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NORMAN H. CHAFFEE
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ROSS-NAZZAL: Today is February 7th, 2006. This oral history with Norm Chaffee 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.

Thanks again for joining us for this fourth session.

CHAFFEE: It's my pleasure.

ROSS-NAZZAL: And I'd like to begin by talking about your work on Space Station. How did you become involved in this program?

CHAFFEE: Okay. Well, I was Deputy Chief in the Propulsion [and] Power Division in the early eighties. Shortly after we successfully launched STS-1, and it was clear that the Shuttle program was entering its operational phase, the activity got kicked up to start talking about what is our next program going to be, because in the course of events, the engineering staff has essentially done its job and turned the project over to the operations people by the time the vehicles start flying. And although we had plenty to do to monitor the flights and work problems, that kind of stuff, the development guys needed something to work on, so the push really came to start to—the push toward getting approval from the government for something next, the intention being that it be the Space Station Program. So very early in the eighties, late '81, '82, there was an

awful lot of studies going on that we were participating in, trying to define what the Space Station was, that type of thing.

Along about—I can't remember exactly—'82, late '82, early '83, there was a tiger team formed to write what they call the systems engineering and integration plan for the Space Station Program. And we had realized that the vehicle was going to be so large that you can't launch it now in a single—you can't put it together in a single activity somewhere—you can't check out the whole thing in a single activity at Kennedy Space Center [Florida], you can't launch the entire vehicle in one fell swoop like we had done in all our previous activities. This was going to have to be built in pieces, assembled on orbit.

It was also clear that the scope of the program was going to be so large we were going to have to spread it around amongst the NASA Centers that were typically involved in the manned spaceflight and maybe even some others. And, some of the other Centers were very actively politicking and trying to establish themselves where they could get a piece of the business, realizing that Space Station was going to be the big dog in the kennel.

Anyway, this systems engineering [and] integration team was formed, and each division had [to] supply a senior type and a couple of junior types. And being the Deputy Division Chief—one of the rules for being Deputy Division Chief is that your job includes everything the Division Chief doesn't want to do. So in that case, my Division Chief was Henry [O.] Pohl, and there was no way he was going to go off and work on some tiger team when he could do other interesting things like working on the Shuttle flight problems and that kind of stuff that came up every two or three months, when we flew another Shuttle.

So I went off to this tiger team, and they sequestered us over in Building Seventeen, I believe it was. And we had a room, and we started talking about the process and looking at the

designs and everything. That was the first time I really came to understand what a complex and complicated job the Space Station was going to be, because in previous programs, the interfaces between partners were very, very simple. For instance, on Mercury, Gemini, and Apollo, one contractor basically and one Center was responsible for a big piece, you know, the spacecraft side, and then Marshall Space Flight Center [Huntsville, Alabama] and their contractor was responsible for the booster. And relatively, technically speaking, the interface between those two was very simple. You bolted it together; you connected some wires. And that's oversimplification, but you really weren't deeply into each other's knickers in doing your work. You could go off and work independently, do your job. If you met your specification, you could meet at the Cape [Canaveral, Florida], bolt everything together, make sure it was done right, and then you could have a pretty good feeling that everything was going to be all right.

And for those areas you really needed to watch, you'd form a little committee that would review interfaces and be sure that nobody had a misunderstanding of how it was supposed to go together and this type of thing.

Once we got into the SE&I work, systems engineering and integration work for the Station, and started looking at some of the management proposals that were coming up about how to divide the work, it was clear that not only the technical job of putting together something on orbit with forty-plus launches was going to be tough but that the interfaces were so intricate and intertwined between the Centers that might have to do the work in whatever management and political way the work got divided up, that that was really going to complicate the issue. And the problem of controlling interfaces between organizations, between physical pieces and everything, was going to be an immense, immense job.

One of the things this team did was to prepare an overview of the SE&I process and then write an SE&I plan, which included not only the engineering and the suggested methodology for coordinating all the activities, but it was all the nitty-gritty stuff about how you select engineering standards, how you select the drawing system that everybody's going to use so you can exchange drawings, what specifications are we going to jointly specify on the parts that different Centers are going to procure, so that when everything comes together, it's all been made to a common set of requirements and specifications, and what are the safety, reliability, and quality assurance standards going to be, how are we going to control interfaces, how do we document the requirements, how do we document changes, how do we control and document costs, and all those kind of things.

So it was an immense job, and I ended up being one of the leaders of pulling that thing together. It ended up being a couple-hundred-page document, and even that just, you know, was kind of a broad-brush approach as a top-level document that would indicate to interested people what the complexity of this thing was going to [be]. Then there was about a twenty, twenty-five page executive summary which a Senior Manager could read and really get their arms around what the job was going to be.

Well, I've always had a way with written words. I never had a problem expressing myself either verbally, because I'm a ham and like to get up and talk in front of people, but I've also had a tradition of being able to write well. I think I inherited that from my father, who was an outstanding writer. When we were living in Tulsa [Oklahoma], he used to write occasional things for the newspaper. And he had a weekly book review column that he wrote for the Tulsa *Tribune*, and we always had lots of books in the house. Even occasionally, when he got one that he didn't want to read, like science fiction or something, he'd give it to me, and I'd read it and

ghostwrite the book review for the paper type of thing. But I've always prided myself on being able to organize my thoughts.

So I ended up designated as the chief author for this SE&I, Space Station SE&I, report and did write it. That was the time when I first realized, boy, what a challenge this is going to be and what an interesting job this would be.

So we got all that done and turned in and went back to the Propulsion [and] Power Division. Sometime after that, they did convince the administration, President [Ronald W.] Reagan and his administration at the time, that the Space Station was going to happen. And with some of the early studies, which were very unrealistic, in my view, as far as scope and content and were very optimistic relative to the lack of problems we were going to have and this type of thing, they told the administration we could go build a Space Station for $8 billion.

Everybody was scratching their head, saying, "Where did they get that number?" I mean, "How did we get there?" But there had been all these studies done pre-Phase A and Phase A that the aerospace industry was involved in. So Lockheed had done their studies, and McDonald-Douglas and Rockwell and Grumman and Northrop and everybody who wanted to be a piece of the business was doing their studies.

At the same time, all of the NASA Centers that had an even remote chance of being a part of the activity were trying to position themselves, not only within NASA but not too surreptitiously even outside, through their elected representatives and that kind of stuff. So the senators from Maryland were making speeches about how much the Goddard Space Flight Center [Greenbelt, Maryland] had to offer the Space Station, and the representatives and senators from Alabama were protecting Marshall, and of course, our people were looking out for Johnson Space Center.

And even the Lewis Research Center, which is now Glenn Research Center [Cleveland, Ohio], you know, had some propulsion and power capability, they were trying to stake out a position where they could get some of that business, which at the time was a very direct threat to me, because I was Deputy Chief of the Propulsion and Power business, and I wasn't about to acknowledge that any other Center ought to pull off responsibility for the development and management of the propulsion and power activity. So we were deeply involved in, you know, trying to shut down that argument and punch holes in it and say, these guys are R&D [Research and Development] guys, they ought to go off and do R&D, and we're the ones that have the experience in building actual flight systems for manned spacecraft, and it's very clear that that's where you go for that hardware on the Space Station, is to the Johnson Space Center.

Anyway, that was going on at the time, and I was looking at it through very jaundiced eyes from the standpoint of being Deputy Chief of the Propulsion [and] Power Division. They did get the formal approval for the program. They named two guys, one of which I knew very well, Neil [B.] Hutchinson, as the first Program Manager. Neil came out of Mission Operations. He'd been a Flight Director. He was very well known. He and I had been to some advanced training together, so I knew him to some degree.

His deputy was a guy named John [W.] Aaron, who had come out, again, kind of on the operations side. He was more of a computer systems guy from the background. He'd been Division Chief of the—I can't remember, it was something like Computer Systems Division or something like that over there. He had a very good reputation.

He had been a flight controller back during the Apollo program and had been one of the guys, I think, that when Apollo [12] was struck by lightning, John Aaron made the call that we don't have to abort, that do this, that, and the other and we'll recover the data that they lost from

the electrical surge. So he was very well thought of as just an extraordinary technical guy who could really think fast on his feet and this type of stuff. The thing is, nobody knew what kind of managers either one of these guys were going to be.

They formed the new Program Office; they need staff. They had a call go out for some of the key people to come over to fill the positions to help them then flesh out the organization. And I expressed an interest to the systems—and, the year, it's 1983, I've been in the Propulsion and Power Division twenty-one years. I'm Deputy Division Chief. I think I've got my arms around this technology, and that kind of stuff. While it's interesting, I'm more right now in a turn-the-crank mode than really feeling personally challenged mode; I think I'm probably ready for something new.

I talked to Henry about that, and Henry said, "Well, you're a good asset. You'd be good in the Program Office if you can find a spot that uses your talents." And he said, "I'm not going to hold you up if that's what you want to do," and said, "Great. I'll support you. Nobody's not replaceable. We can replace Norm over here." So I let it be known that I'd like to do that.

Well, Neil Hutchinson called me and asked me if I'd consider coming over as his technical assistant, and I said yes, indeed, I would, and we started the paperwork along that line. And before that could even come to pass, he changed his mind because he'd recruited another guy from Engineering who was Max [Maxime A.] Faget's Assistant Director of Engineering, a guy named Al [Allen J.] Louviere. He recruited Al to be Manager of Systems Engineering and Integration. Al had tapped a young guy called Mark [K.] Craig, who was an excellent, excellent guy to come in and be Manager under him of Systems Engineering, and he was looking [for] a guy to run Systems Integration. He knew that I had been chief author of this earlier SE&I report, so he had talked to Neil, and Neil said, "Well, I did want you to come over and be my Technical

Assistant, but I'd really like you now to go down and be Chief of Systems Integration under Al Louviere in SE&I."

So I said, "Boy, that sounds interesting, because I know what that job's about. I just wrote this report in the last year and a half or so, I know what a challenge it's going to be." So that's what I did. I went over and essentially became Chief Engineer for Systems Integration under Al Louviere in the SE&I Office.

This was at the Level II organization, which in NASA parlance means it's the organization in the field that has ultimate program-wide responsibility, and it's a detailed technical responsibility, as opposed to a program office at [NASA] Headquarters [Washington, D.C.], which is called Level I, where they had the kind of the political and the overall responsibility but at a very high budgetary and political policy level. So Level II was the highest program level at which you had detailed technical responsibilities and that type of thing.

The next level down was called Level III, and those were called the project offices, where we were called the program office. By that time, they had made some pretty good decisions about how they were going to divide the work up. And I didn't realize how difficult those decisions were going to make the program job, but they took some of the major systems and gave [them] to the Johnson Space Center. They gave some of the external structural work to the Marshall Space Flight Center. They gave requirements for the research modules, some of that, to the Goddard Space Flight Center, who had never done anything like that before. And much to my dismay, they took the propulsion and power work and gave it to Lewis Research Center.

Then later on, they did kind of pull that back, and Lewis ended up with the power and Marshall ended up with the propulsion, which again, I thought was unfortunate, because the type of propulsion involved was not where Marshall's expertise was. Their expertise was in launch

propulsion, very large devices that fired one or a few times and were done, as opposed to the space operations of lower thrust devices that had to operate many times over a long period of time.

They ended up in another bad decision, in my view, pulled out the environmental and life support systems, which had been only done by the Johnson Space Center for years and years, and gave that to the Marshall Space Flight Center, which had absolutely no experience in doing that but had started doing internal programs to position themselves for that responsibility. I'm convinced, without any detailed insight, that it was just a political give and take, that, well, any Center can do anything, and so we've got to balance this out, and what can we give to this Center, what can we give to that Center, that type of stuff. So it ended up being that way.

As a result, the interfaces were very, very tough, because, as an example, I think—I'm not sure, I think there's about forty-five launchable pieces now, or work packages now—I can't remember what the number was there, but the electrical system, electrical distribution system, has to run through all of the forty-five pieces, say, if that's the number of total pieces. Well, if the Lewis [Research] Center was responsible for the electrical distribution system, then you've got to argue, well, does the Lewis contractor install the wiring and the electrical buses and everything in every piece, or do they write the requirements and tell the Houston guys, "Here's how you've got to do it," and the Marshall guys, "Here's how you do yours," and the Goddard guys, "Here's how you do yours," and that kind of stuff. Who actually does that? Who fills these things up? The same thing with the environmental systems, with the guidance navigation and control systems, which Houston had.

So all of these things exist mostly in all of the pieces, and then the question about, okay, how do you get into the other guy's element that he's responsible for to install your stuff? Do

you tell him to do it and send him the stuff? Do you let him do it independently, or do you do it? I mean, how do you work all that? It ended up being a nightmare.

Not only that, but the program control capability at the top of Level II was not given enough authority and hammer, in my mind, to really control and drive what the project offices were doing. So we ended up with four main sets of activities called Work Packages. And I think the Marshall Space Flight Center had Work Package One, and that was a set of hardware and responsibilities, and Houston had Work Package Two, and I believe Goddard had Work Package Three, and Cleveland, Lewis, had Work Package Four.

Well, each of those had a strong Project Manager, and not only that, they had a Center Director that stood behind them and was interested in maintaining that Center's control over things and maximizing their domain within the program, and things of that nature. So it became a political problem, where Neil Hutchinson, as the Program Manager, would have difficulty forcing a technical decision because the Project Managers would object and then the Center Directors would get into it, and they'd be calling Washington, and then Washington was calling Neil, wanting to know why did he want to make that dumb decision and this kind of stuff.

