

# NASA JOHNSON SPACE CENTER ORAL HISTORY PROJECT

## ORAL HISTORY TRANSCRIPT

CHARLES W. "CHUCK" PACE  
INTERVIEWED BY JENNIFER ROSS-NAZZAL  
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ROSS-NAZZAL: Today is November 3<sup>rd</sup>, 2004. This oral history with Chuck Pace 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 Sandra Johnson and Rebecca Wright.

Thank you for joining us this morning.

PACE: You're welcome. It's a pleasure.

ROSS-NAZZAL: Great. Can you tell us how you came to be employed with NASA?

PACE: Pure blind luck. I went to a small state college in Missouri that principally turned out teachers, and I worked construction in the summers for a cousin who worked for a company in Kansas City [Missouri], and was probably leaning toward a career in the construction business. I went for two years, taking what then was called an industrial arts program.

I graduated high school at I was sixteen, so I was a little skewed, a little behind all my peers in age and maturity. So my eighteenth summer, I was in Shreveport, Louisiana. Grew up in Missouri, had never been to the South, Little Rock [Arkansas] was as far as I'd been south, and I spent the summer in Shreveport, at eighteen. There were a bunch of young guys, and we all roomed together. We were in a boarding house, and I discovered drinking, because if you could sit on a bar stool and order, they would serve you in Louisiana, and this was 1955.

So I came home at the end of the summer with my last paycheck, which was—my dad and I had a deal that I had to have enough money to pay my fees and expenses for school and then he paid room and board and car expense. Well, I didn't have enough money, and Dad said, "So what are you going to do?"

I said, "Well, gee, I guess I'll go back to construction work." So I spent that winter in Kansas City, working construction, five above zero, outside, and the next fall, I decided I wanted an inside job. So I shifted my major to math and physics, and graduated 1959. Couldn't find a job; jobs were scarce. My dad had always told me, because he'd gone through the depression, that I should get a job that was secure. So I applied to all of the civil service districts to see if I could find a job, and went back to construction.

I got a phone call in October, I think it was October of '59, from Aberdeen Proving Ground in Maryland, asking if I would be interested in interviewing for a job. In those days you had to pay your own way; the government would not reimburse you for any of that. So I talked to my dad and a family friend about it, and we decided that I ought to go try. First time I'd ever flown commercial. I flew from Kansas City to Washington, D.C., and caught a bus up. Lengthy story, but it really sets, I think, the tone for how I went through all of this.

I can remember I got into Aberdeen about nine o'clock at night on this bus, and I was just a dumb kid, you know. So I looked around and there was a motel sign, so I go up there and bang on the door and wake the guy up, so I got a few hours' sleep. Went out for my interview, interviewed about three different people, and I considered it a disaster. So I said, "Well, I'm going back to Missouri and I'm going back to construction."

At that time, we were actually working a job site in Omaha, Nebraska, and it was November, early November. I'm out there; we had had our first sleet. It had taken me two hours

to get to the job site. I didn't have any antifreeze in my car, so I'm borrowing antifreeze from the company and pouring it in my car. My boss says, "You've got a phone call." So I go in; it's the woman from Personnel of Aberdeen. She offered me a job.

So I went to Aberdeen and I worked—it was the Department of the Army, and we built firing tables for weapons systems, and I did that for two and a half years on recoilless rifles and mortars, 4.2 mortars, etc.

We watched the John [H.] Glenn flight and everybody was pretty excited about the space program. One of the guys in there was a native of Texas, and he had found out that the Space Task Group was looking for people, and he'd sent his application in and he got a job. At that time I had two small children and one on the way, and winters were bad on the Chesapeake Bay and I thought, "Why don't I send my application in."

So I did, and I get a phone call and they said, "You know, if you were willing to drive to Langley [Research Center, Hampton, Virginia]," which is about 120 miles, 150 miles, I don't remember, "for an interview, it might help, because we've got a stack of applications that's about two feet tall." They were hiring as fast as they could, because Space Task Group was a nucleus of around thirty-five people, as I remember, and so they were trying to staff up to create the Center here.

So I said, "Sure, I'll do that." So I took a day off, drove down—at my own expense again—drove down to Langley and interviewed. I thought, "Well, I don't know if anything will come of it."

Came back, and about a week later I get a phone call, "Would you like to go to Houston?"

I said, "You know, that's probably not a bad idea." So that's how I got to the space program. A lot of the guys were engineers, were interested in space and all. I was just interested in getting a good, secure job, and this one sounded like it would be a good one.

ROSS-NAZZAL: What did you think of Houston when you finally arrived here?

PACE: Cow town. [Laughter] In fact, the day I arrived, what we did is I sent my family to Missouri and I packed up the house and moved, because my wife was pregnant at the time. I drove to Missouri and spent a week and then I came on down, and the day I drove across Oklahoma, it was like a 125 degrees, one of the hottest summers we had in Houston, and I had an abscessed tooth. So I had a miserable beginning.

I found a room in the YMCA up by Gulf Gate, no air conditioning, right on Highway 225. You had to sleep with your windows open, and you'd wake up in the morning to the exhaust fumes, because they put big fans in the ends of the halls to pull air through your rooms. It was a pretty miserable start.

But I finally got into the office. The guy I was working for was named Carl [R.] Huss, who has passed away. I wish you could have interviewed him. You would have enjoyed Carl. He said, "Well, you got a place to live?"

I said, "No."

He says, "Well, why don't you go get squared away. Go over to Personnel." They had a Relocation Center set up. "See if you can find a place to live and get your family down here."

I thought, "Gee, I've died and gone to heaven." This is a pretty liberal organization, because Aberdeen Proving Ground was your traditional government bureaucracy—slow moving;

somebody had to die before you could get promoted to the next position—and this thing was just wild and wide open.

The town was, like I said, a real cow town. Gulf Gate was the last shopping center. I mean, it was the end of Houston. From there on out it was country, and you've heard the gravel road for NASA Road 1 and all of those stories. If you wanted to go out to dinner, there were very few decent restaurants, and if you wanted to have a drink, you had to join a private club. So it was quite an experience at the beginning, yes.

ROSS-NAZZAL: You said that you were directed over to the Relocation Center. Where did you eventually end up settling here in Houston?

PACE: I came down here in June and, like I said, I needed to get my family down, so I rented a house. I didn't know the area, so they had places for rent at the Relocation Center, and I found one that was over in Pasadena [Texas], and I thought, "Well, that probably would be reasonable." So I rented this little house. It was about a half mile off of 225. What I didn't realize was on the other side of 225 were all the chemical industry. So you wake up every morning to the lovely smells of money.

So I got the family moved down and moved in, and my son was born in September. In December we bought a house over off of Belfort and what's now Martin Luther King, which was a nice little blue-collar neighborhood. First house cost me \$12,500 and \$105 a month payment. I was located at the Houston Petroleum Center, like a lot of—being in the operations side of the house, MPAD [Mission Planning and Analysis Division] and all. I was officed over there, so it was very close for that. We lived there until 1970, when we moved to Dickinson [Texas].

ROSS-NAZZAL: What was the work atmosphere like when you first arrived?

PACE: [Laughs] It was very interesting, because the computers were at the University of Houston [Houston, Texas]. When you started in those days—and nobody knew that much about orbital mechanics in general. I mean, my background had been ballistics, so it had had a little bit of a correlation, if you will, to orbital mechanics, but not much. They gave us this document—it was about this thick [demonstrates]—it's a really neat thing. We called it the "Space Notes;" they had a little fancier title on it. But what it was, Ted [H.] Skopinski, a good engineer, had gone and reviewed all of the literature on orbital mechanics and had pulled together this document. Even it had hand-drawn graphs in it and all of this, and this was basically the bible that we had. So they give you this and say, "Now, read this. This is what we know about how to go to the Moon."

So you spent a couple of weeks doing that, and then slowly they started integrating me in to starting to do studies, and like I say, I think Carl was the section head and he was also the retrofire officer on the Mercury flights. I remember I could hear him coming down the hall in the morning. He had to go past my office. Tom [C. Thomas] Hyle and I were in an office together. Carl would stop and open the door, and he'd say, "You know, while I was in the shower this morning, I was thinking about these studies," and he had me working on Apollo, so I started working on Apollo basically from the day I started working, because they had the guys that were flying Mercury; we flew MA [Mercury-Atlas]-8 and MA-9 after I came to work.

