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ORAL HISTORY 2 TRANSCRIPT

THOMAS KENNETH MATTINGLY II
INTERVIEWED BY KEVIN M. RUSNAK
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RUSNAK: Today is April 22, 2002. This interview with T.K. Mattingly is being conducted in Houston, Texas, for the Johnson Space Center Oral History Project. The interviewer is Kevin Rusnak, assisted by Sandra Johnson.

I want to thank you for coming by this morning to spend some more time with us. You mentioned that you wanted to talk about George [W. S.] Abbey's role a little bit in the space program.

MATTINGLY: Yes. The last time when I talked, we had mentioned some of the things that George did along the way, but in retrospect I realized that while most people that work in the program recognize George's role, I at least wanted to trace my relationship with that, because he's got such an unusual insight and he also has the memory for people's faces and names that's just absolutely extraordinary.

I first met George when he was—I thought he was this nondescript guy. He was called the secretary for the CCB [Configuration Control Board] in Apollo, and I had no idea what he did. I knew he had been to the Naval Academy and he'd been an Air Force officer, and I don't know, he may have been an Air Force officer when he was assigned here, but he stayed on, and he was kind of helping out George [M.] Low and company. He was one of these unusual people that seemed to know everybody. I never did figure out what he did. He would maintain this network of informal connections that he'd developed throughout the center and did a great deal of his work after-hours. So he had this amazing connection of people.

Jack [Harrison H.] Schmitt, who was one of my personal friends because we were both bachelors and lived in the Bay House over there, and Jack and George became, I think, pretty good friends. So through that I kept wandering in to George in different places, and found that he was playing this extraordinary role, that he was not in the chain of command. You won't find him on the org chart in any position of influence. But after Low took over the program following the fire, the two Georges were a remarkable team in that George Low did everything in public and did all of the formal stuff and wrote memos and gave directions, and everything he did was a matter of record, Mr. Abbey, on the other hand, was intimately involved in every one of those things, every conversation, but he also had this network of working people. He knew all the troops and all the buildings, and he'd wander around and just talk to people and bring all of that stuff back. He knew what George Low was concerned about, the kind of questions, and so he would bring that stuff back, and informally, just no attribution, he would just make sure that George Low was aware of everything going on as perceived from the bottom of the barrel, as well as the reporting structure that officially brought things in.

I think that the combination of George Low, it was always—well, George Low is the finest program manager that ever walked the face of the Earth. I've seen a lot of good people, but I've never seen anybody of his caliber. He had this way that he could take that information and use it, but never embarrass anybody or never expose. He would just ask questions based on his knowledge that there was more to this story than perhaps was immediately obvious. He would just ask questions, and the source of a lot of this came from sources that George Abbey would gather. They would share. I think a lot of the success of the program was due to that combination, because it was done in such a discreet way that it never caused any problems. But it made sure that the boss knew what was really the state of affairs throughout the Center, which from the top of the pile is really hard to find out. It's the hardest thing in the world. And those two guys worked together to make that happen, and I, frankly, have—I've seen a lot of number one-two positions in organizations that work together well, but never have I seen one that could reach as far down in the organization as what Mr. Abbey did.

Throughout the program we'd have these lame-brain schemes that people would push on. Jack Schmitt was really big on, "Let's go finish off with a landing on the backside of the Moon," and we used to have these little cabals of meetings, sitting around at people's rooms at night and debating how we could do this. It was a small group, but it was a group that represented a diversity of technical disciplines. We all thought we had pretty much figured out how you could do it and do it with a reasonable degree of safety, and Abbey was aware of all that. So I know that management knew, and when it came time to just knock this off, why, that was also handled discreetly.

So I thought that was really an insightful management style. Whether it was deliberate or whether it was just a natural attribute that found its right place, I don't know, but it was extraordinary, because George Abbey saw every bit of the program from the management and from the ops and from every aspect, just because of this propensity he has to wander around and talk to people and listen. He doesn't speak very often or very much, but he sure soaks up a lot of information, and he's maintained that. In that same style, it was pervasive in his activities in the Shuttle Program. I would presume he hasn't changed. I'm sure that that same network of personal communications with a rapid communications link probably persists to this day.

But the two Georges working together, I think, play the—there were a lot of extraordinary roles in Apollo, but I think the two Georges are one of those elements that people may not always recognize because it was in the background. So I wanted to make sure that at least I had added that to my Apollo commentary, because coming from the military when I got to JSC—MSC [Manned Spacecraft Center], as it was then—I was totally perplexed. They had org charts, they had telephone directories with lists of names, and yet none of those descriptions about who did what and what their titles were seemed to match what they really did in life. From a military background where organizational structure is very rigid, you know, this was really perplexing. I just could not figure it out. But he's the one that's supposed to be doing this; this person over here is doing it.

But they had a structure that they had put together where the job was so hard, they had the best people doing each job, and they didn't pay any attention to the organization. They didn't have to. They knew who to go see and who could do stuff and who to listen to and who to ignore, and that didn't cause us any problems. From my perspective, I didn't see any until we got in the Shuttle Program, and the Shuttle Program represented a real turning point in the way NASA and JSC operated.

So I guess it's time to stop Apollo and say how did I get into the Shuttle, and what do I recall about the progression. One of the most extraordinary experiences I've ever had was the ability to—I actually joined the Shuttle Program the same month that the contract was given to Rockwell [International] to develop the Shuttle. They had already awarded the contracts for the propulsion system and some of the other things. That was in the late summer or fall of '72, I believe.

When I got back from Apollo 16, Deke [Donald K. Slayton] asked me, he said, “You know, there's only one more flight, so if you really want to fly again anytime near term, you might want to take the backup assignment on 17. Chances aren't very good, but we do know that we replace people occasionally. So if you would like to have that chance, you can do it, or you could work on the Shuttle Program,” which was just—you know, studies had been going on towards the end of Apollo, and a lot of E&D’s [Engineering and Development Directorate] work had been started early, and really I hadn't paid much attention to it. I kind of knew the work was going on, but I didn't know what it was, because my ambition had always been—I didn't think I would go to the Moon, but I was really hoping that I'd get to be on the Mars mission, which I was sure was going to happen the following year. To a young kid, it just seemed obvious that the next step is you go to the Moon, then you sharpen your tools and you go to Mars, and I thought, "Boy, that's where I'd like to go." Even by then it was becoming obvious that that wasn't really a likely proposition.

I wasn't enthused about the Shuttle because I still thought going to Mars was the next step. I believe that we needed to build a space station first so we could have hardware which would gather years of lifetime experience while we could get to it and fix it, and we could build the transportation system while we're gaining the experience with a space station. All of that architecture was obviously politically driven, and they were having to fit into a tighter budget. There really was not a great swell of emotion or enthusiasm for things following Apollo in the political arena, nor in the public arena, for that matter. So I think they had to walk some very, very tight lines in order to keep the program going, and so they chose the space transportation as the way to go.

I went up to pay courtesy calls to the navy after we got back, and John Warner was then Secretary of the Navy, and we made a courtesy call to him. He was all enthusiastic. He says, "You Navy guys need to come back, and we'll give you any job you want. You pick it. Whatever you'd like. You want a squadron? You want to do this? Just tell me. It's yours."

Boy, my eyes lit up, and I thought, "Wow." One of my escort officers was a captain in the Pentagon. He went back and told his boss, who was the Chief of Naval Aviation, what Warner had said, and very quickly I had an introduction to the Chief of Naval Aviation, who made sure that I understood that despite what the Secretary had said, in the environment we were in, I was not going to come in and take over his squadron. He'd find a place for me, he'd give me a useful job, but don't think that with the Vietnam War going on and people earning their positions the hard way, that I was going to walk in there and do that. He says, "The Secretary means well, but we run the show." [Laughs]

So armed with that piece of information that if I went back on real Navy duty, at that point I was probably not going to find a particularly rewarding job, and I thought the opportunity to get in on the Shuttle at the beginning and go use some of the experience we gained would be useful, so I told my sponsor I'd do whatever the Navy preferred I do. After all, they gave me my education and everything else that mattered. "So you tell me, but if I had a vote, I would say why don't I stay because the Shuttle Program's only going to take four years." That's what we were advertising. [Laughs] You know, four years, that's not all that long.

So after a significant amount of discussion within the Navy side of the Pentagon, they said, "Okay. Well, we agree. You probably can contribute more if you stay there."

Years later when I did go back on real Navy, one of the flag officers took me in and says, "There's a file you ought to see," and there was a letter in there from the officer who was in charge of monitoring the Navy astronauts, to the Chief of Naval Operations. It was a little two-thirds-of-a-page letter, and I don't remember the beginning two paragraphs, but the ending paragraphs says, "In summary, after laboring mightily, the elephants have created a mouse." These guys are not coming back. [Laughter] That memo didn't get published in too-wide circles.