All this is somewhat hearsay that I heard through Al Louviere and Neil Hutchinson and that kind of thing. But I knew that the program was very difficult.

But Mark Craig and I tried very hard to say okay, this is the cards we've been dealt. Now we've got to figure out how to deal with these things, and we tried to strike a balance between being helpful and collegial with our Work Package counterparts but also saying, this is a whole entity, it's not a collection of four independent parts. When it comes together, it's got to function as a whole.

The analogy I used to use when I was trying to explain to people the complicated nature of the Systems Engineering and Integration activity was that you have to realize that the program is made up of forty-five different elements which are going to be added sequentially over a period of time. The first element you launch has to successfully be able to survive by itself in Earth orbit, so it has to have control capability, life support capability, electrical power capability, environmental control, all of those kind of things. It has to be successful as an individual entity in itself.

When you bring up piece number two and hook it on, it's got to last, again, as a successful entity for at least three months until piece number three. So it has to be designed as a successful stand-alone spacecraft composed of part one and part two.

Same thing when part three goes up and gets hooked on and so on and so forth. So at every intermediate stage from one to forty-five, where everything is complete, the resulting configuration has to be able to operate in orbit successfully in the context of every system that's there.

Every time you go up, you add additional mass, so that affects the mass and the centers of gravity and the moments of inertia, that type of stuff. It affects the amount of electrical power you need. It affects the amount of life support that you need. It affects the amount of thermal heat that has to be controlled, either generated or rejected. A piece goes up, you may cast a shadow that causes something to get too cold. Or when the piece goes up, in order to control the center of gravity, you may have to rotate the thing so that something that hasn't gotten a lot of Sun in the past now gets too much Sun. You've got to think through all of these things. With the way the antenna points, you know, you don't want to bring up piece number sixteen and suddenly the antenna is blocked and you can't have satisfactory transmission to the TDRS

[Tracking and Data Relay] Satellites or to the ground or something like that. So all this stuff has got to be very, very carefully gone through, and that's just from a configuration standpoint.

So in effect, you have forty-five different spacecraft before you get to the end result. So instead of doing a complete design for a complete spacecraft one time, as we did for Mercury, Gemini, Apollo, Skylab, [Apollo]-Soyuz, we have to do a complete design and analysis forty-five times for the forty-five different spacecraft that are going to be on orbit, always knowing that we never know how long we're going to have to dwell in orbit successfully between Stage *n* and Stage *n+1*. And indeed, that's happened. You know, after the problems and things of that nature, right now we're sitting up at an intermediate stage on the Space Station with Valery Tokarev and Bill [William S.] McArthur [Jr.] up there because we don't have the Shuttle capability to go ahead and bring up the subsequent pieces and all that kind of stuff. So we always knew that the possibility was there that we were going to have to do that and it had to be designed to accommodate that.

That's just configuration kinds of issues. The interface issues and the commonality issues across the program were the tougher kind of job. The configuration thing is a fairly straightforward engineering. It's complex and complicated, but you know what you've got to do and you can go off and do it, and it's subject to rational analysis and this kind of thing.

The interface problems, sorting out how to do that and how we can control who does what in what piece of the thing and make sure that when we plug it together everything, in fact, works the way it's supposed to work and this type of thing, was a much tougher job. So Mark Craig, Al Louviere, and I rewrote the System Engineering and Integration Plan, and we tried our best to get input from the four Work Packages underneath us, at Level III. We did get some, but for the most part, they had an attitude that, well, we're really busy, and we'll support that as we

can, but when all is said and done, we're going to do what we want to do anyway. So we're not going to necessarily do what you want us to do. That may be a little bit cynical, but that's the way it appeared to us at Level II, was some of the resistance and non-responsiveness we'd get from the Level III work package.

Anyway, Mark and I had a big meeting scheduled where the Systems Engineering and Integration managers and staff from the four Work Packages came to Houston, and we were going to present our draft of the suggested program-wide Systems Engineering and Integration Plan that would control the whole program, so [we] at Level II, them at Level III, we came in, and it was an absolute pandemonium.

I mean, one Work Package manager—they had had the document for a week to look at it, and that kind of stuff, and they came in, and we were going to go through it and get comments and try to come to some common ground that were their issues, which we didn't think there would be many. It turned out there were thousands of issues. All of them felt like we were encroaching on their domain and on their options and their sets of responsibilities.

One guy, the Project Manager from Marshall, a guy named Luther Powell, just physically took this loose-leaf notebook that we'd sent to him, ripped the pages out, and threw the whole thing around the room. I mean, he would do things like that for effect, or stomp out of the room or something like that.

On top of that, Mark Craig, who was the Systems Engineering guy—I was the Integration guy—that afternoon he had to leave early to go on an international trip to Nordvik in the Netherlands to begin some discussions with the international partners that we were talking about, so it was total pandemonium and chaos by lunchtime. Then after lunch, Mark had to leave, and I was stuck with trying to get all these guys back in the room and do something positive. It ended

up that we didn't have much positive. It was a real management eye-opener to me to really appreciate what we were going to have to face and that type of thing.

But gradually we did, over a couple of years get these guys to come in, begin to wrap the bag around some of these things, even the problem of figuring out what common electronic drawing system we were going to use so that we could share drawings, because if the Lewis [Research] Center is going to put electrical cabling in buses in the modules that the Goddard Space Flight Center, Johnson, and Marshal are building, you've got to have their drawings so you can see where you can put this stuff and how it's going to work and get access to it for maintenance and all this kind of stuff.

Well, Johnson Space Center had one preferred system, Marshall had another preferred system, Goddard had their preferred system. Lewis didn't have a preferred system, but they didn't like any of the other three. If they were going to pick one, they'd pick something else. So every decision like that was just like pulling teeth. It was just absolutely awful.

So that was some of the challenges of the technical nature. It gradually did come together. We would write documents and finally get buyoff, you know, amongst all the Centers, this is the way we're going to do it, and this is the procedures for this, and this is the procedure for that, and just various things like SR&QA [Safety, Reliability, and Quality Assurance] standards that we were going to apply and how are we going to write an interface document that says what your half is going to look like, what my half is going to look like, and what are the controls with the signoffs that we've got to have to be sure that when they put Piece A to Piece B that it'll fit and work and all that kind of stuff. All of those things were just horrendously difficult.

But we had some really good staff working with us. As the Integration manager, I had some very fine people working with me to cause some of that to happen, a guy named Harold [E.] Benson, who had, I think, come down from Langley [Research Center, Hampton, Virginia] very early on with the Space Task Group, really an outstanding guy, and several others that I won't name but really were important to us.

The other thing that was happening early on was we had to staff our organizations. So there was a call went out to the Center saying these new program and project offices were being formed. And of course, at JSC, we were forming the Level II program office, but the Level III Work Package guys under Clarke Covington were trying to form their project office, which were going to do the individual hardware elements assigned to the Johnson Space Center.

In the meantime, all of the other institutional organizations were trying to protect their staff from being shanghaied or going over to these new organizations that looked like they'd be a challenge and fun and all that kind of stuff. So there was an awful lot of managerial grunt work to be done writing position descriptions and coming up with organizational charts and how much staffing do I need and this kind of stuff. Then there came a rule down that the Level II organization should not, by any means, be staffed just by people selected from Johnson Space Center. It needed to be a United Nations of NASA Centers. So therefore, we had to actively recruit at all other NASA Centers to bring people down and this type of thing.

So between that, putting out the calls, writing the job descriptions, getting the job certifications through HR [Human Resources], and getting the positions graded—were these GS [General Schedule]-13, GS-14, GS-15 jobs or 11s or 12s or what were they—because everybody who came over wanted a promotion. At the Johnson Space Center anyway, the agreement was that the giving organizations could, in some cases, veto people going over, because you didn't

really want to decimate all the talent in a division, someplace that had a lot of disciplinary talent. You didn't want to take it all, because you need those people to support you from your standpoint during the program. So it almost got to a point where, "You pick one, and we'll give you one. You pick one, and we'll give you one."

So we ended up—we did get staffed. It was a torturous process, and we had a very mixed bag of people and skills, all of whom came over eager to do the best job. Some just had a better set of tools to match than the others. And we did get some jammed into us that we would not have preferred to have, but that's just the facts of life.

But we were able to form and build an organization, and that was one of the most interesting aspects of this thing, to take people who came from a variety of organizations within the Johnson Space Center, many of whom had been there where they were many, many years and came with an ingrained culture from that organization. So I had already learned that within the Engineering Directorate, my division had one culture, this is the way we thought and operated and these were our norms and myths and legends, you know, what was good and what was bad and what you did and didn't do. The other divisions all had their own set. And although they were reasonably congruent, they weren't the same by any means.

But when you got over to SR&QA and Operations and Mission Analysis and that kind of thing, all of those guys over the years under strong leaders had built up completely different kinds of cultures, again grounded in the fact that their job was different than Engineering's, that the way they had to operate was different, and all that kind of stuff. Suddenly I've got sixty-five or seventy people within the SE&I organization, all with different backgrounds, many from other Centers, who came down here, and now you're faced with the job of building an organization that is us and not a collection of them.

So Mark Craig and I and Al Louviere spent a lot of time talking about that and working about that and trying to craft ways and take actions, group dynamics, and setting expectations and talking to people individually and in small groups that were in the organizations under us to try to build this sense of, who is the SE&I organization and what do we do and what are our norms and start developing some myths and legends about the way we operate that are successful and, you know, a list of, gee, we should really do it this way, and what's our view in dealing with the Level III Work Package people and all that kind of stuff.

Very, very interesting challenge and not one that I had even had a glimmer of thinking about. When I was thinking about moving over to the Program Office, I was thinking only in terms of the technical job and how fun and challenging it was going to be. I had no thought—even though I'd had lots of management and behavioral science training and that kind of stuff, it just somehow it occurred to me that everybody's going to come over there just as energized and committed and excited as I am and it's all just going to come together in this seamless organization, we're all going to agree about everything and march off into the future, waving the Space Station flag.

It didn't happen. We had people that just didn't fit. We had performance problems. We had people that came in, realized they'd made a mistake, wanted to go back. We had people protesting that they didn't get picked. So it was a very interesting and dynamic time to get focused.

At the same time, the new organization both below and above us was trying to figure out what they were going to do and how they were going to do it. One of the areas, and I can't remember whether I talked about this in the past or not, but it's a cultural impact—the Program Manager, Neil Hutchinson, is a very self-confident man. He's very capable, but in my view, his

self-confidence sometimes overran his real ability. And one of the things he had to do and that our area had to do was set up a Program Control Board, which made important decisions in the program that were going to be binding on all of the work packages and on the Kennedy [Space Center] and this type of stuff. And when there were issues, they would be brought to this control board, and they would be decided at that level.

All of the Work Packages and Kennedy and everybody had representation on the board for input, but the decision was the Program Manager[’s]. And he could be appealed to Washington, but that was the way it was supposed to work.

So one of my jobs as Director of Integration was to kind of staff and run the content of that board to the point where we would understand what items needed to be on the agenda, would try to make sure that the people who were bringing the item had done all of the coordination work they could possibly do ahead of time, that they had worked with the other Work Packages, if there were issues that they had with them, that they had tried their best to sort them out and work them out and all that kind of stuff. And then we would bring only the stuff that couldn’t get worked out at a lower level, only those kind of things, up to the program board or something where a major impact would come up for final discussion and agreement and everyone would raise their hand and say, yeah, verily we will abide by that, and all that kind of stuff. Then it could be written down in the minutes and put out as a program directive and all that kind of stuff.

So whereas the Level II program control guys staffed the board and did the minutes and did the secretary and did the agendas and all that kind of stuff, it was my responsibility for knowing what the content of all the agenda items were, making sure that it had all been worked technically, and we didn’t have any trivial or unnecessary items coming up that could have been

resolved at a lower level. So I went and told Al Louviere and Neil Hutchinson, I said, "Okay., I want to get on your calendar for thirty minutes or an hour, the day before every one of these program control board meetings, and I will come up with the agenda, and I will give you just a snapshot of what the issues are, what the points of contention are. If everybody agrees, I'll tell you that. If there are still some things to be resolved that you're going to need to make a decision on, I will tell you what the arguments are, pro and con, who are the litigants and advocates, pro and con, and give you our recommendation for things for you to consider and a suggested decision for you to make."

Neil said, "No." He said, "I've had many years' experience as a Flight Director. I'm used to absorbing huge amounts of data just on the spot and making the right decision." He said, "That would be a waste of your time. I don't need that, and therefore I don't want you to do that for me."

I tried to tell him. I said, "Neil, some of these things are complex, and I realize that you've got an amazing capability to absorb and sort out and analyze data in real time, but," I said, "I think it would be a service to you and the program if we went through this, so at least you could be thinking about stuff, it's not just an on-the-spot shoot-from-the-hip kind of thing." But he wouldn't go for it, wouldn't hear for it.