So that was how I really got started, was Carl would give me an action. To do it, we had a computer program called CO3E, which was a fairly simple three-degree-of-freedom program

for Earth orbit analyses. You'd set up the cases that he wanted me to run and then you had an option, you could either drive over to the University of Houston, and they would pay you mileage, or you could ride the bus.

So you'd essentially come into the office. The way your day went, you'd come into the office and you'd kind of get squared away, have a cup of coffee, a little chitchat, and then you'd head off to the University of Houston and you'd get your deck set up. You had keypunch machines and everything where you could set it up. I can remember carrying it out on the floor and handing it to the computer operator. He'd load your deck and you could stand there, and we had this clunky old printer that would print one line at a time, so you could stand there and watch and this thing would go "ka-chunk, ka-chunk, ka-chunk," and you could watch the readout, and you were trying to determine if the run was good or not. If it wasn't, you'd tell him to kill it and you'd go back.

So you'd work over there, maybe get two runs in, and then we'd take off someplace and have lunch. We knew all of the places that had cheap lunches, so like on Tuesday there was a chicken place over on Griggs Road that we would go to. Anyway, that was pretty much your day. Then you'd go back, you'd set up some more runs, and then you'd go back to the office and spend a little time there, and then go home.

That was the early phase. Like I said, I was working on preliminary studies for how to do all of the testing flights that we needed to do during the Apollo Program, in order to qualify the hardware and learn what we needed to learn about using the hardware to go to the Moon.

ROSS-NAZZAL: What kind of computers were you using at that point to do these runs?

PACE: We had what I guess was IBM's [International Business Machines] finest. They were called 704s initially, and then they got upgraded to—I forget. There were a couple of upgrades that went on. I remember we ultimately got to something called a 7094, but it was basically the best computers, I think, that IBM could provide us. To give you an example, I don't know if you found any—I put out I think it was an internal note, and it was nothing more than because we didn't really have a good feeling for the ground tracks in the—I mean, they had flown the Mercury, so they did, but we were going to fourteen-day missions in Apollo. So you were looking at a much longer duration in Earth orbit and how you were going to utilize the tracking stations, because we were tied to ground stations in order to make decisions and monitor burns and those kinds of things.

So Carl asked me to generate a document that was fourteen-day missions with various inclinations and various orbital altitudes; to do a little parametric study so that we would have a reference source. So for an extended period of time—and each one of those runs, fourteen-day mission, took right at four hours on the computer. So I was using a lot of computer time to crank these runs out. Then I would get a mag [magnetic] tape from them, and we had a—it was called an XY plotter that you could put a Mercator map on and tape it down and then you could actually—and I did my own plotting of the ground tracks. So it was interesting.

ROSS-NAZZAL: Were you writing the computer programs at that point?

PACE: I never did any programming. I was not a programmer. I had tried a little bit while I was at Aberdeen, took some courses, and my interest was never in getting down into the real technical aspect of it. I enjoyed trying to figure out how you could design the mission to



accomplish certain mission objectives, so I never really got into any of the programming or any of that part of the technical thing. It was more of analysis. I would use the programs to run the trade studies and analyze the data and those kinds of things.

ROSS-NAZZAL: Other than studying the fourteen-day missions, do you remember what some of the other studies were that you were assigned to?

PACE: Well, there's one that I thought you might enjoy. We had a limited number of flights we were going to be able to accomplish in Apollo in order to meet all of those test objectives. We would have a mission and they would give them numbers, like 205, and it would be A, B, and C, and you'd have different plans for each of those versions, based upon did you accomplish this set of objectives. If you didn't, what would you do? We were trying to build multiple profiles in case if the previous flight accomplished something or didn't accomplish it, then we would know what we needed to concentrate on. That was the kinds of things that I was working on with Carl, and everybody in our organization, in the section, was working on those kinds of things. Some of the guys were working on Gemini.

My favorite story is Apollo 9, from a personal point of view it's my favorite story, because it was to be a demonstration of all of the things you needed to do on a lunar mission. In other words, we wanted to profile an Earth orbit that would approximate the kinds of maneuvers that we had to deal with for a lunar landing mission. For example, to do the deorbit burn into lunar orbit, was, as I remember, about a 10,000-foot-per-second maneuver, and to do the same maneuver coming out was about another 10,000 foot per second, and this was on the service module, using the service module engine.

Carl and I were there one night and we were trying to figure out how we could do these two burns in Earth orbit, because if you did it in-plane, you had a big high ellipse, and that wasn't what you wanted, because you had the guys going way out and then you had to wait for them and track them and come back and then do another burn. So we spent one night in his office with a globe and some parametric data that had been generated and, of course, our slide rules and we designed the Apollo 9 mission.

What we decided to do is when you pass across the United States, you had good tracking coverage, so you could cover the duration of the burn with ground stations and make sure the crew was safe and you knew what had happened to it. So we decided we'd do it out of plane. So we did an out-of-plane burn so we would figure out exactly how much that was going to rotate the plane of the orbit, and then we would do that on the globe and we would set up the globe and say, "Okay, now, what tracking stations are we going to have?" Because the globe had a band that was like the equator and then it had another one that was at an angle, the globes that we had. So we would set up the inclination and then we would rotate the Earth under and say, "Okay, we did the burn and we rotated it this much out of plane. Now what is the ground track going to look like?" so you know what stations you're going to have coverage for and get ready to do the next burn.

Then we did the other one back in the opposite direction, so we brought ourselves back to where we had been in that process. We worked that whole profile out, like I said, sitting in his office, using a globe and parametric data, etc.

Then the next day we gave that information to some of the guys, and they went off and set it up and ran it on the computer and it worked. So we were working pretty basic. But that was a fun mission because of that.

ROSS-NAZZAL: How unusual was it for you to do something like that in the office?

PACE: I'm not sure I follow your question.

ROSS-NAZZAL: How unusual was it for you to work with just a calculator and a globe?

PACE: Well, I mean, at that time because of the expense of computer time, the time overhead and those kinds of things, you would try to do as much as you could, and I think that may have been one of the talents, if I have any that I brought to this, was my ability to visualize the three-dimensional problem, because essentially you're dealing with a three-dimensional problem. You're dealing with ground stations; you're dealing with an Earth that's rotating; you're dealing with orbital planes, and you've got to work lighting into all of that, usually.

I can remember one other thing we were doing. We were working a communications concerns on the translunar leg, going from Earth to the Moon, and I can remember a meeting with some guys, and we had an eraser that they had stuck pins in to represent the coordinates of the vehicle. We were using that with a globe and figuring out the Moon and what orientation we would use as the Earth rotated and how you could keep up with tracking the vehicle. I mean, the globe—in fact, I let mine get away from me and I wished I had kept it, because it was something—I had my name on it and if anybody ever came to use it, I would have shot them, because it was a tool that I used a lot in order to visualize the missions.

ROSS-NAZZAL: How many other people were working on these studies in this section, do you recall?

PACE: There were a lot of guys, because there were so many mission options, but looking back on it, what I remember is I was so focused on what I was doing, and I worked with a few people in that process, but basically I was just—because a lot of the guys were working on Gemini, we were finishing up Mercury, and I was one of the few that was really working on some of the advanced stuff for Apollo. So I really don't know, to be honest with you. I just didn't pay that much attention. I just worked on my stuff.

It was interesting, because like I said, most of it would be Carl would come in in the morning and he was my section head and he would say, "Go run these cases."

"Yes, sir." I'd go run them and then I'd make sure I had the data right, plotted up. Sit down with him and we'd go over it, so that's kind of how it worked.

ROSS-NAZZAL: How long did it take you to begin and then complete a study for Carl?

PACE: Gosh, it was continuous; it never stopped. Carl always had one more thing he wanted, so you never got finished. There were so many options, because you had so many mission objectives to try to achieve and a limited number of missions, so the focus really was on developing as much of a knowledge base as you could of how you were going to deal with the off-nominal cases.

ROSS-NAZZAL: I understand in '67 you started working for the Contingency Analysis Section.