So that lead me to stay with the Shuttle Program, and so the beginning of that was a period of a great deal of the turmoil of getting started. Apollo 17 still had to fly. Skylab was just getting ready. I don't remember when ASTP [Apollo-Soyuz Test Project] was identified as a follow-on. It may have been talked about in that era, but I'm not sure. My sense was it came a little later.

But we were starting to see within the Astronaut Office there were significant number of people who got more of a pleasure out of operations than out of the development process, and they chose this as an opportunity, when Apollo was over, as an opportunity to go do other things, pursue other interests. But there was still a number of folks that had not flown, that came out of my group, and some of the scientist groups that hadn't flown, and they were still around. And those poor folks had only seen the development side, and they were a bit frustrated.

Somewhere in that initial "get organized" process, the Center went through a reorganization, because FCOD [Flight Crew Operations Directorate]—I think that's what we called it in those days—was a fairly big organization, and the FOD [Flight Operations Directorate] was a large organization, staffed for all of this stuff. I guess it was after the Skylab missions that they reorganized to try and keep some of the operations people on payroll by assigning them to engineering and different places so that they could—they were having trouble defending to Congress the large number of people we had in operations when we weren't operating. So they juggled people around to try to protect [them], which in the long run turned out to be a particularly astute move because it did save the right people, and it gave them an insight that they might have missed otherwise by working from the other side and understanding the development and design problems. So we all got a chance to go do that.

When we powered down Apollo, Jack [John L.] Swigert was more or less the senior guy that was still working on Shuttle things, and so Jack kind of took over being the den mother for our activities. I don't have the time frame down, but for the beginning period there really wasn't a lot to do except kind of learn what's going on and to try to figure out who's who and what companies are doing what and so forth. Jack went off to run for Congress not too long after that, and I ended up sort of being the Shuttle den mother for CB [mail code for Astronaut Office].

Again, I don't have any idea when, but it seems to me like it was after John [W. Young] had taken over the Astronaut Office, that's probably when Al [Alan B. Shepard, Jr.] left, I would guess, and so we started working on these things. We broke up the Astronaut Office into two groups of people. We had some that were designated to work with E&D on the engineering and development side, and another group that was designated to work with flight and operations and training people to look at the operational side. Then we'd have a once-a-week meeting where everybody got together to make sure we were doing the same things.

But we found it was kind of useful to have direct support for the two groups that was independent, and then we could cross-check the—we'd get different answers. One group of people would advocate a solution that came from the design process, and another group would advocate a solution that came from the operations process. Then in some of these meetings we could see the differences and understand them, and I think we made perhaps better recommendations than we would have if we had followed our more traditional role of just sticking with the operations crowd. So that then led us into doing a lot of things that we might not have done or might not have done as early.

RUSNAK: Can you give me an example?

MATTINGLY: Well, yes, I will. Let me kind of wander through the progression, because it started with—the first strong feelings that I remember about this, after getting organized, was setting requirements, and we had a general idea of what specifications the Shuttle was supposed to be, but in those days it was substantially larger and more aggressive than what we know today.

So we went through this requirements refinement where everybody broke up into groups to go lay out what they had to do, and it evolved into something we called design reference missions. Rigidly, the idea was, we knew the Shuttle was going to last for decades, and we knew nobody was smart enough to define what those missions that would come after we started were going to evolve into. So we took great pride in trying to define the most stressful missions that we could. This was a Center-wide effort. I don't remember who led it. It may have been [Howard W. "Bill"] Tindall initially, but Bill left fairly early in that era, I think. So I don't remember who took over that piece of the job, but as I recall, it took months, maybe a year, before we finally had this refined.

The whole idea was, we started out with three missions. One was to be acting as a laboratory, and we laid out all the requirements we could think of for a laboratory—the support and what the people need to work in it, and all that kind of stuff. Then there was another mission that was defined as deploying a payload on orbit, and that was to be one that launched and had the manipulator arm and cradles and all of the things necessary to do that. Then there was a polar mission. The laboratory mission was high inclination, the deployment mission was a due east azimuth launch, so it's 28 degrees, and each of these were sized to stress the vehicle to its maximum.

The polar mission was really shaped after a DOD [Department of Defense] requirement. The original mission, as I recall, was a one-rev [revolution] mission. You launched, got in orbit, opened the payload bay doors, deployed a satellite, rendezvoused with an existing satellite, retrieved it, closed the doors, and landed. And this was all going to be done in one rev so that—or maybe it was two revs, but it was going to be done so that by the time anyone knew we were there, it was all over.

Well, we worked on that mission and worked on it and worked on it, and finally it became a 3A and a 3B. We just couldn't figure out how to do it all on one short time line. But each of those missions were then sized to maximum payload, maximum electrical power requirement, and the idea was that after you had defined these missions, then the design of the vehicle had to satisfy all three, or four in reality. And that's where the cross-range requirement came from, from the polar mission, on just once around, because you had to be able to come back on one flight and had to be able to do an abort, and that gave us the polar cross-range requirement, which had remarkable impacts on the whole program.

I dwell on this stuff about requirements, because having had the opportunity to watch this program evolve from a concept through logistical support into a mature state, I look back and I say, "Well, we know what we started to do, and we know what we have, and they're not always the same. Why?" Because it was an extraordinary job. Essentially, it was so demanding that all of the engineering and ops people that had made subsequent flights up through Apollo work generally stayed on. We didn't have a lot of technical attrition after Apollo. At least that's my impression. At least the middle-level guys all stayed, and they kept working it because they recognized that the Shuttle was a far more challenging job than Apollo in many technical senses. Apollo was a challenge because it was just so big and it was audacious, and time frame was tight, and all of those things.

But the part of the Shuttle that was different was whereas Apollo was a collection of boxes—if you had a computer, you could build it, you could test it, you could set it out and do it all by itself. You had a second stage. You could build and test the whole thing by itself. Well, with the concept of this reusability and integration, you didn't have anything until you had everything. There was no partial thing. There was nothing that was standalone.

I remember we were trying to buy off-the-shelf TACANs [Tactical Air Control and Navigation System], an airplane navigational system, and as part of this integration process, rather than take the TACAN signal that an airplane generated in those days and used for navigation, we stripped it all out and put in all our own software so that this off-the-shelf TACAN box was absolutely unique. There was nothing else. And it was part of the philosophy of how we built this system.

So these requirements we set really had some interesting things. Some of them were politically defined, like you'll land at any 10,000-foot runway in the world. That's all it takes. In selling the program, they had to appeal to just every constituency you could find to cobble together a consortium of backers that would keep the program sold in Congress. People don't recognize how that ripples back through a design into what you really get, and, of course, by the time you know what you've got, the people who put those requirements in, they're history. So it's interesting.

But that 10,000-foot runway requirement set a lot of limits on aerodynamics and putting wings on the airplane. The cross-range—that was the Air Force requirement for this once-around polar mission abort—that sized the wings and thermal conditions. That precluded us from using a design called a lifting body that the folks out at Edwards [Air Force Base, California] had been playing with and had demonstrated in flights. It was structurally a much nicer design, but you just couldn't handle the aerodynamic characteristics that were required to meet these things. So we had a vertical fin on this thing and big wings, and it's a significant portion of Shuttle's weight, and the maintenance that goes with it is attributed to the same thing.

But at the time we were doing this and putting all these requirements on there, we were actually, I think, quite proud of having had the foresight to look at all of these things. Today you can hardly think of a mission the Shuttle—you'd like it to do that it can't do. It is an absolutely extraordinary engineering piece, just unbelievable. I think the Space Station is probably going to exceed it in the magnificence of the engineering and operations side, but the Shuttle really did fulfill almost all of the requirements that we were tasked to put into it.

So after we got these all done, now we get into the hard part of, okay, now we know the requirements, how do you make this all happen. And that all settled down certainly after Skylab, and maybe even after ASTP. Then we started working—I remember Phil [Philip C.] Shaffer was designated as the lead for pulling together all of our software and stuff. Because the Shuttle is such a highly integrated vehicle that the software architecture has—it has the architecture that makes the system run, and then it's got all of the applications which are the heart of the vehicle.

And so we were building all of this from scratch, and in Apollo we were astounded we had computers. I guess Gemini had a little computer, and then Apollo had something which, by today's standards, your wristwatch is far more powerful than what we had those days. But we were still astounded with what you could do with these things. Now we were going to build this Shuttle with these computers and it's going to be their lifeblood. There won't be a lot of direct wire. Everything goes on a data bus, and this was all relatively new for most of us.

So it meant learning a whole new design process, and we learned that the software was the pacing item. We blamed it on software. When we think of developing software, we think of it as coding, "if/or" statements and counting bits, but in fact the massive amount of energy that went Center-wide into collecting the requirements—what does it have to do, write it down, and then see if you can package it before anybody could start worrying about building cold, that was an extraordinary operation.