As a result, in many, many cases, you know, Neil was a very, very capable, decisive guy, but the issues would be so complex and he couldn't beat up the Level III guys. We got to the point where those agenda items, even for relatively simple stuff, would just drag on for way too long, in some cases hours, discussing it and arguing it and Neil unable to get it focused and come to a decision. They'd have to say, "Well, I'm giving you an action item to go off and work on these two or three things that we can't seem to decide and then come back." As a result, these

issues would come back up, and they'd come back and come back and come back, and it was very inefficient.

To try to keep that from happening, there was a lower level board that was chaired by Al Louviere called the Engineering Control Board, where the technical issues were supposed to come up for working and you'd try to resolve as many of them as possible before they moved up to Neil's Program Control Board. The same thing would happen there. On both of those boards, they'd start at seven in the morning, and you'd still be sitting in that darn room at nine o'clock at night trying to get through the agenda, and maybe you'd only be halfway through or something like that. I mean, it was just a killer.

On occasion, when Al was out of town or wasn't able to do it, Mark Craig was the chair of the thing. When they were both gone, I was the chair of the meeting. It was interesting that I had a different view of the meeting than—although Mark understood how to run the meeting in the way it should be run, he tended to get sucked into the technical discussions and that type of thing. I didn't think he controlled it as best that he could. But I'd go in; I'd look at the agenda. I'd try to get spiffed up the night before on what was coming up, what the issues were, talk to my staff, "What's going on here, and why doesn't Lewis want to do this the way everybody else wants," and that kind of stuff. I'd go in, and the agenda item would come up, and I'd say, "Okay, has this been coordinated at the lower level?"

"Well, no. We weren't able to get that."

I said, "Okay. I'm deferring this. I'm not even going to talk about it. I don't want to have the argument going on at this board, so you have the action to go back. Next item. Next thing."

We'd start at nine o'clock, and sometimes I'd be through by eleven, because I just wouldn't countenance or tolerate having the discussion at that level. "That's the responsibility of you guys to do that offline. You bring to me a suggested decision that everybody can agree to. That's what this board is all about."

So I got several complaints about that from the Work Packages, that, "Norm won't let us air our positions," but I also got some nice compliments saying, "That's good. I had other stuff to do that day than sit in the room and listen to these guys argue." So those were some of the interesting aspects of working in Space Station.

It was a challenging job. I got to the point where I was coming to work at seven in the morning and going home at ten at night and working half days Saturday, some days all day Saturday, go to church, come in after church, and work Sunday afternoon and that type of thing. That was like from '83 to '86 or so that that was going on. Luckily, my kids were—my daughter was already gone to college, and my son was on the verge of going to college, and he wasn't around anyway. He was in his car out running around, that kind of stuff.

I regret that I didn't offer more support to my wife at the time, because she was doing some significant things in her career and I just wasn't there to pat her on the back and tell her how proud I was of her and that type of thing.

But, this went on in that mode. We were making gradual progress. The first big program review meeting we had after everybody had gotten together—this is early in the program, and Neil Hutchinson had done the best job he could of estimating what the program was going to cost—we went up and talked to the Administrator, whose name escapes me. He was the—second time he'd been an Administrator –

ROSS-NAZZAL: [James C.] Fletcher?

CHAFFEE: Fletcher, yeah. He was the guy from Utah. We went up and talked to him, said, "Okay, here's all the content of the program. We've scrubbed it down the best we can, and the answer is like $18 billion."

Fletcher looked shocked, and he said, "We told the President it was $8 billion. You've got the wrong answer. Go back and fix it."

So Neil said, "Well, this is really scrubbed. We were optimistic we'd beat the Work Packages down as much as we can, everything. Our only option would be to remove content. I mean, there's got to be something that we won't do in order to get real costs down." He said, "Do you have recommendations about what content removal would be acceptable?"

Fletcher basically said, "Don't take anything out. Just go and figure out how to do it for $8 billion."

So we came back and scrubbed and scrubbed some more and made other pretty wildly optimistic assumptions and took credit for figuring out new ways of doing business. That was a real buzz word, that kind of stuff. We went back up, and it was something like $15 or $16 billion.

Fletcher was really ticked. He said, "You guys are not listening. I told you it was $8 billion. That's the answer. Go away and come back with an $8 billion program."

So, that's kind of what had to happen. You had to go back and come forward with this thing that everybody knew we couldn't meet, but that's what the politics of the situation was going to be. That's a greatly oversimplified view, but from the top level and from my knothole view of what was going on, we were forced down into that box, and it was either give up the

program or change the people or say, "Yes, we'll do our best. Yes, we think we can make it." And then you go back and think, what am I going to do now?

And then, as we went back, it kept getting bigger and bigger and bigger. At one point, it had climbed some more, and John Aaron, who was the Deputy Program Manager, told me to get all the Work Packages together and figure out how to get the costs in the Systems Engineering and Integration down. He said we needed to save several billion dollars.

So all of the Work Packages sent their representatives, and we sat at JSC for three days and talked about options. The requirement was everybody bring your suggestions for what can be done in your Work Package and then bring suggestions for what you think the other guys can do that they're protecting. So we want, to some degree, to attack one another, attack the other guy's assumptions and sacred ground and this type of thing.

So at the end of the three days, everybody was mad at each other. There had been several episodes of people stomping out of the room and then coming back, and we had achieved very, very little real reduction.

So I told John Aaron that evening, I said, "John, we're just not getting anywhere, and in my view there's really not much real that can be gained here."

So he gave me a hard time and said, "You just don't know how to be a manager," and that kind of stuff.

I said, "Well, boy, that may be, John. I could sure use some help."

So he said, "Okay. All the Project Managers are going to be here tomorrow. I'll get all of them together. You come up and tell us where you are, and then I'll take it from there with the Project Managers."

So I did. They all got in the room, and I came up and said, "Okay. Here's the issues we talked about, here's the savings we've got, here's the things we talked about we weren't able to make any progress on," and this kind of stuff.

So he and the Project Managers talked for about thirty minutes, and suddenly they all jumped on John's suggestions. He said, "Well, we've got to find new ways of doing business that will save money."

All of them said, "Yes, yes. Yeah, verily. New ways of doing business. We'll save money."

So John says, "How much do you think we can save?"

Well, they decided they could save $3 billion by finding new ways of doing business.

"Good. All in favor, aye."

Everybody ayed.

"Put that in the minutes. We're going to save $3 billion by finding new ways of doing business."

So, I'm sitting there just amazed at all this. He saved $3 billion, but I don't know how. [Laughs] So I just said, "What are the new ways of doing business that we're going to implement?"

"Well, I don't know, Norm. That's up to you. Go find those out."

So it was a management learning process for me. My experience in the Space Station from that standpoint came to an end kind of with the *Challenger* accident. I was running a Level II budget meeting. It was in the second floor conference room—I can't remember the room number now—in Building One, and we were sitting there trying to hammer out some budget

stuff with the Level III Work Packages. Somebody came running in and said, "The Shuttle just exploded."

Everybody said, "No. Come on. We've got work to do. Don't pull cynical things like that."

"No, no, no. It really did."

So everybody went running out, and in the office right outside, they had a television with NASA TV. So we just all stood there absolutely speechless watching the pictures. The debris was still raining down. You could still see the smoke up in the sky where the solids had gone off at different angles and that kind of stuff, absolutely shocking. So there was some activity after that to go back and re-look at everything that the Shuttle had done, all the engineering and all that kind of stuff. I wasn't involved in any of that immediately, but I was later.

At the same time, we had decided in the Space Station Program that we needed a Systems Engineering and Integration contractor. So that was going to be a major contractor in addition to the work package things. In [Level II's] *de facto* work package, we were going to have a major contract of somebody who was going to help us integrate all of these work packages that was going to be our contractor. That was going to be a major procurement, multi-billion-dollar, multi-year kind of thing.

They wanted an experienced senior executive to lead that procurement board, source selection official. They called it a source selection board. They picked a guy who was the Deputy Director at Kennedy Space Center, a guy named Andy [Andrew J.] Pickett. He had, I think, led the board that had picked the integrated contractor that was going to be the Shuttle support contractor, that ended up being a consortium, I think, between Lockheed and Rockwell. They formed a company, USA [United Space Alliance], that was going to manage all the Shuttle

launch operations at Kennedy. So he had been the leader of that source selection board, as well as others prior to that, and was very, very knowledgeable about that process.

I had been on many boards and had led many boards, not many boards, but a couple of boards at a lower level of cost and complexity and that kind of stuff, but I was very familiar with the NASA procurement regulations and the source selection process. I knew the source selection manual very well, had been through it a number of times back in the technology days, when we were trying to develop hydrogen/oxygen technology for the early Shuttle. So I got sent down to be on the source selection board.

One of the ground rules that Andy Pickett had made to the people who asked him to do this, which was the Administrator, had said, "I will only be the Chairman of the Board for this source selection board if we can do it at Kennedy Space Center." He said, "I don't want to leave home for a year and go off and do this."

So they said, "Okay. Well, you can have it wherever you want."

So I got shipped of to this to be the JSC Level II representative on the source selection board, essentially got shipped off to Kennedy for a year. Much to my wife's chagrin and mine, but at the time that was very exciting. I could see it was going to be a tough job and that type of stuff.

I went down there, and basically it was early October. I can't remember what year, '86 or'85, maybe. Maybe it was '85. Seems like it was before the *Challenger*, but I'm kind of losing—I should have checked my records. I'm kind of losing track of time. But we went down and formed the board, and I was named as chief of the technical committee.

Any board has at least two committees. There's a business evaluation committee and a technical evaluation committee, and then there's some other groups that evaluate other factors and this kind of stuff. But I was to lead the technical evaluation committee.

We prepared the request for proposal, and we prepared the total procurement package. It's a big thing about two inches thick that not only lists all the technical requirements that you want the offerer to give you but all the clauses and everything that apply to everything they're going to do and what meetings you want and what documentation you want and legal things about what data the government owns and what can be proprietary to the vendor, all this kind of stuff. So it took many weeks and weeks to put that together and get that to the point where everybody was satisfied with it.

Then you have to go through a process where you put out a preliminary version of the thing to industry and get their comments back. So they look at it and say, "Well, you're asking for something that doesn't do, or we can't do, or it doesn't make sense, or we wonder why you want it done this way when there's another way it can be done better, or, you're asking for something that's proprietary to my competition, and I object to that because you're automatically excluding me from being able to respond in this area," and all that.

So you work all that out, get all those comments back in. We had a conference at Kennedy where all the companies came in and listened to our explanation of what we wanted and how we wanted it done. They could ask questions and then send back in written questions that we had to respond to, a big long process to make sure that it's above board, open, and fair to everybody.

Then the request for proposal in its final form does get issued. You give them sixty days or some period of time—I think in our case it was sixty days—to write their proposal and send it back in, and then the evaluation starts.

Well, the evaluation now has to be staffed by a committee of people. So whereas I was head of the technical evaluation committee and had a couple other of the board members with me, I had to get evaluators who were competent in all the areas that we wanted to be proposed on, had to get evaluators to come in from the various Centers to be technical evaluators. We had to work out well ahead of time all the criteria, the evaluation criteria, how we were going to evaluate it, what the factors were, what the points were for each factor, how you put all this stuff together to come up to a final grade for evaluation. All the people had to be trained in those procedures.

You don't speculate about what the contractor is offering, you only react to what he specifically says that you can understand. If you read the proposal and you don't understand exactly what the offerer, or the vendor, is going to give, you need to write a question that we send back to the vendor saying, "We're unsure about what your intentions are here. Would you clarify," and that kind of stuff, and do that without implying to them that this is either a strength or a weakness in their proposal.

For instance, you wouldn't send them a question saying, "We don't see anything that talks about how you're going to integrate the electrical system. What is your intention?" Well, that would be a dead giveaway, see, and that's a weakness that they had omitted. They would get that question and say, "Oh, my gosh, we forgot that." So you try not to do that. If it's a clear omission, then it's an omission and they get a reduction in their grade for that. If it's just

ambiguous and you can't quite figure it out, then you can ask them to clarify so that you can resolve the ambiguity.

Anyway, all of this takes months and months and months to get it together. Then the people come in for interviews, and you ask them questions in real time, and then you go back and do some more. Then you give them a chance to submit what you call best and final offer. So all of the companies end up submitting, "Well, we've scrubbed it, and we've decided that we can cut out some hours here," and, "We've suddenly got a new computer program now, and we can do this with less hours, and we can do this better, and so our price is going to go down," and all this kind of stuff. And it's really just kind of an auction kind of thing is what it ends up to be and who can give the lowest price.

So we go through that, and by this time, almost a year has passed. We got in, I believe, four proposals. We down-selected to two, one of which was from Grumman and one of which was from TRW [Thompson-Ramo-Wooldridge], and then the final evaluation was between those two companies. We did, as a result, select Grumman for this major contract and took that recommendation with all their justification and everything up clear to Washington with the Administrator being the source selection official, the final person that says, "Okay. I've heard what you said. I've probed you, I've asked questions, and I now concur with your recommendation. We will select Grumman." So that all happened.

Then TRW protested the selection, saying, "Well, we don't understand that. We wrote such a good proposal and blah, blah, blah." I'm not sure whether it went to a—I don't believe it went to a formal protest-but they did come in for a debriefing immediately to try to understand what was going to happen, why they had lost, where they had fallen down, and this kind of stuff.

It turned out the corporate Vice President from TRW, who had been in charge of this activity, was later to become the Administrator of NASA, Dan –

ROSS-NAZZAL: [Daniel S.] Goldin, Dan Goldin?