PACE: Yes, that's probably—to be honest, I've kind of forgotten the titles. I mean, I can relate what I was doing. Sixty-seven. I don't know. Through that whole period there were organizational changes that went on, but I don't remember exactly all the details of what was going on. Most of my career, for working on Apollo, was working for Carl Huss, and as he became a branch chief, then I had Clay [Claiborne R.] Hicks as a section head, and there was a lot of organizational changes that were going on, so I don't remember that as anything significant.

ROSS-NAZZAL: When you were working with Clay Hicks, what sort of work were you doing?

PACE: It was the same. Same kind of stuff. I spent a little over eighteen years in the Mission Planning and Analysis Division. I joked, because it was on the third floor of Building 30, and I joked that I had gone around the building three times, with offices mov[ing] me, and I concluded after eighteen years I didn't want to go around again. I needed to look for something new to do.

But basically I worked for Clay in those kinds of jobs up until—well, let's see. Somewhere around '67 would have been when I became a mission manager. Did you find anything on that in there?

ROSS-NAZZAL: We did. What were some of your duties as a mission manager?

PACE: I noticed that in John [W.] Aaron's interview he talked about what we were really doing was kind of a systems integration type of job, and I'd always thought of it that way. So we had

an organization that was kind of a staff job, and you were assigned a mission and your task was to kind of make all of the meetings, find out any decisions that were being made that affected your mission, and then going back and making sure the guys that were working the daily work on those missions were aware of what they needed to do.

We had an action-item system where we could document what changes were happening. You've heard of the flight techniques data priority meetings, I'm sure, Bill [Howard W.] Tindall ran, where they were working out the real nitty-gritty details of how to go fly a mission, and out of that would come things you needed to go study and go make sure that you could do. So that job was kind of integrating—also we would track the schedules, because you had one organization that had to generate certain data and hand it off to another organization in order for them to do their job in the process of building the mission plan and getting the software squared away and all of those things. So it was kind of an integration type of job, and I did that through all of the lunar landing missions.

I worked on 12, 13, and then more or less on all the rest, because we also had a support role in real time to the flight control team during the missions. I was the lucky one; I got the eleven-to-seven shift, and that was sitting in the—I think we called it the SPAN [Spacecraft Analysis] room, which was a backroom support room, where if they needed anything, I was the contact for MPAD. If they needed any analysis from MPAD, then I could get the guys to run it.

It was while the crew was asleep, so there wasn't a lot of action going on, but the good part of it was, was that was where the problems got worked on the missions. In fact, to give you an example of how important that probably was, George [W.] Jeffs, who was head of the Apollo Program—you've interviewed him, I know; I haven't read his interview. But he was a real good

engineer. He worked that shift, because he wanted to make sure that his guys, the Rockwell guys, were on top of any problems.

So, like I said, I worked the missions from that point of view and from the mission manager point—but we called them “mission mothers”—until the end of the program, 1972. Then I didn’t have a job, really. I mean, I didn’t know for sure what I was going to be doing. I’d gone on vacation to Colorado, a camping trip, taken my family, and I was sitting in a campground in Durango, Colorado, and I got a call from Jim [James C.] McPherson, who was the Deputy Division Chief under John [P.] Mayer at the time, and asked me if I would consider taking a job running the Consumables Analysis Section.

So here’s a guy who has spent all of my career doing flight design orbital mechanics kinds of things, I knew absolutely nothing, had no background in systems, but they had had a personnel problem there. The guys had rebelled against working for their section head, and I guess there was some sort of negotiated agreement that they could tolerate me as their section head. I don’t know all the background that went on behind that, but I suddenly found myself as a first-line supervisor over an organization that was building math models of all of the systems on the Shuttle so that we could run analyses to determine the adequacy of the consumables to fly the missions that they were looking at, which was a lot of fun. I really enjoyed it. It was a dramatic change in what I had been doing. I did that for seven years; I think it was about seven years.

Jerry [C.] Bostick was the Deputy to Glynn [S.] Lunney at the time, and they were responsible for payload integration work on the Space Shuttle, and that was at that time that the DOD [Department of Defense] had decided they were going to use the Shuttle as one of their major lift capabilities. So they were putting in all of these secure facilities at the Center, and I ran into Jerry one day in the hall and he said, “You know, Pace, you need to come to work for

me. I need somebody to oversee this DOD stuff," because the guy that had been doing it had just quit the agency and had gone to private industry. I didn't know anything about security or DOD or any of that, but I was ready for a change in my career, so I took the job.

That was another interesting experience, because—shall I just keep talking?

ROSS-NAZZAL: You can keep going, and I'll just come back. I hate to interrupt individuals when they're on a roll.

PACE: I can ramble on through this or we can go back, so it's your call.

ROSS-NAZZAL: You can keep going, and we'll come back.

PACE: Okay. I had no idea what I was getting into, and we were doing a lot of facility modification, so it was another dramatic change in my career path, because now I was dealing with Center Operations personnel on building out secure rooms and implementing classified requirements that the DOD was placing on us.

I was saved by a man by the name of Howard Ferrill that McDonnell Douglas had hired to help. They had a task to support this activity, and he was retired Air Force and had been in the security business his whole career. So on a daily basis, Howard would come to my office and he'd say, "Okay, now, here's what we need to do," because I was NASA, he was contractor, so he couldn't direct the people. [Laughs]

So I'd say, "Okay, how do we do it?"

He'd say, "Well, we need to set up this meeting."



"All right, who do we need to have there?" [Laughs] So I went through this really drinking-from-the-fire-hose learning process, but it turned out to be another—I mean, I enjoyed the consumables work and I enjoyed this. It was a totally new challenge.

We managed over the next few years to put all the secure facilities in and then get them certified, and the DOD said, "Nope, we don't want to fly on the Shuttle." So it was the only time, I joked, that I ever had a job where I put all of this capability in place and then I removed it, because we then took it all out and put everything back to the way NASA did business.

ROSS-NAZZAL: Let's go back to the Apollo material, which we kind of skimmed over. Can you talk about being the mission design manager for one of your Apollo missions and sort of walk us through what you would do and how the mission progressed over time and changed?

PACE: It's gotten very murky. It was a lot of years ago. I was thinking about that. We had a formal process for the mission design so that you went through the phases, which I think showed up in some of your interviews, about design reference missions. Then you went from that to moving toward more of an operational mission and trying to put more flesh on the mission. Of course, in that process, basically, it seems like the job, looking back on it, was I tried to attend all of the pertinent meetings where those discussions were going on. Bill Tindall's data priority meetings, he got the Ops [Operations] guys and he would get the technical guys from MPAD, and he would get the engineering guys in there and then they would just have at it, arguing over could you do this, how would you do it, and just, inch by inch, working your way through the mission.

So my job at that time was kind of keep up with what was going on and make sure that the guys in MPAD were working on the right problems, because we were under such a time crunch, you didn't want people—and everybody couldn't afford to spend the time going to all those meetings, so it became important to have somebody that was looking at it across the whole process, to see that the right actions were being given and people were working them and that they understood what they were supposed to be doing. That's why we called it a "mission mother" job. I mean, you just kind of mothered the system along. Like I said, we didn't have any inline function beyond just seeing that the mission was being developed properly by the right guys and the right information was being disseminated.

ROSS-NAZZAL: If you had to look back and say that there was any sort of big challenge in this role, what do you think it would be?

PACE: From a personal responsibility point of view, I think the biggest challenge was making sure that you had gotten all the right information to the right people. Like I said, it was not an inline type of responsibility. You were basically mothering the mission along and you needed to know what decisions were being made and why, so that you could convey that so that people would understand why they were being asked to do certain jobs. That's basically what it was. It was, I thought, a fun job, but that's because I liked that integration aspect of things. About the best I can do.

ROSS-NAZZAL: What are your memories of Apollo 11?

PACE: Well, my memories of Apollo 11 are—see, I didn't work on the mission to start off with. Ron [Ronald L.] Berry took the lead on that one and it obviously was a very critical mission that they wanted the top guns overseeing it. But in addition to that, the day that they were going to land on the Moon—and I didn't have any role in the Apollo 11 mission. I didn't even have a real-time role. I was more focused on Apollo 12 and some of the subsequent missions.