Phil drove that thing. I'm sure if Phil hadn't been there, there would have been somebody that could have done it, but I have a hard time imagining anybody that could have done it the way he did. He just had the extraordinary personality and insight. He knew all the key players from the Apollo days, and they just set out and they went to work, and they really made the program go. In spite of all the delays that the Shuttle Program experienced, and we generally tended to blame that on truncated budgets, maybe some more money would have held the schedule a little better, but the best I could tell, we were working as fast as that group of people that were. And it was such a massive job, and it just took so long to get everybody educated up to the same level, because it was all integrated. I don't think when we started, anybody knew that it was going to be such a challenge, and so we learned to do those things and went through it.

This doesn’t sound like a CB perspective, but we had taken half of our people—actually a little more than half were working the engineering side, working on the development of these things and trying to look ahead to see what was going to be required as part of getting started. We not only wanted to land on 10,000-foot runways, but we were going to be an airline. So people went out and got contracts with American Airlines to teach us how to do maintenance and training, and we had people come in and start giving classes on how you give instructional courses and how we do logistics [in] the airlines. For a couple of years, we studiously tried to follow all that, and finally after a good bit it became clear that, you know, if there is anybody that's going to explain this to someone, it's going to have to be us explaining it to ourselves. That's where it evolved back into the way we had done things in the earlier programs.

I remember when we first started building the flight control schematics. You're familiar with those?

RUSNAK: Yes.

MATTINGLY: Those are the most magnificent educational tools I've ever seen. I've never encountered them in any other organization. I don't know why. I used to carry around a couple of samples and give them to people and say, “This is what you really need.” And they'd say, "Oh, that's all very interesting," and then nothing ever seemed to happen. But working with people to put those drawings together, and then understand what they meant and develop procedures and things from, was a massive effort. During those days the Building 4 and whatever the building behind that, where flight control teams had some other offices, the walls were just papered with theses things. People would go around, and they'd walk by it and look at it, and they'd say, "That's not right," They'd draw a little red thing on it and say, "See me." And it was an evolutionary process going on continuously.

The little vignette that has always stuck in my head was, we were learning to do redundant systems. That whole idea of the Shuttle was, we should be able to suffer loss of any piece of equipment and never know the difference, and take another casualty in either that same system or another one and still be able to fly safely. So it was what we called "fail op, fail safe." And that generally led to a concept of four parallel strings of everything. It wasn't mechanical.

And that was great, but now how do you manage it, and what do you do with it? Now a schematic has all of these four strings of things, sometimes they're interconnected, and you could study those things, you'd pull those long sheets out, and you go absolutely bonkers trying to—"Oh no. This line's hooked to that. I forgot that." Trying to figure out how this all works. So you'd go get your colored pencils out, and you'd color-code them. By now the stack of these things is building up, and I'm really getting frustrated in doing this dog-work job just before—I had to spend many, many hours for each drawing to get it sorted out before you were ready to use the drawing. So I said, "We've got to take these things and get them printed in color, right off the bat."

And so my friends in the training department said, "Well, you're probably going to have to talk to [Eugene F.] Kranz about that. He's not that enthusiastic about it." I thought, "Oh god."

So I got an audience with Gene and went over and sat in his office and explained to him what we were doing in trying to get the training program started, and how we were trying to get ready to do that, and I really wanted to get these things printed in color so that it would make it easier for people. I knew color printing would be a little more expensive, but it would sure save a lot of time.

He said, “No. We're not going to do that.”

I was just overwhelmed. I said, “Gene, why?”

He didn't say a word, he just turned and looked at his desk, and there on his desk, right in the corner, was this big mug filled with colored pencils. And he says, “That's how you learn.” [Laughter] And so that was the end of the story. I don't know, I'll bet today they're still black and white. But that was Gene's method of learning, and he figured that by having to trace it out, he had learned a lot, so he felt that others would benefit from that exercise. Even if they didn't appreciate it, they would benefit.

So we went through all of these kinds of things with groups working in different areas. We had one group that worked on the controls and displays, and Gordo [C. Gordon] Fullerton was a major player in that. We'd have little meetings periodically to look at the cockpit. I remember we had—the center console, if you sit in the Orbiter, the pilot and commander are sitting side by side in the center console. It was one of the few places when if you put on a pressure suit that you could see and touch. I mean, you can see the instrument panel. Stuff up here gets really above your head, gets really hard to see. It's in close, so it's difficult for some of us older people to focus, and you can't see a lot. You have to do it by feel, which isn't a good thing to do with important things. So the mobility was small, and this was prime real estate. We all knew it.

As we went on with the program, every time someone said, “Oh, we'll just put this here,” we'd say, “No.” We’d have a big office meeting. We'd all agree that, no, that's not that important. We can put that here, we can do this.

Well, after working on this thing for years, there's practically nothing that's important on the center console. We kept relegating everything to somewhere else, and it's now the place where you set your coffee when you're in the [simulator]. [Laughter] We protected that so hard, and poor old Gordo fought and fought for different things, and we just—we'd think something was good, and then after we'd learn about what it really did and how it worked, we'd say, "No. You don't need that."

So Gordo was off trying to get the cockpit to be meaningful. [Robert L.] Crippen had taken over kind of being the software counterpart to Schaffer. Those were two roles they were playing.

Somewhere in here, Freddo [Fred W. Haise] went off to go to work in the Program Office, and so we started going through the development with teams of people, and CB's Astronaut Office role was largely to work on the flying qualities, to make sure it was something the crew can handle on launch and entry. At the time we got into it, Rockwell was coordinating it, but we were using, I think, every simulator, every cockpit simulator, in the country. I had maybe six or seven people that were assigned to this part of the exercise, and we were flying all over the country every week, going different places.

We finally developed a technique where one guy would go and fly a simulator up at Ames [Research Center, Moffett Field, California], and he'd do that on Monday and Tuesday, and then he'd put his comments on a voice tape and leave it there, and he'd go off to another simulator. Somebody would come in and listen to his comments, and we'd just leave notes to each other and try to catch up. It was not a well-coordinated plan. At the beginning you can only look at little segments of a problem. So one simulator would look at this segment, another simulator would look at a different segment, and then you'd try to intellectually integrate what you had learned from these. We proved how difficult human communication is. We were not doing well at all. We were getting totally confused and using the same words to mean different things.

There is a military spec that publishes about flying qualities, handling qualities of airplanes. It started back in World War II, I guess, maybe even before. It tells you all of the characteristics that have to go into making a good airplane, like how many pounds of force do you put on a rudder pedal to push it. Well, it didn't take us—even dumb pilots finally figured out that with an electric airplane this maybe isn't really relevant. [Laughter] Then the engineers wanted to just throw out all of the experience and say, "Hey, we'll just make it cool and you'll like it."

So we went on a crusade to rewrite this document, which turned out to be one of the most interesting projects I've ever been in, because it required rethinking a lot of the things that we all took for gospel. Every airplane that a pilot flies is the Bible on how airplanes fly. Fortunately, in the office we had people who had flown a lot of different kinds of airplanes. But nevertheless, that shapes your image. And now you get into something that's totally different, and there's a tendency to want to make this new airplane fly like the one you like the most.

The software guys contributed to this bad habit by saying, "Hey, it's software. You tell us what you want, we'll make it fly." I remember one time they gave us a proposal that had a little dial and you could make it a P-51 or a T-33 or a F-86 or a 747. "Just tell me what you want. We'll put—." [Laughter] We had a lot of naive ideas when we started.

I don't remember the original size of the computer, but it had a memory that was miniscule by today's standards, but it was huge compared to Apollo, and it was state of the art for the AP101 computer. By the time we finished this program, we had this horrendous debate about going to what we called double-density memory that would expand it, and I don't remember what it was now, but you can get that from some of the software people. But it was still nothing, and the only reason, management did not want to change to it was for philosophic reasons. And IBM finally said, "Look, you guys said you wanted to buy off-the-shelf hardware. Let me tell you, you are the only people in the world with that version of a computer. So if you want to stay with the rest of the world, you're going to have to take this one." And fortunately, we did, and still it was miniscule. Today I think they've upgraded it several more times so that it isn't nearly the challenge. But that caused us to partition the functions in an ascent, pre-launch and ascent, and then get out of orbit and do some servicing things and then another load for reentry.

We had built the requirements for the backup flight system. So within the office, we were all trying to stay in touch with all these things going on in each of these areas to keep them somewhat in sync from the cockpit perspective. So that gave us a lot of insight into all of these tasks that people were doing. We even found, for instance, that as part of this development program, people working with thermal protections systems, the structure guys found that they were discovering limitations that were going to be imposed on the vehicle downstream that we weren't thinking about, and yet if you fly in the wrong regimes, you will get yourself into thermal problems. Yet nothing in our flight control work or displays was considering that. We had never encountered anything like that before. So, the guys, by working all these different shops, were picking up these little tidbits and we were trying to find ways to look ahead. At the same time, the software guys were having their Black Fridays once a month and telling us, "You can't have all this stuff."