CHAFFEE: Dan Goldin yes. Daniel Goldin. He came in. He came to the debriefing. Andy Pickett did the top-level debriefing, and then I did the technical debriefing, and another fellow did the business debriefing. And Goldin came in, and he had his whole proposal team with him and made a very—it was respectful, but it was strong and aggressive, that they had just really worked hard on this thing and they felt like they had done an outstanding job and they just were really looking forward to understanding where they had fallen down. But it was clearly an implied challenge that, you guys must have got this wrong.

Andy Pickett went through his briefing, I went through mine, the business guy went through his, and at the end of the day, the TRW guys kind of folded up their notebooks and said, "Well, thank you very much," and they left. There was not a formal, legal challenge to the selection, as I remember.

That was quite an experience. I learned so much from Andy Pickett, who was what I call the prototypical good old boy. He was a southern rural Alabama character, talked in this slow drawl, and he'd say, "Well, I opine that and this," and his "druthers," and all this kind of stuff, but underneath that good-old-boy, maybe not too smart looking guy was a mind like a steel trap. Not only that, he had one of the best understandings of behavioral science as applied to management of anybody that I know. He had made a real study of this and had, himself, learned

a lot during the previous big procurement, when they'd picked United Space Alliance as the Kennedy contractor for Shuttle, which he had done.

As part of that Kennedy thing, he had had some issues, and he'd gone out and consulted with—I'm getting so bad on names. You can tell I'm getting old. Kind of the father of management and behavioral science, he's written twenty, thirty, forty books, and he was at Santa Clara University out in [Santa Clara] California. [His name is Peter F. Drucker.] Pickett and his team went out to consult this guy on some issues, and this guy was able just to—when they described the issues they were dealing with in that earlier procurement, he was just able to punch through and get right to the meat of the thing. That had greatly impressed Andy Pickett, and so he had learned a lot from that experience and brought that insight back to this procurement that I was on.

I learned so much from Andy about ways to do it and what your personal responsibility was and this type of stuff really served me in good stead in my subsequent management career, because he made it real clear to us that it's our job as evaluators to understand and evaluate what the contractor is offering to do for us, and if we couldn't understand it, we couldn't just give him a bad grade. He said it's your responsibility to understand, and if you don't understand, as I was saying before, you have to ask a question to clarify so that you do understand completely and therefore can give a valid and fair evaluation grade to that area. But it's not fair to say, "Well, I just didn't understand what they were saying." It's your responsibility to understand. So I learned a lot from him.

He lived in the Kennedy area, had a big house right on the Indian River, and we used to go over to his house sometimes on the weekend for barbecue, and he had a big pool table and all that kind of stuff. He was a great guy. He had grapefruit trees in his yard that were some of the

original grapefruit trees from south Florida. They weren't the hybridized, no-seeds, sweet pink ones. These were hundreds of seeds and sour like a lemon and that kind of stuff. But you put a little sugar on them and they were really good. He'd bring in a bag of grapefruit just about every day, and people would grab those things and have them for lunch and take them home, this type of thing.

We were sequestered in a building over on the Air Force side [at KSC] to do this procurement under very tight security, because all the contractors were trying to find out what's going on and find any leaks that they could and this kind of thing, so it was very tight security, and particularly toward the end, when it was down between TRW and Grumman.

Anyway, when Andy wanted to have a meeting, he had a wooden [whistle] thing that some craftsman up in Tennessee had carved. It's a big square thing, and you blow in it, and it sounds like a train whistle. So he'd be sitting down in his office, and he'd decide that he needed to get the board together or something like that. So in this big, long, two-story building, you'd hear this "whoo." That meant drop whatever you were doing, come down to the conference room, because Andy wants to have a meeting.

So he was quite a character. He and I developed a really good, strong technical relationship, and when it was all over, he told me–and this is one of the things that I'm most proud of in my career. He said that he had been involved in many, many major procurements and that, in his view, the technical board in operation that I ran was the best that he had ever encountered. He put that in a formal letter and sent it back to Aaron Cohen, who was the Center Director at the time, and Aaron called me and told me how proud he was of me and all that kind of thing.

Anyway, it turned out I was gone for almost a year. I rented a condo [condominium] on the beach in Cocoa Beach [Florida], and I actually was in Cape Canaveral city limits [Florida], beautiful place. I was up on the ninth floor of a beachfront thing. I had a putting green and a swimming pool and I was fifty yards from the beach and all that kind of stuff. I worked from six in the morning till nine at night and never got to use any of those kind of things, but I was very popular with my relatives. My son and his wife came down and stayed there. My wife came down, and my daughter came down and that kind of stuff. I had a two-bedroom condo, so they'd come down and stay there. Then occasionally, we'd have a break, and I would get to come back for a few days or a week. In one case, during the time the companies were writing their proposal, I got to come back for a significant period of time. Bless the hearts of the people that were in the condo just kept the place for me, didn't charge me rent, just said, "You can keep your stuff here, and when you get ready to come back, you just move back in." So that was good.

So when I got back, essentially we had selected the Grumman contractor to be SE&I contractor. At that point it was a year after *Challenger*, and the Headquarters had decided that they couldn't run a big program from the Centers, that the expertise just wasn't there, that they needed to move the operation back to Headquarters, where the source of all wisdom and knowledge was located. So they told me, "We want you to continue in the program. We need you to move back to Washington and be part of the new program office that we're forming in Washington."

I said, "No. I've been to Washington lots of times, and I am not going to move back there and live there. I enjoy going there, and I enjoy leaving and coming back to Houston, so I'll find something else to do."

So I did wrap up the Systems Engineering and Integration. Our last job was to catalog all the documentation we had prepared over the years that I was there, from ’83 to ’87, catalog it all, describe it in almost a librarian-type form, put it in boxes, and send it up there, and send them a list of where all the documents were and what all the content of each of these things was. Then I did go up there from time to time to help them understand what was what and where was where.

One of the major studies that I had done before I got sent off on this Kennedy procurement was to develop a ground checkout plan for the Space Station. How are we going to put all these pieces together and check out that all the interfaces and things are really working? Because, in effect, the final piece isn’t even going to be starting manufacturing when the first few pieces are already in orbit. So we’d come up with a concept that we were going to essentially build a second Space Station on the ground in a big building at Kennedy, and we would use that as the ground interface test bed, where you could bring in, build it up. It would essentially look—it wouldn’t be space qualified and might be heavier and all that kind of stuff, but all the stuff would be in it that needed to be there to verify interfaces. And we would build that thing up and be able to test it out. When the new piece was ready to launch, we would bring it over, hook it up, and make sure that it played satisfactorily, you know, the electrical system, communication system, life support system, all that kind of stuff, with the other pieces. Then you could go put it in the Shuttle and launch it. So we had written a very detailed plan about how that was going to go and costed it out and schedule wise how it was all going to work. [I had wonderful help on this from a senior KSC manager, named Ted Sasseen, who was detailed to JSC for a year.]

There was several, probably twelve or fifteen, boxes of documents associated with all the studies we'd done to pull that together. For a couple or three years after that, I'd get calls from guys saying, "Well, did anybody ever study this ground integration plan?"

I say, "Yes, we did that in '86, and here's the box number. A-232 and 233 and 234 is where this stuff is."

They'd call, "We can't find it. Can you come up and tell us what you did, what you decided?"

So I'd go up there, and I did that two or three times. I went up one time, and they told me, "Well, we want you to sit in this room and try to recreate the logic that went into your overall concept for this thing and put it down in just a few pages so we can understand it." Because all these guys that had been recruited to go be the new leaders, they'd either been minor players previously or hadn't been players at all. They were new folks who didn't have the history with the program.

So I went up there, and I was trying to do this, and I ran into a friend from Langley Research Center in the hall. I said, "Oh, I didn't know you were up here."

"Yes. I came up to try to help them out on this ground checkout thing."

I said, "Oh, yes?" I said, "That's why I'm here. What are you doing?"

He said, "Well, I'm supposed to be sitting in a room recreating the logic of why we came up with what we did."

I said, "That's the same thing I'm doing." I said, "It doesn't make any sense for both of us to do that. At this point neither of us has an ax to grind."

So I went in and told the guys, I said, "Well, so-and-so from Langley is over here doing what you wanted me to do, and I don't see any point in doing it, so I'm going back to Houston.

Goodbye." So I came back. They'd call me occasionally after that, but the guys that took that over badly, in my view, mismanaged the set of data that we came up with. It's too bad, because it was a tremendous impact to the program to suddenly terminate where we were and try to transfer all the information to essentially a new group of folks, who didn't have the long history with the thing.

When the Level II organization disbanded here, we had a hell of a party down at the Gilruth Center. It got quite raucous, and there was lots of hugging and back-slapping, because we had all bonded and all that kind of stuff. The engineering group, we went out, and we bought a very nice, expensive bottle of wine for the program and took it. John Aaron at that time was the Acting—I guess he was actually the full Program Manager. Neil had moved on. We gave this bottle of expensive wine to John Aaron and said, "Okay, you're the keeper of the wine. You need to designate a successor. And the last person standing from the Level II Program Office gets to open the bottle of wine and drink a toast to those of us that are not around anymore." So I check with John a couple of times a year, say, "John, you still got that wine? You didn't drink that wine yet, did you?"

He said no, he's still got it. He knows where it is, and it's got a note on it as to what's supposed to happen to it in the event of his demise and that type of thing. So I'm still in the running for that bottle of wine. [Laughter]

ROSS-NAZZAL: You'll have to let us know if you actually get it.

CHAFFEE: Yes. Right.

ROSS-NAZZAL: This actually would be a good place for us to stop for just a minute or two.

CHAFFEE: Okay.

[Tape change]

ROSS-NAZZAL: All right. So we are back, and you were telling me that you returned to the Power and Propulsion Division.

CHAFFEE: Right. When I left the Space Station, I guess in the end of '86, I had an opportunity to go back to the Propulsion and Power Division. There had been an interesting organizational activity. At just about that time, when Aaron Cohen became Center Director, he asked Henry Pohl, who was Division Chief of the Propulsion and Power Division, to move up to be Director of Engineering. So Henry did that, which left open the job of Division Chief. The guy who had replaced me as deputy to Henry when I left was Chester [A.] Vaughan, who had been my first supervisor when I came to NASA, had been moved off to be a Branch Chief, which had allowed my—as I talked about earlier in this interview—allowed me to take his job as Supervisor. Then Henry had moved me up to—when he became Division Chief—moved me up to be his assistant and then his deputy. So in the first years that I worked for Chester, when I became Deputy and Chester was a Branch Chief, Chester worked for me. When I left, Chester came up and took the Deputy Division Chief job, and then when Henry left to be Director of Engineering, Chester and I both wanted to be Division Chiefs. In my mind, I felt like Chester was the better choice. I felt like he was a better human manager, probably, than I was. I felt like we were probably

technically equivalent, that type of thing, but I went around to visit with him. Chester and I are good buddies, and aside from the episode I told you about at Huntsville in Napoleon's Nook when we were drunk together, we'd been drunk together many, many times and had lots of poker games and episodes together. We're just good buddies.

So I went around and talked to Chet, and I said, "Well, you're the Deputy now. Henry's gone. You're probably the heir apparent. But," I said, "I would like to have the job, too, and I just wanted you to know that I'm going to apply for it, and I don't want you to take anything personally. So may the best man win here."

I said, "I'm particularly doing it because I would hate to not apply and then, somewhere during the process, the Center decided they needed Chester Vaughan [to] do something else or you get run over by a truck or something happens to you where you can't accept the job and then I'm not a candidate because I didn't apply. So," I said, "I just wanted you to know I'm going to apply. I'm going to put in the best application I can, and we'll see what happens."

So he was great with that and all that kind of stuff. I later talked to Duane [L.] Ross about that. I went through the process and turned in what I thought was a very strong application. Chester was selected, and I kind of suspected that was going to happen, and in retrospect, it was the right decision for both of us.

But I talked to Duane Ross later and said, "Well, I was a little disappointed that I wasn't selected," and he said, "You know, that was one of the toughest decisions that the Center had to make." He said, "Both of you guys were so well qualified to successfully assume that job that it was tough."

So I don't know what the final rationale was or anything like that, but I greatly benefited from going through that process of trying to be selected and preparing that background. And I

still use some of that material that I wrote up at the time on the details of my experience and that kind of stuff as a resource for myself to go back and remember, you know, what did I do these years and what happened? I kind of remember being involved in something or other, but what was that, and this kind of thing.

Anyway, after Chester got it, he said, "But now I need a Deputy, and you're looking for a job. Would you come back and be my Deputy?"

I said, "Sure. I'd like to do that." I figured, okay, I'll go back, and I'll finish out my career right here back in EP [Propulsion and Power Division Mail Code]. Chester had been plucked out and sent someplace else and let me succeed him before. I said, there's a high probability that'll happen again. So there's nothing I'd like better than being Chief of the Propulsion and Power Division.

So I went back and was Deputy and was deeply involved then in the continuing activity for the return to flight and evaluating all of the Propulsion and Power Division systems and what they used to call the boiler rooms, where we would get together with the Rockwell guys and just go over all the drawings and the specifications and everything, just line by line, and talk about, well, we made this decision back in the seventies and now, from the standpoint of having flight experience, what do we need to change, and this, that, and the other. So I was involved in that quite a bit.