We were getting ready to sit down to the TV to watch the lunar landing, or listen to it and what we could get on TV, and I got a phone call that my dad had had a heart attack in Missouri. So we ended up on an airplane to Missouri. My mother had passed away when I was seventeen, and my dad had remarried, and her son picked us up at the airport, and while we were driving from Kansas City to Sedalia [Missouri], the hospital where he was, which was about eighty miles, I guess, we were listening to them on the Moon. So my experience with Apollo 11 was basically just that. I got to listen to a little bit of that, because I spent the next couple of weeks with my dad, and then he had another heart attack and passed away. So I really didn't have any involvement. I had a lot more with 13, but not 11.

ROSS-NAZZAL: Could you share with us your experiences during Apollo 13?

PACE: Well, yes, it was funny. I had been involved in the development of a lot of the abort procedures. In fact, when I moved to the mission manager job, I had been working on the translunar abort procedures. We were developing a document that was going to give kind of the—I guess you'd say maybe it didn't set the mission rules, but it provided the information for the flight control team to be able to go in and figure out exactly what mission rules, etc., that they needed, and I'd been working on descent orbit, insertion burns, and if they cut off early, what

was your situation, what was your options. We had been developing a document, and I got this opportunity to go be a mission manager and the document wasn't finished and I was struggling with the decision, because I felt accountability for seeing that the document got finished.

I'll never forget, I was talking to one of the guys in the office—I can't remember his name anymore—and I was agonizing over this, and he says, "You know, it's just like sticking your hand in a bucket of water." He says, "When you take it out, there's a couple of ripples, but then it smoothes over and everything continues," and he was right.

So I was working the nightshift on 13, like I said; that was what I'd been doing. But I was off, as I remember, because I had played basketball up at Ellington [Field, Houston, Texas]. We had intramural sports and I had gone up there and played basketball and I was heading home to Dickinson and it was around nine o'clock. I knew that they were out at the point of kind of what we call no return; in other words, if you'd had to come home at that point, you could either take the service module and burn it to depletion and head back toward Earth, or you could basically stay on your path and go around the Moon, and the time was about the same. So essentially, you couldn't shorten the time much and you would have depleted your service module propellant.

So I kind of knew that was where we were in the mission, so I decided I'd just stop by the control center on my way home and just kind of look at the data and look at the abort charts and kind of where they were. I was sitting in one of the back rooms at a console and I'd called up the displays and was looking at them, and Glynn Lunney walked up and kind of slapped me on the shoulder and said, "Hey, Chuck, how's it going?"

I said, "Well, I don't know, Glynn. I just heard the crew make a call that they've got a problem." It had just happened, and he was coming on shift. Gene [Eugene F.] Kranz was the Flight Director and he was going off shift and Glynn was coming on shift.

He said, "Really."

I said, "Yeah, I don't know what's going on." Well, Glynn took off for the control center, and I would say within an hour or so, I realized and we realized that we needed to start getting guys in, because it was going to take everybody to try to figure out how to get this crew home.

So I called Carl and we started calling people in, and from that point forward, I would go to work and go home and sleep and go to work. I was just supporting, like the back room kind of thing, where the guys were working with the flight control team to work problems, try to figure out what their options were. So it's kind of a fuzzy, hazy kind of a period, but it was like as soon as you woke up, you had to go back to work. You couldn't stay at home; you couldn't relax. So that's my memory of Apollo 13 and working all of those problems.

In fact—a little sidelight—I went to see the movie, so people would ask me, "Well, now, since you were there and you were involved in all of that, how real is the movie?"

I said, "Well, I'll give you an example." I said, "You know, I went through that whole process and you're so focused on what you're doing, you never really think about the risk to the crew. I mean, you know it's there, but you don't have time to get emotionally involved with it." But when I went to see the movie, I came out of it with tension headache that was horrible, because it all came back to me, and the magnitude of the risk, and the fact that the guys were able to pull it off was unbelievable.

ROSS-NAZZAL: That's a pretty impressive film.

PACE: Yes, it is. Did you all know that the guys that were shooting the zero-G part of that film, they used what we called the "vomit comet," and they set up the LM [Lunar Module] module in there, a simulation of it, they actually have more zero-G time than any of the astronauts. [Laughter] Something over four hundred hours it took of zero-G time for them to film that, is what I heard. Now, I've heard that; I can't prove that.

ROSS-NAZZAL: That's good to know.

PACE: It makes an interesting thought, doesn't it.

ROSS-NAZZAL: Did you ever have a chance to work with any of the flight crews during the Apollo Program?

PACE: I was very close with the Apollo 9 crew, because I followed that mission very closely. You work with them in the context of—we had what were called mission requirements meetings, which the Apollo Program manager would chair, and it kind of became what's now called the Program Requirements—PRCB—Control Board, but it was the forerunner of that in the Shuttle Program, and it was where everybody sat with the Program Manager and you worked out any issues and got your actions. That was another one of the meetings that you had to attend.

So you were always in there with the crews. In fact, I remember when the subject of Apollo 8 going circumlunar came up, and I read one of the interviews of that and my perception

was a little bit different. Now, it's somewhat based upon hall talk, perhaps, at that time, but I had been working on a mission plan for Apollo 8 that would take it to a high ellipse, because one of the objectives on Apollo 8 was to test the heat shield coming back into the atmosphere at temperatures near what we would see on a lunar mission. The return velocity is 35,750, something like that, typically; it's in that range, and you had to get it up, and we were looking at doing mission that had an ellipse that went up to about 10,000 miles above the Earth. Then when they went over apogee, they would burn the engine to pick up speed and they would essentially just drive the thing back into the atmosphere.

We'd been working hard on that, and the rumor had started to surface that the Russians might be getting ready to attempt a landing. John Mayer, our Division Chief, had been quietly planning with some of the guys on the side about what would you do if you decided to go to the Moon early, because the plan had been the first mission was going to be 10, where you would go simulate everything but the landing. Fly the same ground track so that you had an idea of the problems you were going to have with orbit determination and those kinds of things, and get a good survey of the landing site that Neil [A. Armstrong] and "Buzz" [Edwin E. Aldrin] were going to be facing.

We were sitting in the Mission Requirements Board meeting and—what was the astronaut's name that was the commander?

ROSS-NAZZAL: Frank Borman?

PACE: Borman. Borman. We were all sitting in there and we'd been talking about this high-ellipse mission and Dr. [Christopher C.] Kraft [Jr.] was sitting at his position at the head of the

table, and there were these positions where people sat and nobody else would ever sit. There was some discussion going on about that, and Dr. Kraft turned to Frank and says, "Well, what do you guys think about that? What does the crew think?"

My memory. Frank says, "Well, you know, I kind of like Johnny Mayer's idea of we ought to go circumlunar." Dead silence in the room. The first time it had ever been publicly talked about and Frank started that conversation.

I remember that Kraft kind of thought, "Hmm," and he got up and he walked out, and as he walked out, John Mayer was following him out, because I think John was afraid he might get fired for having planted this idea in the crew's mind. But that was the point at which it then became a viable consideration, and the guys had done some preliminary analysis on how to do the mission and they pulled it off.

ROSS-NAZZAL: As the Apollo Program began to wind down and Apollo 17 was flown and then returned, what was the mood like at the Center?

PACE: It got pretty bad, because we faced a reduction in force [RIF]. Some similarities to what we're seeing right now with the Shuttle Program, where they've made the decision that they want to terminate the Shuttle Program by 2010 or some number like that, and they're going to build this new vehicle, but there's nothing but viewgraph hardware for the new vehicle and it's an easy ten-year process to put a new vehicle into space.

We were kind of in that same situation at the end of Apollo, so you could say we kind of scrapped together the Apollo-Soyuz [Test Project] and we did the Skylab Program as, in a sense, filler, but essentially at the end of Apollo 17 in 1972, I was without a job. They started the



reduction-in-force stuff and there were rumors everywhere and, of course, they actually reduced the Center population from somewhere around 5,000 down to some 3,500, thereabouts, and I actually ended up on a RIF list. But fortunately, my boss took care of me so I didn't have to go through that, but a lot of guys did. So it was a pretty depressing time; very low morale. People were looking for other options, but I never gave any consideration to leaving the agency. I figured if I survived the RIF, I would find something to do, and it worked out for me.