We learned quickly that the man-machine interface is the most labor bit intensive part of building all this software. The little machines that go do something didn't take a lot of power, but making that interface natural and useful, that was a new thing. It was really—really, really caused people lots of trouble. They got lots of fights between the crew and everyone else, because we were using all the computer resources for video games, and the engineers, when they needed it to make the vehicle fly. And it's some of both.

So in the flight control world, after we've flown these simulators, we realized we were really not converging on the answer, whether it was by accident or what, I really don't know, I don't think it was a design, but we ended up building a team of people: Joe [D.] Gamble, who was working the aerodynamics; Jon [M.] Harpold, doing guidance; and Ernie [Emery E.] Smith [Jr.], who was the flight control guy. They all worked in E&D. We all got to going around together in a little team, and we would all go to the simulators together, and we would all study things.

We built a simulator from Apollo hardware that was called—we called it ITS, the Interim Test Station. We had a couple of people—Roger [A.] Burke and Al Ragsdale were two sim engineers that had worked on the CMS [Command Module Simulator] and the LMS [Lunar Module Simulator]. They were very innovative, and they took these things before we had the Shuttle Mission Simulator [SMS] that was back in the early part of the design, and went to the junkyard and found airplane parts and built an instrument panel out of spare parts and had a regular chair that you sat in and had different control devices that we had borrowed and stolen from places.

These folks were so innovative, they could hook it all up. They took the initial aerodynamic data books and put them in a file so we could build something that would try to fly. We even took the lunar landing scene television. In the lunar module simulator they had a camera that was driven by the model of the motion and it would fly down over the lunar surface, and so you can see this thing, and that was portrayed in the LMS as what you'd train to. So they adapted that to a runway. We tried to build a little visual so we could have some clues to this thing, put in a little rinky-dink CRT [cathode ray tube] so we could play with building displays.

And we got no support from anybody. I mean, this wasn't space stuff. And it is probably one of those things I was most proud of, because we were able to get this thing into some place where we could actually tinker with how we're going to fly the vehicle and what we're going to do and what the aerodynamics mean. It was only possible because we had these two simulator guys who were wizards at playing with software and this team from E&D who joined us.

Then we divvied up the different mission phases to different people so we could play with ascents and entries, and tried to do landing but our visual was never really adequate for that. But we developed all of what's now called the TAEM, Terminal Area Energy Management. All that stuff was developed using this little simulator and trial and error. We'd struggle with it, and it didn't work right. In the guidance world, Harpold would go off and play, and we developed all that stuff. If I recall, Vance [D.] Brand was probably the guy that was doing the TAEM energy management part, and Joe Henry [Engle] and someone else were really focused on the landing. The entry stuff, we had a group of people working that. Ascent, we had a rudimentary capability. But we went through each of these things and found out what we could do and what we couldn't do, and developed things that we could feed back into the engineering design.

As the vehicle developed, there was a great deal of resistance towards having a backup. Well, not too long into the program, they overcame their resistance to having a backup control system. We had four computers and four redundant strings that ran the primary system, but we had learned in Apollo we had the backup lunar system with a computer in it. The command module didn't have a backup computer, but the lunar module had this thing called AGS, Abort Guidance System. It was a separate computer coded with different algorithms, coded by different people. It was totally different, and it did most of what the primary system did, but it didn't land. It would only abort and just take off.

So we tried to have something similar, and wisdom prevailed and we ended up with a fifth computer which was identical to the other, so we didn't have a different kind of computer. We had a significant amount of debate about whether we should have a totally different code or just have the same algorithms coded by somebody different. So we ended up with the latter, and [MIT Charles Stark] Draper [Laboratory] would often work the backup system in order to do that.

So we ended up realizing that we had built an electric airplane that had essentially only one operating flight control system. So we said, "Well, what if we're wrong? No one has ever flown a Mach 20 airplane. This whole flight envelope is something that nobody's ever had the opportunity to experience. So what do you suppose our tolerance is to this?" Because wind tunnel models for the ascent vehicles, they fit in your hand, because the tunnels that were able to handle these things were small. The wind tunnel models for the Orbiter were larger, but they're still not all that big, and going through this tremendously wide flight regime where the air density is going from nothing to everything, and it’s just high speeds to low speeds, I said, “What's the chance of getting all that right?” And yet as we played in these simulators, particularly this little ITS, we proved to ourselves that, boy, if you're off on that estimate of the aerodynamics, you can often play with the software to make it right, but if the real aerodynamics and the software you have don't match, it's a real mess. I know I worried a lot about that.

So we came up with a concept that we would have some tolerances on the aerodynamics, and we would try to make sure that the flight control system could handle these kind of uncertainties in aerodynamics. So the way you model all that stuff in the computer is you have this very, very extensive lookup table for all the aerodynamic characteristics as a function of flight regime and control surface positions. It's an enormously big processing job.

These guys were able to put all that stuff in, and so then we started building these aerodynamic uncertainty sets. Joe and Ernie were participating in this with us, and the rest of E&D was really, really not in favor of all this—design and—”We get the aerodynamics down. That's what these wind tunnels are for. Let’s put your energy into building good wind tunnels and good models of the vehicle and not into all of this extraneous stuff.” And over the years we had a number of interesting conversations about that philosophy and were able to hang on.

So we were able to build these sets, and then because of the unusual configuration of the Shuttle, the little elevons have all kinds of funny characteristics, and we ended up exploring all of those and different uncertainties until we found a flight control—did something which is not typically done. that we decided to optimize the flight control performance to be tolerant on uncertainties rather than the best flight control system they could build. The whole idea was, after we've flown and we have some experience and we know what the real world is, now we can come back and make it better, but the first job is to make ours as tolerant as possible to the things we don't know.

We developed a set of contingency procedures which drove Max [Maxime A. Faget] absolutely crazy because we had a couple of little gain changes and things that said, now, if all of this fails, you still have a couple of fighting chances left if you have practiced and kind of know what signatures to look for and what things might be wrong. Max was absolutely appalled that there was such a thing. But I think we took that out probably after STS-4. They quickly took that system out before somebody killed themselves with it. [Laughs] And Max was justifiably concerned that some pilot was going to think he knew more about this design and get a wild idea in flight and make a mess of things. So I think everybody felt better when we took it out.

We put all that stuff in, and it was really a wonderful operating environment where I seldom have seen that integration of the people that were going to fly it with the designers and people who were doing the theoretical work and the operators from the ground. All of that stuff was converged in parallel, and I think that's one of the reasons that the Shuttle is such a magnificent flying machine. It does all the magic that we set out to do.

I'm ignoring the cost because the Shuttle, in my recollection, by the time it was sold to Congress, it was probably different than what the people in the trenches remember, but we had to do all these technical things, and it was a matter of faith that if you build it, it will be cheap. I mean, it was just simple. If you could reuse it, it saves money, and so you've got to make it reusable. If you fly a lot, that will be good, and we're going to fly this thing for $5.95, and we're going to fly it once a week and that's how we're going to do this. And none of us were ever told to go build a vehicle that we could afford to own. And had we been told that, I doubt if we would have been able to do it. I think the job was so complex, you had to build one that flies in order to learn the lessons that say, "Now I know what's important and what isn't." I just think it would have been asking too much, but that's just personal opinion, but it's from having struggled through ten years of this development program. It was an extraordinary experience to do that.

All that work we did on the flight control system paid off a little bit later when we finally got into ALT [Approach and Landing Tests]. Freddo had the last ALT flight, and he was supposed to land on the runway. We were sitting back here in Houston watching the video of the flight, and when he came down and landed, he got into this PIO [pilot-induced oscillation]. Those of us who were sitting there watching, our eyes got huge, and, my gosh, you know, he got it on the ground. Wow, what happened? So all of this little flight control team had all gotten together and they pulled the start thing out. What could have happened? We decided to wait for Freddo and talk to him, because we assumed something had happened in the cockpit that we didn't know about.

Well, what happened was, he didn't know he was in a PIO, and the landing, in those days we didn't have the HUD [head-up display], and so you'd look out the window of the Orbiter, you can't see the nose, so you just have this window of the world that doesn't have any references in it.

The way pilots normally land an airplane is they have a perception of the rate that the ground is approaching, and they adjust that by what they do with the nose of the airplane—pick it up. Since you're in a glider, you have to always be raising the nose as you slow down to keep the lift up, but as you see that—you really don't want to run out of air speed ten feet in the air. So if it looks like your rate of approach to the runway is being diminished or leveled out and you're not there, you're going to have to do something, because otherwise it's really bad form to be up here and fall out of the sky. So you'll drop the nose a little bit. Oh, it's coming up fast, you raise the nose.