We were involved in some requalification of some hardware. One particular item was the main propulsion system [gaseous] oxygen flow control valve, which was a big chunk of metal that allowed gaseous oxygen to let oxygen be vaporized in the engine and then go back in and pressurize the oxygen in the tank to provide what we call autologous pressurization. That thing had some problems of failing in a catastrophic event because of the warm and high

pressure oxygen [flowing] through this metal [valve]. If there was any ignition source in there, either from friction of rubbing services or a little piece of grit coming down at high velocity and impacting the metal as it flowed through the valve and causing enough localized energy from the impact, that it would start reacting with that oxygen, and the valve would burn up.

We had been through a lot of work on that thing. I think it was a piece of hardware that was going to be incorporated into the program, although I'm a little hazy in my memory on that. It hadn't been yet; it wasn't fully qualified, and we had changed materials a number of times and gotten down to a material called Monel, which is, I think, a nickel-based material, alloy. I forget what the other components are. And we felt like we had it. We had finally changed the internal design of the thing, the way it was built so all the flow passages were smooth, there wasn't really any good ways—if a particle was entrained coming down and got past the filter somehow, there wasn't any good surface for a particle to just slam right into. They were gently curving surfaces. And we hoped the flow would carry these particles, if there were any, on through. We tried very hard to filter upstream to make sure there were no particles and that type of thing.

The guys who were in charge of that hardware had set up a formal qualification program, where there was going to be like thirty or fifty tests or something like that, and it had to successfully get through all of these tests at various flow conditions with various pieces of hardware to say, "Okay, we've done everything bad we can to this thing, and it's okay." Well, these guys got down to the last test, and then everything burned up. I mean, they were one test away from declaring that the design and materials and everything are all okay for incorporation into the Shuttle vehicle.

It's hard for anyone who's never seen oxygen react in something like that. This thing is about twice the size of the coffee cup here, probably weighs twelve or thirteen pounds of metal,

and you're looking at it on TV and with movie cameras running. It's focusing on this thing in the test facility, which was out at White Sands [Test Facility, Las Cruces, New Mexico], where we did this, and they're flowing warm, high-pressure oxygen through this thing.

The function of the valve is to open and shut to allow oxygen as needed to flow back into the tank to maintain the oxygen tank pressure during launch. And you're watching the TV, and all of a sudden, it's like a flashbulb goes off. The flash is that bright and that short a duration. And suddenly now there's just two pipes, and this fifteen pounds of metal that was sitting there that was the valve is no longer there. It's just gone. So that was a big deal.

So that was one thing I got involved in. We had to put together a big tiger team to go out and do the failure investigation at White Sands and figure out what to do, that type of thing. I tapped a guy who was the supervisor in the thermo-chemical test area named Brian [G.] Morris to go out and do that, because I was involved in some other things in Houston I couldn't leave. As a matter of fact, at that time, Chester was off on special assignment, and I was the Acting Division Chief, so I couldn't go, but it was something that worried us greatly. But we did get that resolved. [Brian Morris did a super job, as he always did on every assignment.]

At the same time, we began working on the Lunar/Mars activity. So I was only back in Propulsion and Power Division for about, maybe a little more than a year when they decided the Shuttle was mature, the Space Station was coming along, and we needed to start early thinking about going back to the Moon and going on to Mars. So they formed the Lunar/Mars Exploration Program Office, and once again, we had a tiger team, went over into Clear Lake City into the Nova Building over here to write some initial plans and this kind of stuff for how we would do that.

I was assigned from Propulsion and Power Division since I had done a good job on writing the early plans for Space Station, they said, "Norm, you go over and do that." Besides, Chester didn't want to do it. So I went over and got deeply involved in that, working with Mark Craig and a guy named Doug [Douglas R.] Cooke, who had come over. All of these guys I had worked with on Space Station, and none of them ended up wanting to go to Washington when the Space Station activity moved up there. So they all stayed here, and they had moved over as Managers of the Lunar and Mars Exploration Program Office.

So they got me over there, and we wrote an SE&I plan and a program plan and did a bunch of studies and some pre-Phase A things and looking at how we would do it and this kind of stuff. Once again, the structure that was there was a Level II office under Mark Craig, and I was kind of helping him out as an assignment from Propulsion and Power Division.

They were forming also, at the other Centers, the equivalent Level III organizations just like we had in Space Station. Johnson was going to work on some things, and Marshal was going to work on the launch vehicle thing, and Houston was going to work on the lunar surface habitat and the equipment you needed on the lunar surface. Marshal was going to work on the launch vehicle and on the orbit transfer vehicle, and Lewis was going to work on power. Once again, it was going to be one of these horribly complex interface kind of deals.

I thought, well, maybe if I go back and help work on this, I can get that corrected a little bit so that it doesn't become so difficult to manage as the Space Station. So I was over there working on all that right after President Bush Number One [George H.W. Bush] was inaugurated, and one of the things he wanted to do was go back to the Moon and then go on to Mars. Really, he didn't say go back to the Moon. He said he wanted to go to Mars, and he asked

NASA for recommendation, and he had in mind landing on Mars by the fiftieth anniversary of Apollo 11, which would have been in 2019.

So suddenly the requirement came rolling downhill from Washington and from Headquarters that we need a ninety-day plan; we've got ninety days to write a credible plan of how NASA is going to go to Mars and what all the technical details are, what the schedules and costs and everything are.

Mark Craig got tapped to pull that together. So he talked to the Center Director, Aaron Cohen, and he said, "I need Norm to be assigned to this tiger team."

I said, "Okay. I'd be happy to work on that," and I took a couple of folks from Propulsion and Power to go over and work the power and the propulsion issues from the JSC standpoint. Went over and in a very, very intense ninety-day period, we put together a credible plan that we thought was credible at the time. It turned out, in retrospect, although we'd used the best technical concepts and the best information we had at the time, it was way too long and way too much money. So at the end of ninety days, we produced this plan, which would have worked, but it had a price tag of around $430 billion and like a twenty-five-year timeframe or something like that. It did achieve the 2019 landing, but it needed all this new hardware and new, humongous launch vehicles, and all this kind of stuff.

Well, it got enough credibility that the President said, "Well, let's go ahead and keep working on this thing," although in Congress, in general, there was eyebrows up and people shaking their heads about the money and the time and everything like that. They made a decision to formalize this thing to continue the studies and try to improve on this program and put flesh on the bones and work the technology issues and all this kind of stuff, the Center set

Mark Craig and Doug Cooke up as the formal Program Manager and Deputy Program Manager of the Lunar/Mars Exploration Program Office.

They sent Barney – what was Barney's last name? He was essentially the leader of the Level III JSC activity for the lunar habitat and the lunar—Barney's name will come to me at some point. So I was back in a similar kind of situation with some of the same guys that I'd been in in Space Station.

Mark Craig said, "I want you to be the Manager of Systems Engineering and Integration."

So I said, "Yes, I'd be happy to do that, but," I said, "I need some good staff." This was kind of going to be a study organization, so the Center wasn't all that interested in staffing it too heavily, but we did have the same kind of opportunity to select staff from the Center to come over there.

Well, we had contract people supporting us from Lockheed, and one of the people that I'd come to know very, very well was a lady named Joyce [E.] Carpenter, who was a Lockheed engineer who had transferred up from Lockheed, Marietta, Georgia. She'd worked on aircraft, but she was a specialist in systems engineering, really a smart, smart lady and a good people person, good manager, no nonsense, this kind of thing.

So Aaron Cohen called me over after Mark Craig told him that he wanted me to do the job. Aaron called me over and said, "Norm," he said, "I know you've done these other things we've asked you to do, and now Mark wants you to come be his Manager of Systems Engineering and Integration." He says, "I know it takes you out of a possible succession position in the Propulsion and Power Division, but the Center needs you to do this, and I would like very

much for you to do this, and I would appreciate it. Certainly you can be assured that I'll look out for you," and this kind of thing.

So I said "Yes, sir." And of course, when the Center Director asks you to do something, you salute the flag and say, "Yes, sir," and this kind of thing. So I said, "But, you know, I would like to ask for a couple of things that go with my accepting what you're asking me to do." I said, "The first one is, if the program appears that it's not going anywhere, I don't want to complete my career just pushing paper and studying pie-in-the-sky kind of things. If it appears that the momentum of the Lunar/Mars Exploration Program Office is slowing or being diffused, I'd like to be able to come to you and say, 'Aaron, I need to be relieved and go someplace where there's more immediacy to what I'm doing.'"

He said, "Okay."

I said, "The second thing I need is, if I'm going to be the Manager of Systems Engineering and Integration I need somebody to help me do that job. And that person would be Joyce Carpenter."

So he said, "I'll see what I can do."

Later on, it turned out, after we were into the thing, that both Mark and Doug Cooke got pulled up to Headquarters, Mark to be an Assistant to the AA, Associate Administrator, for Lunar and Mars, who interestingly was Mike [Michael] Griffin, who's our current Administrator, and Doug Cooke got pulled up on a special tiger team having to do with redesign of the Space Station that General Tom [Thomas P.] Stafford was leading, leaving me on the spot there with no Program Manager, no Deputy Program Manager.

Again, Aaron said, "I want you to assume the Program Managership, [as Acting Program Manager]."

I said, "Okay. Now I really need Joyce Carpenter."

So he said, "Okay. If Joyce is willing to come, I'll work it with Lockheed, and we'll get that transition."

So I mean it was an amazing effort. Human Resources procedures normally take a long time, but in just a very short period of time we'd worked a deal and she left Lockheed under favorable circumstances and got hired at JSC, and she became the Manager of Systems Engineering and Integration for me and did a super job. She's still around, working in the Exploration Program Office, which I think has recently been dissolved and folded into this new Constellation Office, which is the new "go to the-Moon, go to Mars" kind of thing. She's an amazing asset, really an amazing woman. Tells me she's going to retire in a year or so and go into teaching systems engineering and integration.

So I got into the Lunar/Mars Program Office, helped write the initial formative plans for participation in the pre-Phase A and Phase A studies, played a role in the ninety-day plan that we wrote for first President Bush. When the formed the Program Office, I came in and worked as Systems Engineering and Integration Manager for Mark Craig and Doug Cooke. When they moved off to other assignments, I assumed the management of the program. That meant I was now a member of the senior staff and had to do stuff like go to the Director's staff meetings and all that kind of stuff.

I did that for about a year, and it became clear to me that we were getting into the point where the Space Station was taking all of the Center's energies and this kind of stuff and the Lunar/Mars thing was clearly going to be a back-pocket activity with a little bit of money and that kind of stuff. I came to that conclusion when, as Manager of Systems Engineering, I was given a budget for the last year I was there, which I don't remember if it was '90 or '89, of $12

million. So I had $1 million a month to go on. So I structured my outlays and my work to spend my $1 million a month.

Halfway through, they said, "Well, Space Station needs money and all that kind of stuff, so we're cutting your budget to $6 million."

I said, "You can't do that, because I've been on a $12 million annual budget, and my resource flow is $1 million a month, and now I'm out of money. You can't tell me now that —."

So we negotiated something, but a greatly reduced thing where I had to let contractors go and things, really power down the activity and tell all the Centers that were supporting me, that got a little bit of this money, that, "I'm not giving you your money," and all this kind of stuff. That was very disheartening.

So I could see the writing on the wall, that all this interesting technology work and studies and stuff was just going to devolve into, "do-loop," and everybody would say, "Well, that looks good. Go around again and see if you can scrub it and do a little bit better," and, "Now we've learned some new technology. Factor that in." So you do the same bunch of studies time and time and time again, and you get better every time you do it, and you think of new things, and new ideas come along, but that just wasn't what I wanted to do. So I did go back to see Mr. Cohen and say, "I think the time has come, and could I be relieved?"

Something that had triggered that was, a couple of months before that, a guy who was an acquaintance from Engineering, Walter [W.] Guy, had called me and said that he had been asked to leave his very long-time assignment as Chief of the Crew Systems Division—I think it had gotten its name changed to Thermal and Crew Systems or something like that—and had been asked to form a new Robotics Division, because the Center Director, Aaron Cohen, had noted that, as he had gone around after he'd become Center Director and visited with each division to

try to understand what they were doing, that there was a whole bunch of organizations that said they were doing a little bit of robotics work but nobody had enough concentration of resources to do anything really very meaningful. He could see that robotics was going to be an important technical discipline for human spaceflight in the future, and he felt like it would be to the Center's advantage to establish a strong, disciplined center here within Engineering, so they'd asked Walt Guy.

Henry Pohl had been given marching orders by Mr. Cohen, and he called Walt and said, "I'd like you to take this on. I'd like you to give up your comfortable, long-time assignment in the Crew and Thermal Systems Division and go and start this new Robotics Division.

Well, Walt called me and said, "Would you come be my Deputy?"

I said, "I can't, Walt. It certainly sounds interesting, but I'm the Acting Manager over here for Lunar/Mars, and the other two guys have been sucked off to do other things, and I just can't responsibly walk away." So I said, "I'm sorry. I'd like to work with you, and it sure sounds like a whole lot of fun and everything, but the timing is just not something that I can do."

Well, about four or five months later, the guy that he had selected got another opportunity and left, and so Walt called me back, and said, "Has anything changed?"

I said, "Let me work on it."