The Apollo [1] fire was a very discouraging time, of course, what we were down for about a year and went through some redesign. The Apollo 13 was a down period and, of course, then the *Challenger*. That was the last one that I experienced working. Those were all very depressing periods for us, because, you know, you lose family when you lose somebody in any of those situations.

I'll go back and bunny-trail on you a little more. When I came here I was twenty-five years old, and it turned out that my age was the average age of the Center for about the next fifteen years. In fact, I was giving a talk for Personnel for new employees and my subject was the creation of the Johnson Space Center. So I went back and went through the personnel files and picked a year—I think I picked 1964—just to get the ages, because the thing that was so fascinating was, we were all a bunch of kids and we didn't have any idea what we were doing, but, by golly, we knew we could do it; just get out of our way. It was kind of that attitude that permeated that whole period through Apollo and all of that.

I found it very interesting, the Center Director was forty-eight years old, and Dr. Kraft, as I remember, was, I think, around thirty-eight years old. Lunney, he was a year older than me; he was twenty-six and he was becoming a Flight Director. So when you look at the ages and the

responsibility level that these people had, it's just an amazing thing that went on there. But at the time, we didn't think about any of that; we were just doing our job.

ROSS-NAZZAL: Before we move away from the Apollo Program, when we had started talking this morning, you said you wanted to talk about the Christmas parties.

PACE: I didn't say I wanted to talk about them; you led me to think you had some background data.

ROSS-NAZZAL: I thought it might be a good opportunity for you to talk about the Christmas parties, if you'd like to.

PACE: Clearly, it was a stress reliever kind of a thing. We got this thing started where we would have a Christmas party, and we would have talent. This was an MPAD party, and we would get guys, like we had a banjo band. Jim [James R.] Elk had gotten some guys together, about three or four of them, and they played banjo music. But the biggest thing was we tended to imbibe and we'd have music and we'd dance. During that period, if you go research it, you'll find there were a lot of divorces in the space program, just because—I mean, used to, you could go to work on Saturday morning, which you typically would do. You'd go in for a few hours and the parking lot would be full. The Building 30 parking lot looked like a regular workday. I mean, people were in and working. That was the kind of thing we were going through.

So when Christmas came around, we kind of wanted to blow off some steam. We would have various talents. A friend of mine got up and did a standup comedy routine and was booed

off the stage. But probably one of the best ones was we had a secretary who had studied ballet, so about a half dozen of us, she talked us into dancing to the *Dance of the Sugarplum Fairies*. So here are these guys in tutus and combat boots, dancing, and there's a film out there somewhere, but I can't find it. I'd like to destroy it. [Laughter] But that's an example. And we had wigs on and, of course, I had this big bushy red beard at the time. So we got a little crazy; had to relieve the stress.

ROSS-NAZZAL: What was it like normally, working for MPAD? What was the organization like?

PACE: It was a great organization. John Mayer did an excellent job. He was a good leader in the sense that he expected you to do your job. He didn't come help you. You never doubted that if you made a mistake, "Okay, fix it." It was that kind of an attitude. There was no recrimination. Everybody worked as a team. We had very few personnel problems. Everybody was so focused and, of course, what we were doing was so challenging and so exciting that it was just an amazing experience for me to have been a part of that. That's about all I can say. I mean, it was as good as it gets, in my opinion.

I used to joke, you know, sometimes on a daily basis I'd think the day was really not all that great, but if I looked at it from a career point of view, I mean, a kid off of a sixty-five-acre farm in Missouri that got an opportunity to work at this is just mind-boggling, and all because of just pure blind luck that I got the job, and it was a real ride.

ROSS-NAZZAL: Once you started working on the Shuttle Program, you started working with the consumable issues. What were some of the major concerns that you dealt with in that office?

PACE: The electrical power system was very marginal, based upon our analysis. We looked at all of the consumables, but most of them, the power was the big one. The vehicle had been sold on the fact that it was going to pull like 8 kW [kilowatt] of power to run. What we did, we had a task with McDonnell Douglas, had some really good engineers on there, and they actually math-modeled the entire electrical system. You could go in then and you could set up a mission profile, and you could actually turn on and off equipment in the computer program to run the analysis so that you could develop a power profile.

It turned out that heaters were going to be a much bigger percentage of the power hog than what had been projected when they had done the early design work on the vehicle. Our analysis was coming out around 12 kW, average power across a mission, and that was really going to take power away from your ability to do payload work and other things.

So there was a big kind of a debate going on about, well, if it's going to take 12 kW to fly the Orbiter, what else can we do? We can't do anything else. This running debate was going on, and at the time, John [F.] Yardley was head of the Office of Space Flight—I forget what the name was—at NASA Headquarters [Washington, D.C.], an outstanding engineer and a very strong-willed individual, and he had been involved in the design of the fuel cells originally. So we were going to have one of those, not a come-to-Jesus meeting, but he was upset over our 12 kW stories that he was hearing, so he asked Lunney, who was then head of the Shuttle, he wanted a briefing on our power analysis.

Well, I had to do the briefing, and we're doing it by telecon [teleconference]. John's in Washington and we're here. Glynn and I are sitting in his conference room and I'm giving this briefing with viewgraphs, and I've worked my way through building my case and working my way up to why it's 12 kW, the heaters, and how we dealt with heaters and this and all this, and I get up and then there's the plot that shows this 12 kW ripple line on this plot. And you'll have to excuse me, but if I'm going to tell this story, I have to tell it right. Yardley says, "Horseshit!"

And I looked at Glynn, thinking, "Okay, Glynn, bail me out. I mean, what am I supposed to say?" Glynn looks at me and he goes [gestures]. So I sat there for a little while and I just picked up the briefing and kept going, because there wasn't anything I could say to that comment. I mean, what do you say to that? [Laughter]

That debate went on until we flew STS-1 and, sure enough, our analysis was within about 10 percent of accurate, so we were vindicated. But that was the biggest challenge that I remember having with doing the consumables job.

We had some struggles with the Flight Ops guys, but part of that was when I came in, the section had a real bad attitude. They just decided nobody liked them; they weren't doing well with their supervision, and there was just a lot of unrest when I took the section over, so it was a pretty good challenge to try to build them back into a team, which was essentially what I worked on. Like they'd say, "You know, the Ops guys don't care about our data; they don't use it."

I said, "Really?" I said, "Why don't we go talk to them." I said, "If they don't want it, then there's no reason for us to do it."

What I found was the previous supervisor, he just didn't work well with the Ops guys, so they just said, "To heck with them. If that's the way they're going to be, we'll get our data someplace else."

So it turns out, after we sat down with them and said, "What do you guys need? Do you need this data? How do you use it?" we got a pretty good working relationship with them. So it turned into a fun job, but it did have its challenges because of those kinds of things.

ROSS-NAZZAL: So how were you able to build that team attitude—you said you came in, the office was pretty negative—other than working with Flight Ops and turning that around?

PACE: Well, I used a very simple approach with them, because they would come in and, ya-ya-ya-ya, they were talking about everybody. I said, "Well, wait a minute, guys. What's the right thing to do?" And I just kept hammering on, "We will do what's right and let the cards fall where they will. If it's an important function, it will get taken care of."

I quickly learned that we had some good guys doing the modeling and that we could have pretty good credibility with the analyses that we were doing. They could defend their data well. So that was basically a very simple-minded approach that said, "Look, let's do the right thing." I even had a thing made up and put it in a frame and hung it on the wall in my office that said, "When in doubt, do what's right," and it seemed to work, because we ended up with a good organization and did some really good work with a lot of fun.

ROSS-NAZZAL: Once you started working on Center operations, building those facilities for the Department of Defense, can you give us an idea of what some of those facilities were that you worked on?

PACE: Basically, when you're dealing with classified data that's going to be flowing, you have to build a room like we had the computers in. You had to have the room built so that the bad guys couldn't monitor it through the walls. You had certain requirements for how the walls had to be built in order for nothing to get outside of them. Had to put in a lot of secure communications lines, data lines. So it was principally that; building out these facilities to these very rigid requirements that the DOD was leveling on us.

The struggle we had was the conflict between our guys, because the philosophy that we had always used was everything's open. You keep nothing from anybody; you share everything you know. So NASA's challenge was to be very open, and NASA had basically no classified data of its own. I had to deal on some occasions with some Air Force information that was classified, but other than that, we really didn't do any. Then all of a sudden we're going to be dealing with top secret, which is very strict in its requirements.