What none of us realized at that point was that the lag between the time you make a control input and the time you see the cockpit respond, it's about three-quarters of a second. Due to the geometry of the airplane where the elevators are, the elevators are 60 percent of the exposed wing area, not counting the fuselage. They're big and they move fast, and what you're controlling with your stick or your hand controller is a rate command, and then the elevators do whatever it takes to create that rate. A big, heavy airplane takes a lot of mass. So if you get aggressive and you want to maneuver the airplane and put in a big input, those big elevators really move, and when they do and they come to raise the nose, which should improve your lift, those elevators are so big, they're spoilers, and the first thing that happens is they go [up]. The CG [center of gravity] first goes down as the elevators reduce lift, and then the rotation starts, and then the increase in lift, due to the higher angle of attack, starts to climb again. Once you stop commanding the elevators to rotate up, you let go. Well, because it's a rate-command system, the elevators now go down to stop the rate, which adds a chunk of lift all of a sudden. So now it goes up even more, and all of this happens with a very long time delay.

Surely we had been exposed to the knowledge that these dynamics would happen, but nobody internalized it, and Freddo wasn't seeing this. He was just flying and trying his best, and Gordo was calling off the altitudes. Instead of being a nice, smooth approach to the runway, it was down and then up and then down, and Freddo was trying to integrate what he sees with what Gordo's telling him. Then they finally plop it down.

So, armed with the knowledge that Fred didn't know he was doing a PIO, we started in a—well, E&D also had started to go figure out what was wrong and recognized that these were the symptoms of a time delay somewhere in the control system. They brought in a team, and I remember [W.] Hewitt Phillips came down from Langley [Research Center, Hampton, Virginia]. He was one of Dr. [Christopher C.] Kraft's—I think he may have been one of Dr. Kraft's mentors when Chris was there in the beginning. He had him come down because Chris trusted him explicitly on things like this.

So they went off, and when we converged, we stumbled on the idea that it was the vehicle's geometry that was causing the problem. And everybody said, "That's preposterous." So we went back to our little simulator. We lost our ITS now that we had a real SMS, but these same two software kids were still there, and we surreptitiously went in and modified the files so that we could simulate changing the aerodynamic characteristics of the vehicle to see if our theory was right. We'd all had trouble landing this thing on the simulator.

After they put in these little changes in aerodynamics, my mother could land that airplane on first try. It was so natural. And we all said, "My gosh. Should we take it in and take it out?" Boy there's no doubt this was the culprit. I thought it was really humorous because we got into a big to-do because the engineering side had determined that they could take some 25 milliseconds' time delay out of the control loop by reprogramming some of the filters, digital filters and things. We were saying, "Well, the real problem's like three-quarters, 750 milliseconds, not 25, and there's nothing you can do about it." I mean, the airplane is the airplane, and you've got to learn to live with it, not—you can't change this with software. That was not well received, but it probably was good for us, because armed with that data, we were able to get the HUD put into the cockpit.

I'd flown a HUD in an A-7. Oh, boy, I don't know when that was, '75 or '76 maybe. And the first time I saw it, I fell in love with it. I said, "This is just what we need." And, you know, "No money for that. It won't fit in the cockpit. The cockpit's already in design. We can't do any of that."

But this is what you really need. And I think the problems that Freddo had on ALT flight probably got the HUD force, and that HUD is the most useful piece of equipment that's in the cockpit. It is just magnificent. [S.] David Griggs was probably the guy that did the most work on bringing that to fruition.

So those things came after the '78 group came on board, although David had been out at Aircraft Ops [Aircraft Operations Division] before he joined the office, so he got to working on the HUD. He and Marsha [S.] Ivins were the first ones that worked on HUD displays. Marcia became the world's leading expert and really did a lot of wonderful work on that. That was when she was still in E&D.

So the role of the Astronaut Office during this Orbiter development program was quite different than what I saw of it in Apollo in that our involvement was far more extensive and pervasive, and a heck of a lot more fun. I mean, this was really cool stuff. There was a problem every day, and you got to learn about all of these little things that were interesting. I spent a lot of time with Tom [C. Thomas] Modlin [Jr.], trying to understand the stress loads and the thermal characteristics and mosure on the TPS [thermal protection system], and how do you get it to stay on, and all of those things were things that came through the office as experiences that really were just extraordinary opportunities to go see that.

As we moved down the stream and we got into some of these development programs and started turning out hardware, we started splitting people up to go follow different components of hardware, whether it be the engines or the SRBs [solid rocket boosters] or the Orbiter, different things.

Somewhere earlier in this development stage, we went through a series of activities where the first Orbiter was going to have air-breathing engines, and it had some solid rockets that were on the back that were for aborts. Right off the pad you could fire these two big rockets, and they would take you off in a big loop so you could come back and land. We had these air-breathing…engines that were going to—after you come down through the atmosphere, you open the door and these engines come out, and you light them and you come around and land. They had enough gas for one go-around.

The other thing we had was the big solids were to have thrust terminations and ports that blew out at the front end so you could terminate thrust on them if you needed to in an emergency. Every one of those devices was something which had a higher probability of killing you by its presence than it would ever have in saving you. I'll put that ejection seat in the same boat. Everybody was willing to get rid of the air-breathing engines. They were really, really not a very bright idea. And we got rid of the thrust termination and we got rid of the abort solid rockets.

My guess is, John Young was probably the most active stimulus in pushing those issues, and that was one of those cases where the flight crew perspective and the engineering perspectives converged. We all wanted to get rid of these things, and yet we retained the ejection seats for reason which I will never understand. If anyone knew what the useful envelope of those ejection seats was and the price we paid to have them. [Laughs] But it had become a cause: "You will protect these kids by giving them an ejection seat." So we had one, not if anybody wanted to ever use it, but it was there.

So as time went on and we got through these things and started building hardware, the first new astronaut selection process came into play. I think they came aboard in '78, if I remember right, but I don't know when the selection process started, but it seemed to me it predominated everybody's thinking for a year. It got to be really a really big process and the selection was just—it was huge. I presume they were working on lessons learned during their Apollo selection and mistakes they felt they made that they didn't want to repeat. So the selection process was far—you know, in Apollo at least when I came down, the bulk of this stuff was the medical screening and so forth, very little other. In our case, we had an interview with the selection board, and never had any private interviews. No one ever talked to us about what we were getting into or anything. It was just a bunch of people.

I remember John and Mike [Michael] Collins were the two guys from the office who were on the interview panel that I went to, but when they brought the new group down, they brought them down in relatively small groups. They'd spend a better part of a week here, and they'd meet everybody, and then George had his group go around and talk to everybody that had talked to the new candidates. They really got the bugs worked out of it on the first one, then they started doing this, but it was really a major time-consumer.

I remember we were working the HUD at the time and happened to take Dave down to the trailers, and in order to get in and see George and folks, you'd go down in the evenings or whatever because they were just totally preoccupied with the selection process.

Once we got these folks on, the OV-101 was rapidly approaching the time to get ready to go. So we put together the training program for the new folks and helped them get started on that. Then we split them up and sent some to the Cape, and the SAIL [Shuttle Avionics

Integration Laboratory] was established here, and we used them to staff that and they picked up—we had been doing RMS [remote manipulator system] work, just spread amongst the few of us that had been around. So RMS and a lot of these other activities were all getting sort of a lick and a promise instead of real attention till the '78 group came on board, and once they went to work, then they really took hold and played very key roles in the development of things like that mission stuff. The second group that came aboard—it was a year later, maybe two.

RUSNAK: 1980, I think.

MATTINGLY: Was it '80? But it was before we flew STS-1, the second group came in. They came aboard much quicker and came up to speed because we practiced on the first group and kind of learned how to do it. So I had all of these folks that I was kind of managing that were doing the sail and working to keep things.

John more or less had taken an interest in the Cape, so the Cape Crusaders, as we called them, were essentially being managed by John and Cripp [Bob Crippen] because they were there, and John has a passion for the hardware, and so it was all quite consistent. Our job then was to go do all of the rest of the laboratory support and follow-up on close-outs of anomalies, and did we really understand them, and do that kind of stuff.

I had one detour that I kept secret. I spent about a year working for Deke when he was the director of Orbital Flight Test [OFT], building an entry flight test program, and that was kind of a little interlude. The development and design program had been finished, and now it's the time you're waiting for the hardware to show up. John and company were living in the simulators, so the rest of us didn't have a great deal of things to do. So Deke gave me an opportunity to go over and work for him on setting up the Orbital Flight Test requirements, which essentially we wrote the program of what we were going to do and how we'd do it, and get everybody together on it.

Then I came back, and that's when the new folks came aboard, and we started getting them organized. And I'll tell you, the effect of particularly the second group of the new folks, just had some extraordinary people. I often wonder—psychologists tell us how in siblings, the order kind of has a characteristic property. The first child has one kind of a personality, and then you go down, and they have sort of predictable patterns. I think there's a similar thing in classes of people that are introduced into these programs at different stages under different circumstances. I think some of them say characteristics go along with that group. I'll tell you, some of the people that we had a chance to work with out of that second group were unbelievably good. I mean, that's an all-star cast. There's more superb talent in that than any single group. It was just really, really impressive. Working with those folks was just an absolute delight.