So that's when I went to see Aaron Cohen and said, "It looks like the budget's been cut. I can see that this is going to be a shoestring operation of multiple repetitive studies and we're just going to tread water and do this kind of stuff over on the sidelines. There's not going to be any real program work for a long time, and I know you're interested in this robotics thing. Walt has invited me to consider being his Deputy, and that's something I'd like to do. I wondered if we could work something out."

So Aaron graciously said, "Yes, we'll let that happen."

So I was able to depart. I had some windup work to do to get to the point where I could leave as Program Manager, and then I went over to Walt Guy's division as his Deputy about the end of '90 or early '91, a very, very interesting activity.

Walt had been an acquaintance. I'd never been what I'd call friends with him. I'd worked with him on numerous special projects, and back in the early eighties he'd gotten tagged as being head of a tiger team to find product improvements for Shuttle that would make it work better and more efficiently and less costly and less maintenance between flights and all that kind of stuff. I had been the representative from Propulsion and Power Division to this activity of his, and we had worked together very well. He'd later told me that he was very impressed with the products that I'd brought from the Division, and the quality of the analysis and all that kind of stuff. He'd always thought after that that if there was ever a time where he and I could work together on a permanent basis, that he'd like very much for me to be part of his organization, so that's why he had called me.

So I went over, and then, once again, it was somewhat similar to the situation I had been on both in Space Station and in the Lunar/Mars Program Office, so suddenly you're in charge of this group of people who had been pulled in from various other organizations with different cultures, you don't have a common sense of who we are as this new organization, and you have to build that team and that sense of "us" that every organization needs to get. So Walt was still in the process at the time I joined him of working out the deal, because when he accepted the Division Chief responsibility, one of the jobs was to go around to all these organizations that Aaron Cohen had seen little glimmers of robotics work, go around and find out what they were

doing and make plans to pull all of that work and the people associated with that work into his new organization.

Well of course, that's like pulling teeth, because the Structures [and] Mechanics Division, who was working on robotic arms, they didn't want to give that up and specifically didn't want to give the people up, and in many cases, the people didn't want to leave where they'd been working. So there was about twelve or fourteen different organizations that were doing robotic work that Walt had to negotiate that, you know, this is the work that needs to come over to this new division, these are the people associated with it that need to come, this is how I'm going to organize it, this is what our branches are going to be, this is the charters that we're going to be, this is what we're going to do for the Program Office, this is who are going to be our clients, and all this kind of thing.

So he was still in the process of trying to pull that together and had a bunch of people from different organizations, different backgrounds. We were trying to establish a client-provider relationship with the Program Offices and with the organizations that funded technology work and get our laboratories set up. You know, what laboratories do we need? What technologies do we want to have in-house capability for? So he was well down the road on that.

Just a sideline here, a word about Walt. I had known him because he came here in '62, about the same time I did. I had known him for a long, long period of time. He was known as a very, very tough manager. When viewed from the outside, he was a very, very strong advocate of his organization, a very strong defender of domain, of his people, of his resources, all that kind of stuff. And if you had to have a conflict with Walt and his organization, you always kind of shuddered a little bit, because you knew he was a tough cookie to deal with.

So before I had accepted Walt's invitation, I did a little research on Walt, because I had worked with him a time or two and found him to be good to work with. He was demanding, had high expectations. He was fair and, I thought, a really good manager. But I called several people that I thought were personal friends that worked for him and said, "Look, my perspective from the outside is Walt can be pretty ornery and pretty brutal and a tough cookie, and I'm just—I think I'd like to work for him, but I want to be sure I know what I'm getting into. I know sometimes people are viewed differently within the organization and from without the organization. Can you give me some insights?" And the people, to a man, said, "Walter's really good to work for. He's really fair. He is demanding, but he protects his people, he looks out for them," and this kind of stuff. As a result of that, I did agree to accept the position and work the logistics of going over there to work for him, became his Deputy.

It was a very, very good relationship. I learned an awful lot from Walt. I think that probably the three or four best managers at the Johnson Space Center, I had the opportunity to work for in my career. First was Guy [Joseph G.] Thibodaux and Chester Vaughan, Henry Pohl, and Walt Guy, and I learned so much from all of them. I think each of them maybe learned a little bit from me, too.

In Walt's case, I found him to be an exceptional technical manager with lots of strategic insight and ways to get things done technically and that kind of thing. Where I found Walt sometimes needed a little bit of help was in his interpersonal relationships. He can be very brusque and gruff. And he's a large man physically. He can be intimidating. He can be very aggressive if he's arguing with you, cut you off and beat you up verbally and all that kind of stuff, and you had to learn to deal with Walt.

A few of our interactions early on, I was a little bit taken aback and that kind of stuff and was wondering how to deal with that. Finally I decided that, well, I'm just about as senior as him. He's a year older than I am and has got a year or two experience on me, but so what? So, I'd push back and stand ground, and he'd say something and we had to do it this way. And I'd argue with him, and he'd get after me, and I'd tell him, "B.S.., Walt, you're full of it, and you don't know what you're talking about. That's not the way to do it, and here's why."

So he gradually came to put some credence in—because he wouldn't think about, you know. There weren't that many people who would talk back to him and that kind of stuff, but I would. We ended up having a very cordial relationship, not only business-wise but personally, which continued long after I retired. We'd socialize, he and his wife and me and my wife. We had season tickets together to the Alley Theater [Houston, Texas], and did lots of other things together.

And I felt like that Walt and I were probably one of the best combinations of Chief Deputy-Chief, because I always felt like, and I think the experience bears out, that I was a good people-person and I could work well with people. I'd learned that from Henry and Chet Vaughan and my own father, who was a Human Resources Manager at the Corps of Engineers. Because I'd say Walt was very technically focused on getting the technical job done and didn't mind running over people or was oblivious to their feelings and aspirations and stuff, sometimes, not always, but sometimes.

One of the things that I brought to Walt over the years was a better appreciation of those kinds of things. Walt would be in his office, and if he wanted to know about something, he'd call somebody on the phone, and he'd just say, "This is Walt. Come down." You know, if you were a young engineer or something like that—I'd caught them doing that, heading down the

hall I mean just quaking and shaking that, "The Division Chief wants to see me. What have I done?" and this kind of stuff.

So Walt and I would talk, and one thing we did mutually agree on—I said, "Let's have lunch, a long lunch together once a week when both of our schedules permit and talk about the organization, and what we can do," and I told him repeatedly, I said, "Walt, you know it's 100 feet down to their office down there. Get up off your butt and walk down there if you've got a question. Don't call them up in this abrupt manner and say, come down." I said, "Stroll down there and just sit down and ask them how things are going and then ask them what you want to know and then come back."

Because that's the way I would operate. I'd spend a lot of time. When I needed something done, I would walk down and say, "Hey, you know, I wonder if you've got a few minutes to talk to me about this, that, or the other. I don't understand something. Can you help me out?" or something like that. I had a different kind of approach.

Now, I often didn't have the same good technical insights that Walt did, but you put the two of us together, and I think we ran a hell of an organization. I have amazing respect for Walt as a technical manager, and I believe when I left there at the end of '96, I really believe that I had altered his behavior somewhat, because people have told me that since, even at the time I was there, I could see his behavioral characteristics changing and reacting to some of the inputs I would give. And some of the other Branch Chiefs were giving him the same stuff, too, and now he's—although I know we'll never have the same insight, he's still working here. Why, I don't know, because he's got like forty-four or forty-five years' experience, and he's not earning any more annuity credits or anything like that, but I think he enjoys what he's doing. He's still Chief

of the Automation, Robotics, and Simulation Division ten years after I left. But an amazing man, probably the best technical manager that I ever worked for.

One of the things that he did that I helped him with was write a management manual in the Division. He'd get the Branch Chiefs together, and he had a list of probably fifty or sixty management principles that guided him, and he would present one with the justification for why he felt it was important and how it contributed to a manager's success and how it contributed to the success of the organization. And we would get in and talk about that and mostly agree with Walt but sometimes not completely, or say, "Your focus on why it's good omits this or that facet of this kind of thing." As a result, as a group we came up with a very good set of management principles and doctrines that I think—I suggested at the time that, "Walt, we ought to let Human Resources have this," because what he did was give the final version to all the Managers, and when a new Manager would come into the Division, they'd give that and say, "This is kind of our philosophy of how we manage and what we think," and this kind of thing. And I think since that time he has actually used that in some sense as a training guide within Engineering for other Division Chiefs. When somebody becomes a new Division Chief, the Director of Engineering has said, "Go and get Walt's manual for how to be a senior manager," and this kind of stuff. So most of that work is Walt's, but I did have some impact into that and was proud of that. I've still got my copy, although I don't have the current copy, probably. It's been updated. But I think we had one of the best division programs around. We had communications programs. Every morning at seven-forty-five, we had a Division staff meeting. They were always conducted very efficiently, all the Branch Chiefs and Assistants were there. We'd go around the table, "What's going on today? What's coming up we need to know about?" There was no long discussion about it, just an awareness of what was going to happen that day, and then Walt or I could say, if

somebody was going to be involved in something, we'd say, "Well, we need this other person. Would you make sure you're involved in that or somebody to be sure we've covered all of the Division aspects of that issue?" and that kind of thing.

And then every morning, at the tail end of that, we invited one of the working-level people from the Division to come in and make a fifteen-minute presentation of what they were working on. It not only gave them exposure to us, it gave us exposure to them, where you could really evaluate whether a person was doing good technical work and could present it well, was doing good technical work or was a poor presenter, or any combination of those. And we could ask them questions, and it kept everybody at the management level in the Division up to date, because over a period of two or three months, you'd just rotate most of the working-level people in the Division through the morning briefing.

Walt was also very collegial in all the human resources and personnel kinds of issues, so he had a very collegial process for evaluating people for their yearly evaluations. He said, "I want you to do the people in your Branches based on not only on your Branch input, but then I want you to come down, and we're going to interleave these evaluations together." He said, "When you do that you'd better take off your Branch Chief hat and put on the Division perspective hat, because it's not always that the best guy from Branch A is—and then there's the best guy from Branch B and the best lady from Branch C and the best person from Branch D, and now we go to the second one and just interleave them that way." He said, "The top three people in the Division may all be in one Branch, We've all had exposure to all these people, and I want an honest assessment from this group as to how we really put these people together."

And that was tough, for a Branch Chief to say, "Well, I realize that your best person is really better than my best person, and I'll acknowledge that," and that kind of stuff, but it forced

people to take this higher view of things. So we did that kind of process, not only for the annual performance appraisal but for awards and for significant training, that kind of stuff. You know, so many other organizations, the training book would come out, and they'd just send it out and say, "Send in what your training requests are," and it would come in, and a lot of times, the training request wouldn't relate to anything that was necessarily needed by a person or applicable to their work or something like that.

As a Manager, I'd always filtered that pretty well in my organization, but Walt did the best job of anybody. We would come in, and we would talk about the people individually and what training we felt like they needed before we asked them to suggest what training they needed. In many cases, we would come in and say, "Okay, here are our training priorities, that so-and-so needs to be able to make better presentations, so-and-so needs to be able to write better, so-and-so needs various other kinds of presentation training," or whatever, including technical training. So our training was needs-driven as defined by the Managers, who had a better understanding of the person.

Now, the person got to put down, "I want to go get trained in this new computer program and blah, blah, blah," that kind of stuff, and we would certainly honor that in many cases, say, "Yes, you need that, and we need to send you to that," but there was one NASA program where, I can't remember the name of it, but basically you'd send a person off for a year to go to graduate school kind of thing, with the idea that they were going to get educated in a new field. If they happened to get a degree along with that, a masters or something, that was fine, but the real focus was to send them off and get this new knowledge, not to just go get a degree. There was competition for those kind of things, because NASA paid your salary and sent you off to go to school for a year and this kind of stuff.

What we would do as a group, the Managers would get together and say, where are we deficient in some area, some technology, some new field that's moving up that's important to us? We would define those and then define people who were candidates to go and get that knowledge and bring it back to the organization for us and who were also good candidates for growth in the organization. Then we would go down and tell them, "We would like you to go to Boston College [Chestnut Hill, Massachusetts] and study under Professor Johannson [phonetic] on this new way of analyzing robotic control theory," or something like that. And almost always the people would be agreeable to doing that. So as opposed to somebody saying, "Well, I need to go back to Northwestern [University, Evanston, Illinois] and finish my masters," and some Division Chief saying, "Oh, okay, we can spare you, and we'll nominate you," our process was so needs driven and so well documented that our candidate nearly always was selected.

One of the things I pride myself on was I would always do the final write up on those things, because once again, I thought I did a good job of being able to very succinctly state the case, the requirement, the reasons for selection, and the benefits that were going to be accrued and all that kind of stuff. We were always very successful in our Robotics Division in getting our people promoted, getting our people sent off to these NASA educational programs, other special training programs, awards, that type of thing.

We also had special group sessions, where we got together and talked about people who were doing exceptional work and what kind of awards could we put them in. And we have a ladder. You know, NASA has various levels of personal recognition awards, and unless it was something truly extraordinary, we would start a person on a ladder leading to—you start out a person who was doing a really good job at a lower level with that first NASA award, and then maybe later on, they get an Exceptional Service award, and then later on, you get them

something else. So you work them up the ladder so that there's still somewhere to go in the progression of awards. You just don't start them off at the level at which you can't ever get anything better than this.