So we had to go through a whole cultural change with our guys of realizing that they had to protect this information; they had to accept, if you will, the overhead of what it takes to do their job. You can't just talk to a guy in the hall; you have to go to a secure room if you want to have a conversation. There was just a lot of cultural change that had to occur in addition. In fact, it was probably more difficult—I mean, we had a lot of real strong arguments with the DOD, because, like I said, Howard Ferrill had worked in that world for his whole career, and they were levying requirements on us that were really more rigid than was really required for a lot of the work we were going to be doing for them.

So we had a lot of those battles with the DOD and with their contractors, and then we had the cultural change we had to make with our guys. And it was with the guys doing the jobs. It wasn't with the facilities people. They were pretty much, "Tell me what you want and I'll build

it.” It was that kind of thing and some budget battles, of course. I mean, the DOD wanted NASA to pay for it, and NASA said, “No, it’s your requirement. If you want it, you pay for it.” So it was a lot of those kinds of things, so it was a very different experience from what I had had previously; budget battles, requirements battles, subjects I didn’t understand when I started, but I did learn a lot over there.

ROSS-NAZZAL: How did you transition into this position, since it was so different, as you pointed out?

PACE: It was cold turkey. I just showed up and they gave me a desk, and Howard Ferrill showed up and started telling me what I needed to be doing, because the guy he had been working with, like I said, had left the agency, so he had been pretty much the only guy that was really overseeing it, if you will. Howard was a hard worker and a smart guy. I mean, we had our run-ins occasionally, but without him I could never have done the job. It’d have had to been somebody else, I guess, is what it would have been.

We became great friends and we had a lot of great parties together, because we traveled about twice a month through that whole period. We were doing a lot of work at KSC [Kennedy Space Center, Florida], a lot of work at Huntsville [Alabama], Marshall Space Flight Center, a lot of work in Downey [California] at the Rockwell plant, and a lot at the Center, so we were constantly just going and reviewing where the guys were and working problems, conflicts that they were having with the DOD and with their own people, trying to keep this thing on track, because we were on a pretty tight schedule originally. When I took the job, it was a pretty tight schedule.



It was a good time for me, because I was going through a divorce. I went to the program office in 1980 and started this job, and that was at the time that my now ex had moved out and I was going through that crisis, so it was a good time to have a distraction. So we did that for over two years. I was working all of that very hard.

ROSS-NAZZAL: You mentioned that you did a lot of traveling at that point; you went out to some of the various Centers and then out to Downey. What were some of the issues you were working at these various Centers and sites?

PACE: It was the requirements conflicts. I mean, the DOD, they would say it had to be done this way, and our guys were saying, "Oh, you can't do that." I mean, it was all caught up in this getting our guys culturally to accept that they were going to have to do it, because they really didn't want to, is what it amounted to; it was just a burden, and what they wanted to do was do their job the way they'd been doing it.

So it was just that kind of thing and just negotiating these struggles that they were having, and being an arbiter, if you will, or trying to get everybody—you know, crises like that, typically, I've found, is they get to yammering at each other and they're not communicating any longer. So if you just say, "Get them all in a room." So we'd go down there and we'd get a secure conference room, we'd get everybody in there, and say, "Okay, now, what's the problem?" and just have at it. And suddenly, they could find a way to resolve it, and you become a hero, even though you didn't do anything except make them talk to each other. So it was a lot of that kind of thing.

ROSS-NAZZAL: You talked about the facilities having to be changed at JSC. Were those facilities primarily in Building 30 or were they in other buildings as well?

PACE: The simulators were secured over in Building 5. The control center was secured. Now, that's Building 30, but it's the Building 30 wing. Then we had computers in the office wing of Building 30 that were secured, where a lot of the analysis work was done. Then conference rooms; we had to secure our conference rooms, where we could have classified meetings, telecons and those kinds of things. So it was a myriad of pockets here and there, if you will. But the control center and the simulators were two of the biggies that were real challenges for the guys.

ROSS-NAZZAL: While you were working on this, STS-1 finally went up. What are your memories of that mission?

PACE: I went to the Cape [Canaveral, Florida] to see it, because I had gone through the whole Apollo Program and because I worked the missions, I never had a chance to go down and see a Saturn V launch. I was really disappointed over that, so I said, "By golly, I am going to see the first Shuttle launch." So four of us decided that we would just road-trip and go see the launch. So we loaded up a case of beer, a big bottle of rum—I forget, seems like we had maybe some wine; I can't remember—in the trunk of my car, and the four of us headed out to the Cape.

We left like at three o'clock in the afternoon. We were going to drive straight through, because we had four drivers. About every five miles, you'd see us, the car on the side of the road and we'd be off in the weeds, because we were drinking beer as we were driving.

[Laughter] Anyway, we got into the Cape at, I don't know, it was two o'clock in the morning, I think, and we had to go through to get checked out to say, "Yeah, you can go."

We went out and there's a road that goes down by the Vertical Assembly Building, if you've been to the Cape, and you can actually follow that road down and then come back across into Titusville [Florida]. So we just went down there and parked on the side of the road and we just camped out out there until we watched the—well, you know, they scrubbed the first day. So we decided, okay, by golly, we're not going home; we're here to see this thing. Because they'd had a software problem, so we figured that would probably get worked out.

So we went over to Titusville and we got a room and hung around there and had a nice dinner, went out the next morning and started it all over again. In fact, there's a photo someplace, and I wish I still had it. There was a ditch, and I was lying on a blanket up on the side of the ditch, right by the road, sound asleep, with a beer in my hand. [Laughs]

That was how I got to see STS-1, and it was a very emotional experience. Some guy came down the road, waving a big flag and we were all teary-eyed. I mean, it was an awesome, awesome experience. If you haven't seen a launch, you don't realize the noise; it vibrates you, you know, so it makes it even more emotional, especially since it was the first of that vehicle, and Lord only knew what those guys were going to find when they got into orbit and had to come back through entry, because nobody had ever done it. The only entry experience they'd had was from 25,000 feet down, with the approach and landing tests that they had done. So it was a pretty emotional time.

ROSS-NAZZAL: Once you had finished working on the facilities for the DOD, what were some of your assignments afterwards?

PACE: They put me acting on a—I guess you'd call it a branch in the payload integration organization, working for Leonard [S.] Nicholson. Our job had some guys that worked Edwards [Air Force Base, California] requirements activities. We had a myriad of things. It was not a fun job, from my point of view. It had a lot of dribs and drabs. They worked weather requirements; they worked odds and ends for the Shuttle Program.

They made me acting of the office, which meant I should get a promotion, and I went along for a year in that job and nothing was happening and I was getting pretty frustrated, because normally if you got into a job in acting, etc., they would advertise the job in about six months or so and it would be competed. Nothing had happened, and so I decided I would look into going to industry. I felt I wasn't going to go anyplace with the government; maybe it was time for me to look elsewhere, look outside, and they advertised the job.

We may have to edit this, but I'll go ahead and tell the story. I was angry about all of this. So the day that the announcement closed for them to select, I walked in and told my boss I wasn't going to apply, because I was thinking about going to industry at the end of the year, and there'd been rumors that they might have an early out and I just decided that I would take advantage of that and I was going to go to industry. Then I went on annual leave and left. It was about noon when I told him, and that was Friday.

Monday morning, when I got in, the secretary was frantic and she says, "Mr. Nicholson's looking for you. You need to go see him immediately."

I thought, "Uh-oh." So I went down to talk to him. He was a very strong-willed, a good engineer, and a lot of people struggled with Leonard because he was very strong in controlling his organization. I had intentionally, because of that, tried to stay clear of him in the job when I

was running the branch. Of course, that's kind of the way I work. If I've got a problem, I'll try to go solve it. If I get to where I can't solve it on my own and I need help, then I'll go ask for it. But I'm not one to go talk to the boss about what I'm doing unless I need to. I mean, I'll keep him aware, but I don't ask him for help unless I need it.

So anyway, I go into see Leonard, and he says, "I understand you didn't apply."

"Yeah, I'm thinking about—."