So then we were starting to come to grips with what's this thing called a mission specialist, because up until now we had pilots. Oh boy, what's a mission specialist? Well, those are those other guys. But by now we were starting to get some pilots that have flown the F-14 and F-4s and airplanes that "real men" fly that had two people in them. [Laughs] That was a departure for people. They had learned that that "guy in the back"—we call them "GIBs"—they're really useful. They can save your life, and they can make you very effective.

So some of the newer pilots were more tractable in integrating a non-pilot into roles and responsibility, but those must have grown up from a different environment, I don't think it was any—it was not what would you'd call prejudice, but we didn't have any frame or reference. I was lucky because I'd flown a crewed airplane. That's C-R-E-W, not "crude." [Laughter] It was also a crude airplane, I guess. But I had learned the magic that a crew can do that an individual can't. No matter how big your ego is, you get a team of people flying an airplane, and it's just spectacular what you do. So it seemed to us that we really need to do that here, and we came up with these crazy ideas that since we're going to be flying this airplane, but the mission of the airplane is whatever is in the payload bay, maybe the mission commander should be a mission specialist, or maybe the mission commander is a separate position where both pilots and mission specialists aspire to that being the senior position.

The skipper of a ship doesn't put his hands on a steering wheel; he directs the mission. I thought that was really good, and some of my navy buddies, "Yeah, that makes sense." Boy, that did not float at all, and there was a bigger division between mission specialists and pilots than I had ever guessed there would be. I remember the SAIL groups because I just mixed them up. I said, you know, "Bright people work hard. I don't care where you go." So we sent mission specialists and pilots both to the SAIL, and the job that you had to do over there didn't require any aeronautic skills at all. I mean, it was checking out the software and just going through procedures. Anybody who was willing to take the time to learn the procedures and has some understanding of how this computer system works is going to be fine. We ended up having to put out all kinds of brushfires, and, you know, "He can't do that. He's a mission specialist."

Steve [Steven A.] Hawley was—thank God Steve has a tremendous sense of humor and he came into my—we had a SAIL group was around the table when they were having a debriefing. We did this every week to go over all the things we'd done, and what was open. Steve started it off with, "Did you hear about the pilot that was so dumb the others noticed?" I've told that to a lot of people, and I thought that was great. And at that point I think that Steve finally broke the ice, and everyone kind of said, "This is dumb, isn't it." [Laughter] After that, at least it never came to my attention again if they had any problems, but from then on, they really came together. Old Bob [Robert L.] Stewart, who was an army helicopter pilot, became our flight control guru, and certainly one of the best that we've ever had.

RUSNAK: This actually may be a good place for us to stop, because we've got to swap out our tape. Do you want to take a short break?

MATTINGLY: Okay. So when we got around to taking our next step to get ready to go fly, the new folks had become integrated by then as part of this activity. I remember one of the things when I started on the Shuttle Program, Deke kind of said, you know, "One of the reasons that this would be fun is—." I think we both recognized that I enjoyed the engineering side of the flying, perhaps more than a lot of—Freddo enjoyed it some, but I don't think as much as I did. So the idea of trying to get in on an early flight test was what every pilot wants to do anyhow. So the idea of being in a group that was going to be downsized and have an opportunity to participate in the first flights and maybe even compete for the first flight, that was all the motivation anybody could ever want. Of course, none of us thought that it was going to take so many years before that first flight took place. [Laughter] So I was really not surprised that John got the first flight, but I was a little disappointed that when we got through, the rationale was that since I had worked on the Orbital Flight Test program, I would take the last flight and backup 2 and 3. So Hank [Henry W. Hartsfield] and I were going to go fly as backup on 2 and 3. Then we would have no backup on 4, and finish with whatever was left over from anything that didn't get done on the other flights, which, when you stop to think about it, the way we do business at the JSC, not much chance that there's something we didn't get done. But that was the logic.

It was kind of fun to be part of those missions, but it was something that Hank and I were kind of hoping we could get it earlier going. But it really did turn out to have a lot of benefits for us, because we did pick up a lot of experience we would not have had and were able to do some other activities that wouldn't have had time to go do if we'd been scrambling just to get up and down.

In [Apollo] 16, Hank and I had developed a better than average rapport, I think, because in lunar orbit, Hank ran the show and all the flight plan from the ground. I told him, "You only get to go to the Moon once, so I don't want to miss a minute of looking out the window. So you run the spacecraft, and I'll look and tell you about it." [Laughs] And he really did a magnificent job on that, and as a result, we got a lot of stuff done that we wouldn't have otherwise. So on

STS-4, why, it was kind of fun to go back to working together that way, and we were still trying to see how much we could cram into this thing.

So when the time came to go fly 4, we were going to go. Our job, like Freddo's, was to plan to make the first concrete runway landing. You know, as much as we trained for that thing, I just had this image of doing Freddo's trick all over again. It was, you know, bad karma or something. I just—oh, that bothered me. I could think of nothing else.

By then we had developed some external landing aids that would kind of help a little bit, called PAPIs [precision approach path indicators]. They're some lights that give you some glide-slope references, and we had practiced with them and gotten to be fairly proficient. And the STA [shuttle training aircraft] is an absolutely magnificent thing. It's really remarkable. It's a testimony to the way they maintain airplanes out there at aircraft ops.

The one piece of the Shuttle Program that I really never had a chance to participate in was the development of the STA, but I did get to fly it a lot. The IPs [instructor pilots] that fly that airplane and the people that maintain it, this whole thing is done with a computer, single-string computer, and that's just extraordinary. The beauty is, when you get your first taste of the real Orbiter in flight, it flies like the STA. I mean, it is just wonderful. And without the STA, you know, you really could not be confident of flying a Shuttle. So it's a magnificent thing.

So we got to the place where we had been getting pretty cocky with it, learning to do all of those tricks. But nevertheless, if you learn to fly the Orbiter and just can approach and just do it over and over until you make it look the same every time, you'd think we were pretty successful. But if you start being original, go to different places and look at funny runways and things, you found that your ability to adapt was really, really challenged.

We had by then gotten the HUD approved, but we didn't have it in yet. If I'm not mistaken, it went in for Paul's flight on 5, or maybe it was 6. I think Paul [J.] Weitz made the first flight with the HUD. But we were without it, and we knew that they had hyped up the STS-4 mission so that they wanted to make sure that we landed on the Fourth of July. It was no uncertain terms that we were going to land on the Fourth of July, no matter what day we took off. Even if it was the fifth, we were going to land on the Fourth. [Laughter] That meant, if you didn't do any of your test mission, that's okay, as long as you just land on the Fourth, because the president is going to be there. We thought that was kind of interesting.

The administrator met us for lunch the day before flight, and as he walked out, he said, "Oh, by the way." He says, "You know, with the president going to be there and all, you might give a couple of minutes thought on something that'd be appropriate to say, like 'A small step for man,' or something like that," and he left. [Laughter]

Hank and I looked at each other and he says, "He wants us to come up with this?" [Laughter] And we had a good time. We never came up with something we *could* say, but we came up with a whole lot of humor that we didn't dare say. But that was an interesting experience.

So we did some stuff on orbit. We played with the RMS, and the most magical thing was, after working on this device for ten years, you got on orbit and your attitude was such, and we opened the payload bay doors for the first time towards the Earth. So all of a sudden, it was like you pulled the shades back on a bay window, and the Earth appeared. After that ride which was—compared to the Saturn, the Shuttle is like electric propulsion; it doesn't make any noise, it doesn't shake and rattle, it just goes. It's just nothing like the Saturn, or, as I understand, the Gemini or the Titan.

They got on orbit, and this thing worked, and I just couldn't get over the fact that after—you know, people that I knew that were friends had built and conceived this whole thing, and it works. It's just magic. It does all of these things that we dreamed of, but the visuals are better than the simulator now. So we just had a wonderful time of it.

We had been assigned to do a bunch of thermal tests where you put the Orbiter in an altitude and get one side hot, and then one side cold, and then spin it around. They were collecting the data they needed to understand the thermal characteristics of the vehicle, because after this flight we wouldn't have the instrumentation to do that, so it was get it now or we'll never get it. So it was kind of something that had to be done, but was really not a glamorous kind of test that you can run, from a pilot's point of view.

Fortunately, I just—the flying around the Earth is just so spectacular. I don't care how long you're up there, I can't imagine anyone ever getting tired of it. It's just beautiful, and the Orbiter with these big windows, it is just wonderful. So Hank would say, "You know, we probably ought to get some sleep here."

I'd say, "Yeah, yeah, yeah. You're right. We've got another day's work tomorrow. So Hank will sleep in the mid-deck, and I'll sleep up here. Goodnight, Hank." [Laughter] So all the kids are in bed, and now you can look out the window. I told the ground I went to sleep so they won't bother me, you know, and I'd sit there, having a wonderful time.

