, and you've certainly done a lot.

FUNK: Oh, there's a lot of stuff that pops up every now—I don't have a recall memory. Things will pop up. This will pop up a memory I didn't even know I had. For instance, like the fires in California. My sister that's still living is out there. I called her up and said, "What are you trying to do, burn down California?" She's in Bakersfield, though. I said, "Do you remember that fire when the mountain behind Mercersburg [Pennsylvania] there caught on fire?"

She said, "Yeah, but I'm surprised that you know it."

I said, "You must have been about three years old when that happened."

But I don't know. I mean, those things just pop up.

WRIGHT: Mr. Funk, what's your favorite memory of Dr. Gilruth, of working with Bob Gilruth? Do you have a special moment that you remember working with him?

FUNK: No. You know, in all this work, I didn't go into his office to communicate with him, ever, because he told me what he wanted me to do, and I never told anybody about that. If I go walking into his office, everybody out there wants to know what I'm doing. I always either wrote a report and published it or did it through the regular recordist, tell my Division Chief or my—what did they call the other ones? Told them what I thought, and it always gets up to the top.

He told me one night when I was on a plane going to Washington, D.C., what he expected of me, and he made a point that it wasn't just idle talk. So, no, I didn't—but I do know that they made a great choice when they chose him to be Project Director. Not only did he know how to do it, he got a staff right readymade who was used to taking on something they didn't know about and working, and they all worked with him. They were all under him for years.

So he walked in and they walked in and everybody sat down. We were sitting down around the table when we were only four or five hundred, or maybe less than that, of engineers, and just discussing it, and the engineer that had the problem with designing the pads for landing on the Moon, the landing gear, said, "Well, the biggest expert on the Moon says that the Moon's covered with about twenty feet of suspended dust." Did I tell you this? He says, "How're we going to land in twenty feet of suspended dust?"

I said, "We're not. We're not going to land in that. What you do is you go out and figure what is it you can design for, like desert sand that's been blowing there where it crushes down or rock from a volcano, lava rock somewhere," because there's craters up there, see. "And that's what you do. When we get there, if there's twenty feet of dust, we will abort and come home."

But that success of the project, having chosen a person who had experience with taking on projects and giving him a staff who had experience with taking on projects, a staff which worked together before. We were educated at the Langley Research Center [Hampton, Virginia]. They taught me how to write technical reports. I might have thought I knew when I came from college, but they taught me how to write technical reports.

Every report went through an editorial process. First it was your Section Chief. Second was a group of engineers who were not necessarily expert in your subject, and then they each made changes, sent it back. You made the changes. They made changes. You sent it back.

Then when Mr. [Richard V.] Rhode read it and said, "Okay, we'll send it out for another editorial process," he sent it out to a group of English majors. They went through, and if you made any mistakes in grammar or anything else, they would change words, and they would send it back. But you had to check the words they changed to be sure they didn't change the technical [meaning or] the technical subject of the text.

And then these symposiums that [were] set up with the directorates, or divisions, whichever they were. Once a month, each division had to do a symposium on their work. Now, those are just to sit down to talk about it. These were what you call slides that were quality slides to be given at open symposiums like that. They were all made up by the technical staff. In addition, those people came, too. I mean, the people that did our slides and our graphs and all that stuff, they came, too, so that when we had to make a presentation, it was quality work.

Then we had to get up in front of all these engineers and give presentation. Then the next day, especially me, the boss would tell you what was wrong with it. He told me on the first one of those I did, "It was kind of awfully dull."

So the next one I had to do, I started writing little comments in there. What? Shout something out. Or do this, like—what was his name? Byrd, his last name was Byrd. I forget the first name. He was up there at one of these, and the slides came up in wrong order. The projectionist had somehow—well, he had to stack them so.

He looked and he just went down off the stage, walks back there and looked at it. He was thinking of, "How do I get around this?" He walked up and said, "I just wanted to see if this slide looked the same down here as it did up there," and went on, gave his presentation. He made that interruption, and that taught me a lot about things.

So I got up, and I thought I was acting like a comic or something. The next day, they came in, they said, "That was great." Evidently, making presentations, you need to just do more than what would be put out from memory.

But I made lots of presentations. I have three drawers' worth of slides that I brought home with me of those presentations.

ROSS-NAZZAL: That's an awful lot of work.

FUNK: I was giving them all—well, we did a lot of presentations just to convince the world we knew what we [were doing]. I mean, you get the idea that Congress is going to say, "It's too much money and you don't know what you're doing," and things like that. Nobody knows how much—when you get into a project like that, nobody knows how much it's going to cost or what the schedule's going to be.

But I did manage, when I did the study with that program of where we could land on the Moon and how much maneuvering it would take to get there, I picked the Sea of Tranquility as the landing site just to, again, cut down on the amount of work you need because—and there was a lot of trajectories. It was easy to get to that landing site. And I picked the date. What was it? What date did we do the first landing?

ROSS-NAZZAL: The twentieth, July 20th, of 1969.

FUNK: Yes, '69, right. Well, I didn't pick July 20th. I did '69 to do the parametric study in, because the Moon's in different places all the time, inclination, things like that. I picked the Sea of Tranquility.

After they landed on July 20, '69, they asked me how I knew what year we were going. I said, "I didn't. I just sat it down far enough so I thought I would have enough time to do the work needed to get there," and everybody else. I just plain picked that out. And '62 or '63 is when we wrote that program. What's that, seven years? Yes, that's what I picked. Seven years.

Somebody told me that when they went on a project extended more than seven years, they found out that they were starting to forget, so any project that lasts longer than seven years was a pretty bad project. But anyhow, that's how I picked that.

ROSS-NAZZAL: We thank you for sharing all of your memories with us today. We've certainly enjoyed hearing all of your stories.

FUNK: Yes, okay.

ROSS-NAZZAL: Thanks again.

[End of interview]