We had this conversation, and he says, "Well, look, that's okay. Why don't you go ahead and apply and if you decide to leave later on, that's fine, but you really ought to." So I did and, of course, I got the job.

I was in it for about year, with the official title, and I'm sitting there one day and Leonard walks in my office. I thought, "Uh-oh. I'm going to get payback now." [Laughs]

He sits down and says, "Pace, I got a deal you can't refuse."

I thought, "Oh, boy." So he asked me to come down and be an assistant to him. I called it a "Hey, boy" job, because he had a deputy and they had their relationships worked out, but you get these things that come up that need to be worked, so it's work the brushfires, whatever comes along.

It turned out it was the perfect job for me. I really enjoyed it, and I worked for Leonard then in that job and then he moved down to the fifth floor and became head of the Shuttle Program when Dick [Richard H.] Kohrs retired, and he took me down there and I worked as assistant to him down there. He left and went to Engineering, and Brewster [H.] Shaw came in and I worked for Brewster for a while, but Brewster was just a different style of manager.

Hal [Cheever H.] Lambert was retiring as head of the payload integration, which was the previous organization that Leonard had been in and that I'd worked for him there. Hal came and

asked me if I'd be willing to come back up to his area and help Ron [Ronald D.] Dittmore, who was his deputy, but had only been in the job six months and was going to be taking over the office. He was a Flight Director who had come over to the program, so he really hadn't had the program office exposure and didn't know some of the ins and outs of it, maybe. Hal asked me if I'd be willing to come back up and work for Ron through his transition. So I did that.

Then in '95 I retired. I took the retirement, fifty-eight. I was ready and they were reorganizing and there really wasn't anything I was interested in doing. I had just about been everywhere I wanted to go at the Center and I decided I needed to do something different, which turned out good.

ROSS-NAZZAL: How closely did you work with any of the flight crews as you were working on the Shuttle Program?

PACE: Well, again, you're sitting in the meetings with them. In addition, we would rotate astronauts through the office. When I was working for Leonard, Don [Donald E.] Williams was an Assistant Office Manager for a while and I got to know Don really well working with him. Ron [Ronald J.] Grabe was another one that rotated through there. So you get to know them through that. As far as working intimately with them, because of the kinds of things I did, I knew them, could talk to them if there was something associated with what I was doing. I didn't have any problem with that. But I wasn't really real close with most of them.

ROSS-NAZZAL: This would be a good time for us to stop, actually.

[Tape change.]

ROSS-NAZZAL: What are your memories of the *Challenger* accident? You were still working in the office then.

PACE: We were watching the launch. I was working in the payload integration area. My boss was down at the Cape, so a bunch of us were in his office and he had a TV. So we were all in there watching it. I was standing in the doorway beside Brewster Shaw when it lifted off and then we had the explosion. And everybody's going, "What happened? What happened?"

I looked at Brewster and he said, "I think I know what happened," and he took off, and the reality of it just hit home. And you know, from that point on, you're worthless. I mean, you're just—I don't know. The props are knocked out from under you; you can't function. You can't do work. And it took a while. Of course, everybody started trying to get refocused, but it was a tough year, easily a year of just—it wasn't fun to go to work just because of what we were dealing with.

I had very little involvement with any of the accident investigation, any of that. Like I said, I was—let's see. I'm trying to remember. That was in, what, '86. I can't remember. I can't get all the numbers straight as to where I was working at the time, but I was on the seventh floor. I must have been working for Leonard.

So anyway, you just kind of went on through your day-to-day activities and sat in on all the meetings as they were trying to recover from all of that. But it was a very difficult time.

ROSS-NAZZAL: What was the mood like at the Center when STS-26 finally launched and returned safely?

PACE: Apprehension because of the risk that now was real clear in everybody's minds, but looking forward to getting back to work; eager to get back to flying. I mean, we are a flying organization. If we're not flying, we're not doing well. We had that same flat spot during the post-Apollo period, where it was kind of like make-work. The successful mentality at the Center, in my mind, has been when we were under the pressure to produce. The guys really step up to the plate and will do whatever is needed. That's why, even now, I mean, I'm not actively involved, but my lady friend is. She works for the Program Manager. She's on his staff and she comes home and I have to listen to the day's activities. I know what they're going through; it's a real struggle.

ROSS-NAZZAL: Our research shows that you actually transferred over to KSC for a few years.

PACE: No; another interesting story. The NASA Headquarters folks, in their infinite wisdom, concluded that the Shuttle Program Manager needed to be co-located with the hardware rather than with operations; he needed to be co-located with the hardware. So the Administrator had made the decision that they would move the Shuttle Program management to Florida. I was on Leonard's staff at the time, so he asked me if I would go. I said, "Well, if Joan goes, I'll go." Joan's my significant other.

Leonard knew it was the wrong decision, essentially, so he wasn't going to move the whole management CG, because a lot of it's tied to Engineering, tied to Ops here. Yes, there's



the stuff that's tied to the Cape and tied to Huntsville, but we had a management system that worked fine. So Leonard concluded that we would put a nucleus in place down there: himself; Larry [Lawrence G.] Williams, who was systems integration for Leonard, he was going to go; and I was going to go on Leonard's staff; and about a half a dozen people to staff up a Shuttle Program management team, but basically leave the day-to-day operations pretty much as they were.

So we had gone down and started house hunting, and Leonard had said he wasn't going to buy; he was going to keep his house here, because he envisioned eventually returning. So they were going to rent an apartment. We were in the process of making all this happen and we had found a house in Titusville that we kind of liked. We were waiting for orders, because in the government, you can't make an offer on a house until you have orders to move. Then the government will pay for your move. But if you do it before then and then it falls through, you're stuck. And one of the guys went down there and looked, and made an offer on a house and bought it, and he didn't have orders. Anyway, they had to help him out of his dilemma.

But just about the time we were getting ready to get orders and start the formal process, the Administrator left and Dan [Daniel S.] Goldin came in as the new Administrator, and they talked him into reviewing the decision and he reversed it. So we never moved, which, as it turns out, I'm glad. I really didn't want to move to Florida, but I would have. So that's how all that went.

ROSS-NAZZAL: So you retired, and what have you been doing since you retired?

PACE: We built a house over in Pinebrook, with a three-car garage and I added ten feet on the back of it and I set it up as a woodshop. I had hobbled with woodworking over the years, but because of the work schedule, I had never really been able to put in any serious time. I had bought a few tools, so I decided that that would be my focus.

So when I retired—I retired in March—and I said, you know, I had never worked in retail, because I had thirty-six years of government service. I said, “I think I’ll go out to Sears and I’ll get a job in the tool department, and I’ll work there and I’ll buy all the tools I want that Sears has.” So I did that; I started in it seems like it was September, thereabouts. I can’t remember exactly. It takes about six months to unwind after you’ve been in this business, and some people don’t do it that quickly. I adjusted fairly quickly in about six months. You go through a spin-down process anyway.

So I went out there and got a job and I worked in the tool department. I averaged seven dollars an hour while I worked there, and every paycheck I walked out with all these sacks of tools. [Laughs] I did that through Christmas and it wasn’t bad. I mean, I was working like five-hour shifts about three days a week. They won’t let you have over thirty hours; they have to start paying you benefits and a bunch of stuff.

I got to January and nobody buys anything in January, because they are busy doing income tax, recovering from Christmas, and it was the most boring thing I had ever done, standing there with nothing to do. So I said, “No, I’m done. I’m out of here,” and I’d bought all the things that Sears had that I really wanted.

So I do a little Habitat for Humanity in La Porte [Texas] and I do Meals on Wheels. I would do that one-day a week or so, depending on when they call me. I do a little volunteer work and then playing in my woodshop, and I was doing fine.

Then I got a call from USA, United Space Alliance, and they were getting ready to fly the first Space Station hardware, and the launch was scheduled for about six months away, and they had discovered that their certification-of-flight-readiness process and their document was totally unacceptable, inadequate to do the job. They were looking for somebody that had Shuttle Program experience with flight certification, and I had been going with Leonard to flight readiness reviews and all of these things, working for him. Essentially, my job was to be there with Leonard in any meeting that he had, because the guys would come to me and they'd say, "What did Leonard mean by this?" They were afraid to go ask him, so they would come ask me. So my job was to interpret, and a lot of it was that sort of thing. Anyway, so I'd been to all of the launches and participated in all of that.