So finally even I decided that it was time that I was going to have to get some sleep, and so I stopped, and on the flight deck, I just thought, well—they gave us little sleeping bag things that you could crawl in, and some little hooks, and you can hang it up somewhere, and I thought, "Don't need that. Wonder if I can just lay out here across the deck and just get real still and just go to sleep." So I worked at getting all steady and not moving, and stopped right behind the two seats that were ahead of—had a little space over the hatches that come up from the mid-deck and in between the aft control panel and the back of the ejection seats, which there's a lot more room today since they took the ejection seats out. So it was a place probably two feet wide, maybe two and a half. Got all stable in there. Ah, this is nice. Go to sleep.

Well, the next thing I know, there's something on my nose, and it's a window, and god dang, I was sure I had gotten stable. So I went back and set up again, not moving, did it again, ended up with my nose in the window, in the overhead window. That bothered me. I finally put a Velcro strap over me just to keep me from floating up. I just thought that was really curious.

So the next morning I was telling Hank about it, and he said, "Well, I didn't have any trouble. I just was floating in the middle of the mid-deck." Hmm. He says, "We were doing one of those thermal maneuvers," what we call PTC, Passive Thermal Control. You take the vehicle—in this case you rotate it about some axis, and in this case it was kind of rotating around essentially the longitudinal axis of the Orbiter, just spinning. He says, "You know, I was almost on the center of rotation, and you were up here. This is centrifugal force."

I said, "Oh, come on, Hank." What was it 4 rpm or something, or five revolutions an hour, or some gosh-awful thing." I said, "That can't be."

He said, "Well, we've got another one scheduled for tonight. Lets try it both ways."

We tried it, and sure enough, every time. If this thing was rotating at this really slow rate, it still would—there's no other force. These little forces become important. And after we stopped, he says, "Try it again." I did, and sure enough, no problem. So this is kind of added to some of the little micro physics things that you see in space that are so interesting. We discovered some of this stuff on Apollo that is kind of "Gee whiz interesting."

The day before entry, we were up on the flight deck and kind of getting ready to close stuff up, and Hank said, "What was that?" He was at the aft window, and I was sitting, or floating up front.

Without thinking, I just said, "Well, that was one of the thrusters." We were controlling the Orbiter with these vernier thrusters. They are twenty-five-pound thrusters. They fire little burps, tiny little things. Here's this 200-and-some-odd-thousand-pound airplane, this little twenty-five-pound thruster back there goes "beep." And as soon as I said it, I felt really stupid and I looked at Hank. He says, "You've got to be serious."

I said, "Well, I think it is." I said, "I'll tell you what." We had these little lights in the cockpit that would come on whenever a thruster was fired, and they were put in so if a thruster started to get stuck on, you could look at this display and it would tell you which one was on. So I said, "I'll watch this display, and you tell me when you feel something." And sure enough, he says, "There." The light would wink. We certainly hadn't felt these earlier, but after being in a quiescent state for a period of time, your system adapts to these kinds of accelerations and you start to be sensitive to those things. I just thought that was remarkable, because it takes an instrument to feel that normally.

We came home, and, of course, we were all bug-eyed about this entry and being able to see out the windows and see things that you couldn't see before. Sailing down over the coast is just—gosh, it's really, really beautiful. Crossed over—I remember as we crossed over Mexico and out into the Gulf, having come down from orbit, we were still at probably a hundred, maybe 150,000 feet or so, pretty high altitude. Hank and I looked out the window, and says, “Are you sure we're going to glide all the way to Florida from here?” [Laughter] Looked at that, said, “Well, the little light on the CRT says we are, but it sure doesn't look that way.” And sure enough, CRT was right. We did make it to Florida, we came around.

But on 4—that happened to us—[Loren J.] Shriver—on 51-C, I'm sorry. But on 4, Hank was going to, I promised him he could fly part of the heading alignment circle so he could say, “I was the pilot but I actually controlled the airplane.” So when we did come in and got out at Edwards and came around, when we came around, we got on the heading alignment circle and I was tracking it, and I turned to look at Hank, and I was about to say, “Well, okay, here, you take it for a bit now,” and I turned to look at him, and all of a sudden my gyros tumbled and I just had one of the worse cases of vertigo I've ever had. Broad daylight. It was just really overwhelming.

I went back and started focusing on the eight-ball and looking at the displays, and Hank says, “Are you going to let me fly?”

And I said, “No, no. I can't talk about it now.” And we came around and did our thing, and I was still having this vestibular sensation that was unusual, but once we got on the glide slope it seemed like it was kind of—picture's normal. But I was beginning to get concerned at the pre-flare point. Hank called it off and we did our thing, but it was slower than normal or than the standard, and we ended up coming up on the flare and got over the runway, and all of our external aids are set so that you’ll be sure and land 1,500 feet at least down the runway. Most unpowered vehicles, you tend to land longer, but you don't want to err on the short side. So if you're going to make a mistake, you know, you kind of push it down there and you tend to float.

I knew we were under the standard final approach glide slope, but now I wanted to get down and try to make a good landing with it. Your eye-height perception for this, judging motion is really not all that great. You're sitting high on the Shuttle Orbiter, and touchdown is about like a 747 cockpit height. So it's not like you're picking up good visual cues. So Hank is calling off the altitudes to me, and he gets down to one foot, one foot, half a foot, and because of the ALT bobble, I had put grease marks all over the window so I could see the nose change. Wherever I was, there was a line where the grease pencil—so I could reference the horizon. So I could fly attitudes instead of sink rates. I would listen to Hank tell me what the altitude was and I'd sit there and I'd make little adjustments for the nose.

We kept going through this, and one of the dictums is, you know, you don't want to land short, okay, and you don't want to land too fast, because the tires are already stressed pretty heavily. But you really don't want to land too slow, because if you land below about 165 [knots], you could hold the nose up. Because of that big fat fuselage, the nose will stay up in the air. In the simulator it will stay up there to maybe 70 knots. But there's no way to let it come down without overloading the structure and breaking the fuselage. So you really need to get there and get the nose down before you lose elevator control, because otherwise this thing will just fall. And if you put your nose down too soon, then the negative angle of attack on the wing adds to the loads on the tires, and you can blow the tires. So you kind of don't put the nose down above 160, but not much below that.

So he's calling off air speeds and altitude, and I'm just staring at the horizon and I'm hawking it, and I have no idea what it's going to feel like to land. When I would shoot touch-and-go's in the 135, there was never any doubt when we landed. [Laughter] You could always tell. So I was expecting bang, crash, squeak, something. Then nothing and nothing. Then finally Hank says, "You'd better put the nose down." "Oh," I said, "All right." So I put it down, and I was sure we were still in the air. I thought, "Oh, god, he's right. We can't be very far off the ground." Sure enough, we were on the ground and neither one of us knew it. I've never been able to do that again in any airplane. Never did it before. We also landed at about—according to pictures, it looks like we must have landed at maybe 350 feet down the runway, and we didn't mean to.

So after we got through with all this, we got ready to get up and get out of the airplane. We had built a little sign. We thought the president would come in and want to look inside the Orbiter, and so we built a little sign that says "Welcome to Columbia. Thirty minutes ago, this was in space," or something like that, some handwritten damn thing.

So I got ready to get up out of the couch, or the seat, and took our helmets off. We still had the pressure suits and pressure helmets. Took the helmets off, set them down, and I had a kneeboard on my right thigh, so I took that off, and I went to set it on the center console, and I couldn't lift it. I almost ended up sliding it off my leg onto the center console. I said, "We haven't been in the air that long. How could I lose all that?" So Hank was kind of watching me, and he's still perplexed because I didn't let him fly the airplane. I says, "I am not going to have somebody come up here and pull me out of this chair." So I said, "I don't know what it is, but I'm going to give every ounce of strength I've got and get up under my own."

So I just got there and I just got this mental set, and I pushed, and I hit my head on the overhead so hard, the blood was coming out. Goddamn. It was terrible. Oh, did I have an headache. And Hank said something like, "That's very graceful." [Laughter] So now I really did have something to worry about. [Laughs]

So we got up. I said, "Hank, the crew isn't going to get to open this thing up for probably fifteen minutes or so after landing." I said, "We're not going to have people help us off. So we're going down and we're going to do close-order drill. We're going to walk around the mid-deck so when they open the hatch, we're going to walk out."

Hank's got some of the funniest stories he could tell about this stuff. So we got ourselves down there, and we're walking around, and Hank said, "Well, let's see. If you do it like you did getting out of your chair, you'll go down the stairs and you're going to fall down, so you need to have something to say." He says, "Why don't you just look up at the president and say, 'Mr. President, those are beautiful shoes.'" Says, "Think you can get that right?" He was merciless.

The point of all this story is not just sea story, it is when we got through, we got out, they took us back into the hangar at Dryden [Flight Research Center, California]. We were walking, I thought, pretty well by then, and so we had this long time waiting because the president was there and was going to speak, and all the Secret Service had to do their stuff, and so there was a significant length of time before this ceremony could take place. So I said, "Well, you know, it's been a while. I'll go down to the head here."

They said, "You know where it is?"

I said, "Sure."