So Walt, as a Manager, for looking at all aspects of those kind of things, training, awards, promotions, recognition, that type of thing, was the best Manager from those kind of standpoints of looking at the whole bailiwick of management techniques that builds an organization.

We had a lot of events where we all got together. We had monthly meetings where we'd get together. Walt would talk about a topic. We would recognize people that would get little in-house awards. We had ER [Excellence Recognition] awards. ER was our mail code symbol and this, so every month we'd get together, and he'd talk, and I'd talk, and we'd bring people up and recognize them for something that they had done well. And once again, those things every month were selected by all of the Managers and the Branch Chiefs getting together and saying who did good, who needs to be recognized. We would also make sure that that got moved around so that it wasn't the same superstar every time and that type of thing.

So I have nothing but the greatest admiration for Walt and his management capability. I learned a lot from him, and I think he learned a little bit from me. He was very generous with me when we got together. He said, "Look, I like to handle certain aspects of the Division, and each of us needs our own domain that we'll be responsible for. So let's talk about it."

So we basically divided the work of the Division. I had primary responsibility for 40 percent of the stuff, and he had primary responsibility for 60 percent of the stuff. Then we kept in close contact during the day and in our weekly lunch meetings and that kind of stuff. I just felt like it was a very useful, productive, effective relationship with Walt and look back on that with a great deal of pleasure, because we built an organization. We built a relationship with our

clients. We built up a good technology program. We had good funding. We had good contractors that we had good relationships with. We established like twelve new laboratories to support the technologies.

We put major facilities together. We built a new east end on Building Nine, where the robotic training arms are, put those arms in place, developed them and got them operational to support both Shuttle robotic training and Space Station robotic training and really were doing very, very advanced robotics kind of work that Walt primarily made happen because of his philosophy and his strength of being able to advocate for those kind of things. So I really consider Walt a good friend, along with Chet, Henry, and Guy Thibodaux.

The last year I was working full time, '96, I had just previously been assigned by Leonard [S.] Nicholson, who was Director of Engineering, to go work a special project because the Center had realized that the Space and Life Sciences Directorate had a significant engineering activity going on designing medical and crew systems kind of equipment. The kinds of things they were doing was parallel to the stuff the Engineering Directorate was doing. So the Center decided that maybe there shouldn't be two design engineering organizations, that we needed to go and find out what the design engineering work in the Space and Life Sciences Directorate was and look at considering how could the Engineering Directorate do that instead and then pull those tasks and some appropriate people out of Space and Life Sciences Directorate into a new organization that would be under Engineering, that would do those kind of things.

So Leonard Nicholson got me together to head up that activity, to go and do an audit of all the stuff Space and Life Sciences was doing, identify all their tasks and resources, and then see how they matched the capabilities that Engineering already had and then see if there were

some techniques or organizational structures or methodologies we could come up with that would create an effective transfer of that work out of Space and Life Sciences into Engineering.

Kind of an interesting story. When Leonard called me up, Walt told me, said, "Leonard wants to see you. He's got something special he wants you to do."

I said, "Uh-oh." So I went and talked to Leonard. By that time, I was a fairly senior person, and I took very careful notes of what Leonard wanted me to do. He explained it all, and I said, "Okay. Well, let me have a couple of days, and I'll go back and put together a plan to get this done and bring it back and run it by you to make sure that I'm on the right track."

So I did. I went off and in a couple of days came back, and I had this plan pulled together with something I thought was what Leonard wanted. So I started in to explaining to him what it was, and he was looking at me incredulously and saying, "What are you doing this stuff for? Where did you get that assumption?" and all that kind of stuff.

I said, "Leonard, that's what you told me you wanted me to do. That's what you told me when we talked the other day."

"No, no, no," and he gave me a hard time.

So I went back, and Leonard hadn't been the Director of Engineering all that long at the time, I guess, a couple of years, and I'd had limited personal relationship. Walt mostly related to him. I went back and [Walt] said "Well, yes, a lot of us have that trouble. We think we understood what Leonard asked us to do, and then we go back with a plan and find out that somehow we misunderstood. Now whether that's because he changed his mind or we misunderstood or something." But anyway, it was a little bit of a hiccup. We finally got it sorted out that he and I were on the same page about what he wanted to do.

So I went off for a couple of months and got that done, came back, and made a presentation to the Engineering Directorate staff, which then later went on up to the senior staff, and we had a credible plan that identified all the Engineering tasks that were really not Space and Life Science things, they were building medical equipment or building crew equipment or something like that, and we felt like Engineering could do a credible job of supplying that, and there would be an efficiency of folding that into our already-existing organization.

The problem was, they had one set of support contractors, which was Martin Marietta, and we had another, which was Lockheed, and during this process, that problem got helped a little bit because Lockheed and Martin joined together, merged, and became Lockheed Martin. So it turned out that no company was losing the contract. We were going to consolidate some of this stuff.

So we pulled together a plan, and they formed a new Engineering Office, what they called—I can't remember the name—Biomedical Engineering Office or something like that. The lady who had been leading a lot of that in Space and Life Sciences was a lady named Cathy [D.] Kramer, and she was moved over as the new Division Chief, into Engineering, and brought a bunch of people from Space and Life Sciences with her. Then there were a few folks from other organizations that were doing work that supported that, that got pulled over to that organization.

Then Leonard told Walt that he wanted me to go over there as essentially as close to a full-time assignment and help Cathy as her Acting Deputy for a period of several months to get that organization formed up, because, I guess, Cathy was coming from a Space and Life Sciences culture and didn't understand the processes and the cultures and stuff, necessarily, in

Engineering. Leonard felt like, since I had done this study that had helped lead to this action, that I would be a good resource for her to help get her on board.

There was also a problem of we now needed to rewrite all the tasks and change them from Space and Life Sciences tasks to Engineering tasks and get the money that they had and transfer it to Engineering. But the Requirements people were still over in Space and Life Sciences, so we had to be sure that the tasks we were doing were what they wanted done and all that kind of stuff. I worked with Cathy on getting all that done.

That was, again, a very tough job. It was like pulling teeth. I was answering to Jim [James R.] Jaax, who was the Deputy Director of Engineering at the time, and he was getting frustrated with me, and I was getting frustrated, because we couldn't get the Space and Life Sciences guy to be firm on what they wanted these tasks to do so that we could go off and put together a proposal that said, okay, this takes this many people and this many man-hours and this much resources, and this kind of stuff. Then they'd change their minds and say, "Well, no, no. We want to continue doing that. We don't want you to do it."

We'd have to say, "No, that ain't the rules. You know you're supposed to give that up." Then we'd have to go fight about that some more and all that kind of stuff.

So that was a very interesting process, to make all that come together, and it still had not jelled real quickly by August, when I reverted back to the Robotics Division, because my plan had been to retire at the end of September in 1996. So I wanted to go back and make sure things were in order in the Robotics Division. So about the middle of August, I went back to Robotics and wound things up over there and did retire at the end of September in '96.

It's a thing that I had thought about over the years that had never been real. I'd been counting off the years and then the months and then the days, and suddenly it was on me, and I

had this nice office with a big desk and a conference table and everything. And I worked late the last night I was there. I'd worked very hard to transition all of my activities and status everything and that type of thing.

The person that was going to succeed me was a lady named Kathy [Kathleen E.] Jurica, who has since remarried. Her name is Kathy [Kathleen E.] Symons now. She was head of our Intelligent Systems Branch. She was going to move down and be the Deputy.

I got rid of all my files, took all the personal files. They're all sitting there in boxes, all my textbooks that I occasionally use but not much, they were all there. All my personal artifacts and plaques and pictures and everything were off the wall. I moved them out to my car and came in and erased everything on the whiteboards and wrote, "Good luck" on the whiteboard and walked out and closed the door. I felt very strange about doing that at the time.

Luckily, we had had a—it wasn't an early out, but it was one of these things to encourage people to leave. And one of the provisions at that time was, if you're eligible for retirement, which I was, I had thirty-four years of service, and I never used any sick leave, so I had two years also of creditable sick leave. I was very fortunate over the years never to be sick, so I had two years of additional annuity credit that was going to be added for unused sick leave. I had a whole wad of unused annual leave that I'd saved up.

But one of the provisos to get people like me to leave was that, we will try to get you a job in education, and we'll help you transition, get some training so you can go be a teacher. We'll try to place you in a university position as a professor for a period of time. Or, if you can find a deal on site here, we will hire you back as a rehired annuitant for two years to work half time to do something different than what you were doing. You can't just stay in your organization and go the half-time work and retire and still get paid.

Well at that time, I was doing so much freebie work with the Education Office at JSC because the Robotics had interesting, interesting work going on and particularly interesting laboratories that were always on the tour, and they showed well to visitors, and the Education folks would always call me and say, "We've got this group of teachers," or, "We've got this group of students coming in. Can you take us on a tour of the Robotics Lab?" So I ended up, I was arranging a lot of that or doing it personally and really was enjoying what I was doing. And I'd always participated in the Education Outreach Program. During Engineer's Week, I'd go out and talk to a couple of schools, and I'd always gone to my children's schools and all that kind of stuff. So I really enjoyed that.

I had a nice relationship with Nancy [G.] Robertson, who was Head of the Education Branch. So I went over and talked to Nancy, and I said, "I'm thinking about taking this retirement thing, and one of the options is coming back as a rehired annuitant for half time, and I think there's a pot of money [available] for that, and the deal is that I wouldn't count as one of your staff as far as an official billet goes, and I think I'd enjoy coming over and working half time with teachers and kids."

So she said, "Oh, boy, we'd love to have you. With your experience and breadth of knowledge in Propulsion and Power and Robotics and Program Offices and Space Station and Mars and Moon and biomedical and all that kind of stuff, that would be great." So that was the conditions under which I retired.

So I retired at the end of September in '96. I actually took a month off. My wife and I got in the van and went on a trip all over the country to see all the children and grandchildren. Then I came back, and November 1st I came back to work as a half-time Education Outreach person for two years.

I really, really did enjoy that, developed a number of programs that are still going on that they enjoyed. I did teacher workshops in the summer for not only local area teachers but the Department of State would bring in a group of thirty or thirty-five teachers who teach in their Department of State embassy schools around the world and did teacher workshops for them, each of them in a week or two weeks at a time, and that type of thing. I really did enjoy that for two years.

At the end of two years, I went to see Human Resources and said, "Hey, this is a lot of fun. Why don't we do it for another two years?"

They said, "Sorry. The money's run out, and this was a special, one-time program."

So I went and talked to Nancy, and she said, "Oh, well, maybe we can work something out." So she talked to the support contractor, and the support contractor came and talked to me and said, "Nancy still has a need for this service that you're doing, and if you'd consider coming to work as a support contractor."

So I said, "Well, that's great. I don't want to be an eight-to-five person. Let me just sign on with you as a consultant." And I said, "The rules are that you can suggest assignments to me. I have veto right over assignments. I set my own working hours, and if that's okay with you, I'll be responsible. I know what needs to be done, and I'll do it. But if you want me to do something I consider to be trivial and I don't want to do it or I'm going to see my grandchildren, I'm going to tell you no."

They said, "That's okay with us."

So you know, I essentially wrote a consultant agreement with them, and continued with them for another several years. This fiscal year, 2006, is the first one that I have been without a contract.

I did a number of things in education for them over the years, including running an activity called the Space Settlement Design Competition, where we bring, on a long weekend in the spring, 160 high school kids on a Friday night, divide them up into four teams, and ask them to design a lunar base or a Mars base or something like that. Then they present the results to a team of judges on Sunday morning. We feed them all weekend and take them on tours and all this kind of stuff.

They really get a good sense of what it is to work as a member of a team in aerospace-oriented activity, trying to do a humongous job under very pressing time constraints and with not enough information in some areas and too much information in other areas and that kind of stuff. The kids don't sleep much. It's a Spartan condition. They sleep on the floor in the Gilruth Center, you know, the boys downstairs, the girls upstairs, and they work all night on computers putting together their presentations and figuring out what the results of their studies are going to be, what they're going to propose for this base.

A typical one would set up a scenario for them, say, okay, the year is 2071, and we're going to build the second human base on Mars. This is going to be at the south polar region of Mars so we can mine water ice and carbon dioxide ice, and the size of this base is going to be 12,000 humans with a capability to have 1,000 visiting at any one time, so the thing needs community aspects. It's not just an eight-astronaut kind of thing. You need living-in health care and community and schools and entertainment and all these other aspects of a community, the infrastructure, utilities, and all that kind of stuff. And the setting and the context for this is on Mars or on the Moon, so you've got to resupply these kind of things and communicate and all this kind of stuff. So it's a real challenge for these kids to think that far in advance, to

extrapolate technology, what is going to be the state of the technology in 2071 and that type of thing. It's something I've really enjoyed.

The Center last year—the last two years—we ended up, got so popular we did two sessions of the competition in 2005 and 2004. One of the drivers of that was the state of Iowa got so excited when they learned about it, they said, "Could we bring down half of the kids and you guys go to two competitions?"

So we said, yeah, we'd do that. So each of the two competitions, which were two weeks apart, each of them being a Friday-night-to-Sunday night activity. It consisted of eighty kids from Iowa and eighty kids from Texas, and we'd blend them and mix them all up so that you get this cultural blend, because the Iowa kids were from small towns in western Iowa with a heavy rural, farm kind of background. The Texas kids were from around the Houston area. They're urban kind of kids. A very interesting way to see them mix and get integrated and that kind of thing.