So they were looking for somebody to help them rewrite the certification-of-flight-readiness document. We said, "Boy, it's going to be impossible to write that in six months," especially because they almost needed to start their review process. Well, the hardware slipped. Two years later, we managed to get the document done just in time, and they launched. [Laughs] So anyway, I spent two years working for USA on Space Station doing that. So I really finished out my woodshop.

At the end of that, I knew I could continue. They'd find projects for me, but I really wanted to put in some time in woodworking, so I decided to just hang it up. So that's all I've done since then is play, make sawdust occasionally.

ROSS-NAZZAL: Looking back over your career with NASA, what do you think was your most challenging milestone?

PACE: The consumables section, I think because of the environment that I was moving into and the fact that I had no credibility in that area. It was just that the guys trusted me to come supervise them. That was the key, was that they were comfortable with having me as their supervisor, knowing I didn't know anything about the business, but I learned and we worked and built a team. I think that was the biggest challenge that I had.

ROSS-NAZZAL: By contrast, what do you think was your most significant accomplishment?

PACE: I guess the thing I always go back to is the Apollo 9 mission design. I have a fond memory of Carl and I sitting there and doing this creative work using a globe and a slide rule. It's hard to imagine, but just being able to come up and know exactly where you wanted to do the maneuver and work it all out, using these basic tools, and having it turn out to be—I mean, there were some tweaks the guys had to make to it, but basically the mission plan we put together that night was what we flew. So I always have a fond memory of that one, so I guess I would say that.

ROSS-NAZZAL: If you don't mind, I'd like to ask Rebecca and Sandra if they have any questions for you before you go.

WRIGHT: I have one I was thinking about. When you came to work, the nation was trying to get men on the Moon before Russia, but before you left, we had moved into an international partnership, started working on international partnerships for the Space Station. Were you

involved at all with working with the international partners and doing anything with those systems?

PACE: No. Being on staff to Leonard, I was on the periphery of it, but I had no active role in it. No, nothing to do with any of that; that's the answer to your question.

WRIGHT: Okay, I'll ask one more then. You had mentioned earlier, as back, part of the early part of your career of the planning and talking about Bill Tindall and how Bill Tindall pulled these groups together to do that. Could you share with us your insight to how he was able to and other people that you worked with were able to bring in so many different aspects, with everyone working their parts, knowing that what they had done was right, but how that was all able to come together to come up with a plan that worked? Because some people had to give, some people had to go back and redo. How was there not friction? Or was there friction? Can you give us some insights on how all that worked?

PACE: There were a lot of arguments. There were a lot of unique people that came to the space program, to start off with, in that era. I mean, a lot of individuals, people that were willing to take risk and that sort of thing, and Bill was one of those guys who had the talent and the tenacity, and I feel he had the vision of where he knew we needed to go, because the reason that got started was, you know, the Flight Controllers were over there struggling, trying to figure out what they were going to do, and the MPAD guys were designing the missions, and there was all of this, if you will, sort of turmoil, and everybody was focused on their areas and there wasn't anyone doing that top-down system integration, pull it all together.

Oh yes, there was a lot of competition. I mean, Rod [Rodney G.] Rose and Bill Tindall and Carl Huss and Morris [V.] Jenkins were all very strong people with very strong opinions about how these things should be done. We'd go to those meetings and you'd start at eight-thirty in the morning, and you'd break for lunch and you might go to six or seven o'clock at night, and I mean it was just grind it out. Bill stood at the front of the room, foot on a chair, "Well, what about this?" He would challenge the guys, "Well, how are you going to do this?" It was an inch-by-inch process, and it had all the right people in the room so that you could get the right answers, and there were arguments.

But the nice thing about it at that time was, and we've always joked about it, I mean, you could be in a meeting and just have this hellacious argument with somebody and then go get a beer with them after the meeting was over. We didn't carry grudges. It was all at a professional level, if you will. Everybody was focused on trying to do the right thing, so you gave, you took, you just worked your way through it, essentially. It was a very interesting experience, watching that come together.

WRIGHT: Do you find that same process and that same philosophy as the Shuttle Program began and you became so involved in those meetings from those early days?

PACE: Yes, pretty much. Of course, the culture of the Center has changed over the years. The guys that created the Center, like all of us who came here kind of as that initial nucleus, had moved to various other places and started retiring. When Shuttle came on, a lot of the strong leadership was up out of the mainstream. It was a different situation, but, in general, that culture is still maintained where the guys want to do the right job. People that come to the space

program, in general, know why they come, and it's because that's where they want to be and they want to contribute. So, yes.

WRIGHT: My last question would be that all those years that you worked, there were so many areas of focus that you were involved in and the stress level seemed to stay the same. You mentioned that you wanted to stay here. Could you share with us some of the reasons that you never wanted to leave the space agency during that time?

PACE: There wasn't anything else I wanted to do. It was just too much fun. Yes, I never gave it any thought that there was anything else in life that I would want to do.

ROSS-NAZZAL: Is there anything else that you think we should talk about today, or that you wanted to talk about when you came over?

PACE: I could relate my first briefing I gave to Dr. Kraft, a very intimidating man. We lived in fear of him, and it was a fear because he was the boss. It was that kind of thing. I had been working on the first mission for Saturn V, the first launch for Saturn V, and we wanted to test out the launch phase, so we were working on kind of a ballistic shot for the spacecraft, and I had been working on the design of that.

Dr. Kraft was then head of Flight Operations and he would have these meetings with his staff and he liked to have some of the young—they called them engineers. I wasn't an engineer, but anyway, he liked to have some of the guys come in and brief him on what they were doing. It was a chance for them to see the younger guys, because if you were up for promotion, they

wanted to know who you were and have some feel and get acquainted or get a look at you, I guess.

So I was scheduled for my briefing on the Saturn 501, was the mission name, my briefing to Chris and his managers. It was the first time I'd ever done this. So I'd gotten my charts all put together and I had worked them with my management, Carl and I forget who my section head was; probably Clay Hicks at the time—anyway, to make sure that I had my story and that it was a good, credible story.

So then I would go in the conference room and I would lock the door and I would turn the lights off and turn on the viewgraph machine, just like it was going to be when I gave my briefing, and I would go through the briefing. So I'd hear my own voice, so I would work on what I was going to say and when, because I was so nervous about this briefing, as you can imagine. Well, fortunately, I guess, my work turned out, because it went fine. But it was a very apprehensive day in my life.

I might tell you one other little story. When I first came on board, I didn't know anything. Of course, I had to go through a learning process to get up to where I could even be a productive person. Like I said, we were flying MA-8 and MA-9, and I think you'll find this interesting, because Carl was the retrofire officer and he was in Florida, where the control center was at that time, doing his job during the missions. And what they had set up was over at the University of Houston, where the computers were, we had a back room that some of us were in there and we were to support Carl. So if he wanted any data, he would call us up. He'd call us up on a black phone, on a regular telephone, and Carl was one of these guys that he'd go a mile a minute, so you'd writing as fast as you can, trying to get down what he wanted you to do. "Run these cases," and he'd list all these cases.



I can't remember the guy's name that had been part of developing the CO3E program that we used to run all of these Earth orbit analyses. He had a table in there and he had these drawers out of these file cabinets that would hold the IBM cards; they were designed to hold the old IBM cards. And he'd have flight-path angle of one number, with different velocities, and then he'd have another flight-path angle. And he had all these drawers lined up with these IBM cards already pretyped, so that any case that Carl asked for, we could run real quick.

So Carl would call up on the black phone and we'd get our instructions, and then we'd scramble around and get the decks pulled together and he'd run out on the floor and give them to the operator and he'd run them, and if they were right, then he'd bring them back. We'd get the data all pulled together and then we'd call Carl on the black phone. So this was how we supported him in real time during the Mercury missions. I always thought how archaic that is compared to the way you fly missions today and you've got the TDRS [Tracking and Data Relay] satellite and GPS [Global Positioning System] and all of these things, so that it's such a different world from the way we started. But I think that's an interesting story about how we were providing backroom support to him.

ROSS-NAZZAL: That's a great story. We thank you for coming in today. We really enjoyed it.

[End of interview]