The 2005 competition, the two competitions cost a total of $50,500, not counting the money that NASA paid me, and I gave them a very good rate on me. They didn't pay me much. But it was $50,500 that cost them for these two competitions. And I run out, and between fees that I charged the state of Iowa, fees I charged kids to come, I make it some nominal fee so that it's serious for them to come, that they actually show up and don't decide at the last minute, I'm not going. They've got fifty bucks in this thing, so Mama's going to say, "You're going." And I went around to all my buddies that run all the aerospace companies around and said, "Hey, I'm doing this thing. I'm trying to raise money to support these kids who are going to be your future employees. Can you give me a little money?" As a result of all those sources, of the $50,500 cost in 2005, I raised $45,000. So it only cost NASA $5,500 to put this thing on, which, when

you divide the 375 participants into that, there was 325 kids and forty-five teachers or something like that that came from Texas and Iowa-works out to be like $14.70 a person for a very intense weekend.

This year, NASA said, "Well, we've got budget problems. We can't afford to do that." So I don't have a task this year, but I didn't give up. I pulled an end run on them. I called Iowa and said, "Look, NASA's wimped out on me. They're not going to pay any money, but they might continue to host the thing and support it with in-kind services, like let us use computers and bring tables and chairs over and let us be in the buildings and this kind of stuff." I said, "Will you pay for it?"

Iowa said, "Oh, yeah, man. We'd love to pay for it. We can raise the money for it up here."

I said, "And the second question, if you're paying for it, you can bring most of the kids, but I want to bring some Texas kids, because I think it's important to have that blend of state culture."

So we worked out a deal where they're bringing 140 kids and I'm bringing twenty-four kids from Texas. They're going to pay for it. I brokered a deal between Iowa and the Johnson Space Center, got a formal, legal written agreement that they're going to allow me to go ahead and do it. I've now become an agent of the state of Iowa to do this. But they let me have a desk and a computer and a phone at JSC, and I'm putting the thing on just like I always did here, except Iowa's paying me about 5 percent of what NASA paid me to do it. So we're still doing it this year, and I'm hoping that I can keep this thing going with that same vein as I did before. So that's where I am in my career.

I'd like to go back and interject one important thing that happened to me right after I returned from Space Station to the Propulsion and Power Division. The Marshall Space Flight Center, which is responsible for the Shuttle solid rockets, as part of the *Challenger* investigation, decided that they need a new solid rocket design, because the *Challenger* [accident] was caused by a seal failure between segments in the solid rocket. So they were going to put together the ASRM, the advanced solid rocket motor design, and they formed a big procurement team and were going to go out to the solid rocket community for a rebid and complete redesign, a new design of the solid rocket that wouldn't have these problems that had caused the *Challenger* accident, even though separately, the *Challenger* hardware was being fixed, so that that wouldn't happen again.

So they went out, and they wanted not only a new design but they wanted a brand-new manufacturing and production facility for the new solid rocket motors that were going to be done. Well, it turns out that, as a short-term assignment, in previous years, they had had a failure of a solid rocket motor at the Thiokol Test Facility out in Utah, north of Salt Lake, the Great Salt Lake. And they had said we wanted a failure investigation board, and they called Johnson and said, "We need a representative."

Well, I knew a little bit about solid rocket motors. I was the Deputy Division Chief, and once again, it was one of these things that the Center has got to send somebody at a fairly senior level that can command resources and get things done, but obviously, the Division Chief doesn't want to go to Utah for three months or something like that, so the Deputy Division Chief gets to go. So I got packed off to Marshall and then to Utah to investigate the Thiokol solid rocket motor failure. As a result, I got to know a whole heck of a lot about the solid rocket motor and how it was built and this, that, and the other.

I finished that up on the board, out there quite a bit over a four or five-month period. I came back and was working back in Propulsion and Power Division again when the requirement came that, after *Challenger*, they wanted this new rocket thing. So then they wanted to form the source selection committee. They wanted Johnson to put somebody on the source selection committee. It came down they wanted somebody that knew about propulsion, somebody that knew about solid rocket motors, and somebody that was an experienced person in a big source selection thing. Guess who was picked?

I'd just come back from Kennedy within the previous year or so from being down there a year on a big source selection. I'd been on this earlier failure investigation board on the solid rocket motor, and I knew about propulsion and all that kind of stuff. So Norm got named to be the JSC representative on the Marshall source selection board. So I got shipped off to Marshall for eight months to be part of that board and write the requirements and write the procurement package and participate in all of the consultations with the contractors and preliminary conferences so they understood what we wanted, evaluating the proposals and being sequestered over in some buildings where nobody can find out what's going on and what's happening and all that kind of stuff. So that was another significant activity.

When I got back from that, Aaron Cohen called me and said, "I got good reports on your work over there and blah, blah, blah." He says, "You've done such a good job being at Kennedy, being on this failure board, being on the Marshall board. You've been out of town almost full time for two and a half years." I think for one year I was the JSC person that had the most travel of anybody else in the Center. He said, "I want to really do something nice for you." He said, "I'm going to send you to senior executive management training for two weeks up in Denver [Colorado]."

I said, "You're sending me out of town for two more weeks?"

He looked kind of funny, and he said, "Yeah, I guess that does sound kind of funny, but," he said, "but I want you to."

So I went up to the Office of Personnel Management Training up in Denver for a couple of weeks and that kind of thing. So being on the Marshall board was interesting because they ran things a little bit different than Andy Pickett at Kennedy had run. I learned a lot from that, also. It was interesting. There was a security breach in some of the evaluation. Some of the proposals got stolen, we realized, during the process, and we had to do some funny things to make up for that, and all that kind of thing. So that was another important and significant piece.

Let me just mention a couple of other things. I have been blessed over the years of my career with recognition from NASA. I have a number of nice awards and got a number of nice grade increases and that kind of thing over the years for the work I've done. I've gotten two Exceptional Service medals, which I treasure. The last one I got when I was with Walt and which is the nicest thing that the agency could have done for me was I got NASA's Outstanding Leadership medal, and that means a great, great deal to me and did at the time and that type of thing, and a number of awards and plaques and that kind of thing.

The other aspect I'd like to mention was the importance in my career of professional societies. I got inducted into the American Institute of Aeronautics and Astronautics, which is the AIAA, back in the mid-sixties, after I'd been here for about three years. My Division Chief, Guy Thibodaux, was the incoming Chairman of the chapter here, and he came around and asked me if I'd be willing to run as Secretary. I said, sure, I'd willing to do that if it didn't involve much work, because I was really busy.

He said, "No." He said, "I'm Chairman, and there won't be anything to do. We just need somebody to be Secretary."

So I said, "Okay. I'll volunteer." Well, that's one of those jobs that nobody really wants to do, so I think I was the only candidate, and therefore, I got elected. Lo and behold, I found out there was a lot to do. First of all, Guy, who was my Division Chief, was also the Section Chairman, so I couldn't do a bad job that year.

Well, the next year, the Deputy Director of Engineering was going to be the incoming Chairman. He called me and said, "I want you to continue to be Secretary, because I noticed you did a good job this year." So that was up my food chain of command, so I couldn't turn that down. So I ended up being Secretary for about three years.

But as a result of that, I came in contact with a large number of the senior people at the Center who were also members of AIAA and had a chance to interact with them, get to know them as individuals. They got to know me as individuals, and not only that, in completing my duties for AIAA, they got to know that they could rely on me and trust me to do what I said I was going to do, and not only that, but do a product quality job. That has served me in tremendous stead.

So I decided that AIAA was a valuable resource for me to be a member. Not only did I learn stuff from it, it gave me some management experience and training and let me network with people in other technical disciplines. I'd always known that it was important to my technical career to maintain a very broad overview of what was going on so that I knew how my work was tied into what the other needs of the Center was and what other people were doing and this kind of thing, so that was very important to me. But I ended up being Section Chairman,

Chapter Chairman, after being Deputy Chair and the head of almost all of the committees. I became Chairman of the Section in 1980 and '81.

At the end of the year in my going-out activity, we put together a black-tie event in the Teague Auditorium with a champagne fountain and all that kind of stuff to celebrate the launch that spring, in April, of the Shuttle STS-1 flight. As part of that, I had talked to *National Geographic* and asked them to put together the program, because the fellow I worked with, who was my Deputy Chairman, was a guy named Jack Heberlig, who was a contractor [at the time]. He had some contacts at *National Geographic*, and they've always done marvelous space articles in their stuff, so we called them and said, "Would you come on and put on a program for this event using all of the coverage that you have put together on the manned spacecraft program since the very earliest days when you started covering this?"

So they did that. They put together a magnificent program, which then toured the country, went to museums and other Centers and that type of thing. So I'm still involved as a retiree in AIAA. I participate with them in their annual technical symposium every year, and I act as their interface with the Ninth Floor to get the Center to support that with in-kind support.

The final thing I will say was the National Management Association [NMA] chapter was started at JSC by Director Gerry [Gerald D.] Griffin back in the mid-eighties, probably. I thought that was good deal, also joined that as a charter member and was Chairman of that chapter the year that they sucked me out and sent me to Marshall to be on that source board over there. But I did get to serve long enough to be Chairman of the JSC Chapter of the National Management Association, have continued to be associated with that in a number of positions.

Last year, even as a retiree, I was the Chairman of the training and education committee and this type of stuff. I found NMA to provide another wonderful tool for me, because the

people who belong to NMA are not necessarily the technical people, they're the logistics people, the Legal Office, the Center Operations, the Transportation, that kind of stuff, the kind of people that I didn't have a good relationship with. Now I know all of those folks well, and as a result, by the time I retired there were very few people around the Center that, if I needed to know something, needed help, needed a favor, I couldn't call up on a person-to-person basis and say, help me, can you tell me this, do this for me, whatever.

So here it is, in February of 2006, I'm almost ten years into retirement, I come into the office almost every day, and one of these days I'll have to think about hanging it up. But I've had a wonderful time since 1962, and I've changed directions a number of times and have gotten a great benefit and feel like I've given back a lot.

So that's the end of my story.

ROSS-NAZZAL: I do have two questions that we like to ask everyone.

CHAFFEE: Okay.

ROSS-NAZZAL: What do you think is your most significant accomplishment if you had to look back over your NASA career?

CHAFFEE: Most significant accomplishment. Gee, it's hard to tell. There's one technical one. I think that the problem I discussed with you of helping to resolve the pressure spike or explosion problem of the Apollo service module and lunar module reaction control jets. That explosive residue that was being formed due to the short pulsing and that type of thing, I think that took

some insight that I was particularly well suited to bring, with my chemical engineering background and although there were many, many people involved in that. I felt like I played a key role in making all that happen.

At the management level, probably forming a new organization at the Space Station Level II level and then at the Lunar/Mars Office. Those were interesting jobs. Probably working with Walt Guy to finally put together the really effective Automation, Robotics, and Simulation Division and form a new culture that really had a sense of who we were, as opposed to who we all used to be kind of thing. I think that was my most interesting managerial achievement.

Professional development, I'm proud of having been Chair of both the AIAA and the NMA and leading those organization. NMA did give me their top award one year, the Silver Knight of Management award locally. AIAA nationally gave me their top award one year. I think that must have been about 1990, when I got AIAA's top—that wasn't a local–top national award and was recognized at their annual technical meeting in Washington, that type of thing.

So I've, like I said, contributed a lot and gotten back much more than I've contributed, and I've had a wonderful time, and I look forward to another few years of this, of contributing and staying involved.

ROSS-NAZZAL: What do you think was your biggest challenge, if you had to look back over your career?

CHAFFEE: You know, the technical challenges were always something that I could deal with. I'd be taken aback, but I could come up with a way. So my biggest challenge was probably trying to

balance life, find time for my church, for my family, for my job, for the pets, for other kinds of things. I think I've sorted that out now, but I didn't do as good a job as I could have in the past.

I told you that there was one two-and-a-half or three-year period when I was either working all the time or I was at the Kennedy Space Center on a [source] board or at the Marshall Space Flight Center. At that time, my wife got an opportunity to take a job in Boston [Massachusetts] as a senior executive, and we talked about it, and she agreed to go up there and do that. After a year, she got the opportunity to become CEO [Chief Executive Office] of that organization in Boston. So for a [few] years, we had a bi-coastal marriage, where we traveled back and forth to see each other. But the end effect was that, for three years I was gone, and then when I came home, she was gone for [three] years.

As a result of that, our marriage did fail. It was an amicable failure at a time when the pets had died and the kids were gone and that kind of stuff. So I do regret that. We were married for thirty-three years, and that's a long time. But a couple of years later, I found another nice lady that I've been married to for eleven years, and I still have a very amicable relationship with my first wife. But probably my biggest challenge was, how do you balance your personal life and your work life.

ROSS-NAZZAL: Well, we thank you for coming in today and sharing all your memories with us. We sure enjoyed it.

CHAFFEE: Great. Well, we covered a long time.

ROSS-NAZZAL: We did.

CHAFFEE: Today is the 7th? As of five days from now, I will have been here for forty-four years. That's a long time.

ROSS-NAZZAL: That is a long time.

[End of interview]