"Okay." So I walk out, and it goes down a hallway like this that comes to another hallway that hits it as a T, and the idea is you go down this hallway, take a left, and the bathroom's here. So I was feeling like I got my sea legs back, and so I'm walking down here, and it's one of these tile, linoleum kind of floor surfaces. So I got to down here, and I was trying to walk fast, and I turned and walked right into the wall. And now I was really perplexed. Fortunately, nobody sees this, but how does America's finest aviator walk into the wall? [Laughs]

Quickly those skills came back, but in working with some of the doctors since then, discovering what happens when you reset your inside accelerometers to things, we discovered that you actually haven't—we talk about losing strength, well, there is some muscular deterioration from lack of use, but there's another phenomena that came out of all of this, that when I go to raise my hand, I don't know how that happened, but there's some kind of electrical signal that goes down here and it relaxes these muscles and tightens these. And when you have spent a period in this environment, those electrical signals are calibrated so that they respond appropriately in the weightless environment. So when you want to do things, you do them unconsciously, but in the brain's process it goes through and it sends a signal that says, “I want to raise my arm,” and then sends all these signals around. Well, it's now recalibrated so it doesn't overdo things, and so it says, “Raise your arm,” and it puts this little miniscule thing in there, and if you've got, like, my knee board sitting there, nothing happens. That's normal. It's just kind of tensing your arm a little bit. You haven't done anything. But you don't know that that's the reason.

So that's the reason when I went to get out, and I decided that, you know, it's every bit of energy I can muster, well, the muscles were still there. It just needed to be told to do something. And the same thing happens when you go walking around, you've got the channel back that says I know how much energy it takes to stand up. I know what forces to put on here for locomotion, but to turn is a relatively small side force that we do, and all this is unconscious. But that signal is still down here in the noise, and so just thinking you're going to turn left, well, nothing happened except the wall came up. [Laughter] It was, you know, little things like that, and as we discovered these things, that's where this business of learning about space flight and what goes into it and all this is, it'll never be boring. It's just every day you take one more little step to find something that's really, really cool, and it's always there. Gosh, we've just got to get tourists up there.

RUSNAK: Had you experienced any of that sort of phenomenon after your Apollo flight?

MATTINGLY: No. I've often gone back to that. I realized that there may have been some differences. The only thing I've been able to come back with is in Apollo the entry gave you a pretty healthy dose of accelerations as you came through the atmosphere. The Shuttle, you know, you can stand up through the whole entry in Shuttle. I'm sure people have. I'm sure no one will ever admit it, but there's no reason why everybody shouldn't kneel on the floor and look out the window for the final approach in landing, because it's just nothing. So there's nothing that gets your body started down that road, no. And it may be that as I got older, the system behavior is different, because I did not have those kinds of difficulties in Apollo. And apparently not everybody has had them—maybe nobody else has had the same severe feelings that I did in getting vertigo. But I think now everybody has learned to just kind of be judicious.

RUSNAK: Can you compare the sensory experience of being aboard an Apollo spacecraft with being aboard the Shuttle?

MATTINGLY: My impression is, they leave distinctly different images completely. In Apollo, the image you always have of the command module is the couches, because they were always there for something, and your view of the world is little windows where you kind of compete, and moving around is just not something—you know, moving around is a small thing, in the orbital part.

The reentry was—well, launch in Apollo was really dramatic. It feels just like it sounds. You hear this staccato cracking and all of that from the engines. Man, inside it's the same thing. It's shaking and banging and pushing hard, and there is no doubt that something really gigantic is going on.

The Shuttle would lift off, it's not noisy, it doesn't shake. It just goes. It was a totally different experience, and because of the windows in the Orbiter, it makes such a difference, because now the world is seen in cinemascope, and you think in terms of a volume. Just the cockpit in the Orbiter is comfortable, much less the mid-deck, so you think in terms of a large space. So space and windows are the things that you—and forces, well, that's where the two vehicles are so different. Apollo had aggressive forces on launch and on entry, and small viewpoints to look out at the world, and really no place to go, whereas the Shuttle has just really soft forces, and no particular spectacular noise on launch, and entry is just a piece of cake.

And it's up to—I think the peak Gs on entry is like 1.1, something like that. In a direction where your sitting it's just really easy, and the only sensation that made an impression on me in the Orbiter is that because the entry is flown by flying with about a 50-degree angle of attack, and you roll the vehicle to control your trajectory this way, and not like an airplane rolls around its own axis, but you're rolling about this—so when you roll to the right, this big arm is swinging over, and the picture out the window is totally unlike anything you would get from an airplane that's doing a roll because really it's just a big yaw. And you see that, but once the nose comes down, everything looks like an airplane. It's just a totally different experience.

RUSNAK: Did you like landing on a runway better than splashing down in the ocean?

MATTINGLY: Yes. Yes. As long as you stop on the runway. [Laughter] Always had this image of being the first one—I didn't want to land on the runway on 4, because I said, you know, "My gosh, you could stop this thing in half the runway or less. But why would you take a chance with the president there? Do you want him to come over and welcome you as you're swimming out of the moat on the side of the runway or something?" And it just seemed crazy, but it was the right thing to do. The Orbiter is really just an absolutely magnificent machine.

So, after 4, it was time to decide what to do again, and Deke asked if I was interested in flying a classified mission, but then the Air Force requirements had been driving our program for a long time, and see, we flew—when did 4 fly? April? Should have been able to take this classified mission in six months. With all the training and all of the years we put into the program, the idea of turning around and going right away was very appealing, get my money back for all that time on the—and so I said, "Yeah, I'll do that."

In the meantime, we ran into the problem, I guess it was on 5 that punched off two PAMs [payload assist modules] that both failed with—or 6, I don't—whoever had the two PAMs. I remember sitting in the control center when they launched the first one, and said, “Well, it didn't fire,” and debated about what to do with the second one, and said, “Well, we don't know if anything wrong,” and random failures don't happen two in a row. Until we tried to launch it and lost the second one. That caused a great investigation of all solid rockets. There's nothing classified about the fact that our defense payload rode on a solid rocket. So it grounded us for a year, at least a year.

So we're back to doing other things, so we didn’t fly as soon as we could, but the interesting thing about the classified mission is, JSC and the whole NASA team has worked so hard at building a system that insists on clear, timely communication. The business is so complex that we can't afford to have secrets. We can't afford to have people that might not know about something, even if it's not an anomaly. For something that's different, something unusual, we try to make sure that it's known in case it means something to somebody in this integrated vehicle we've been talking about.

So now we're going to go into a classified mode where we have a limited number of people, and we don't talk about all these things, and I had some apprehensions about could we keep the exchange of information timely and clear in this small community when everybody around us is, you know, telling anything they want, and we're kind of keeping these secrets. We wrestled with—security was a major—security was the challenge of the mission. How do you plan for it? How do you protect things? We went around putting cipher locks on all the training facilities, but then you had to give the code to a thousand people so you could go to work. [Laughter] But we had a lock on the door.

One of the things that was good was, we built a classified ready room in the Astronaut Office, a little place where you could keep a safe and keep our classified documents, and we even had a classified phone. People are used to having encrypted phones. We didn't have one of those, but we had one that was unrecognized, and they said, "If certain people need to get hold of you, they'll call this number." It's not listed and it's not in the telephone book or anything. It's an unlisted number and this causes less attention. "You've got to keep this out of sight, don't let anybody know you've got it, and this is how we'll talk to you on very sensitive things." Okay.

So we had a little desk in there, put it in a drawer, and closed it up. In the year we worked on that mission, we spent a lot of hours in this little room because it was the only place we could lay our stuff out, the phone rang once, and, yes, they wanted to know if I'd like to buy MCI [long distance telephone] service. [Laughter]

My secretary came in one day, and she was getting used to the idea that there's a lot of people we deal with that she doesn't know. Generally, you know, the secretary knew everybody that had anything to do with the mission, and there were some military people she knew, but she knew there were others we talked to that we didn't bring in the office. So she was kind of getting used to some of that, and she came in to me one day, and she says, "You just got an urgent call."

"Okay."

"Joe," or somebody, "says call immediately."

So, okay. "Joe who?"

She said, "He wouldn't tell me. He said you'd know."

We went in our little classified room and said, "Does anybody know a Joe?" [Laughter] We never did figure out who it was, and he never called back.

The Air Force security people were—oh, man, boy, was that a cultural adjustment, because they have all these classified rules, and we make fun of them, but they all come from a—history has taught us [unclear], in any bureaucracy we sometimes overdo things, but as much we make fun of these folks, they convinced me that some of the precautions we were taking were, in fact, justified. I was a bit skeptical, but they showed me some things that at least I bought into. So whenever we traveled, they wanted to keep secret when was the launch time, and they certainly wanted to keep secret what the payload mission was. And to keep the payload mission secret, that meant whenever we went somewhere we needed a—they wanted us to not make an easy trail when we'd go somewhere. To keep the launch time classified, they wanted us to make all our training as much training in the daytime as at night, so that someone observing us wouldn't be able to figure this out. They never convinced me that anyone cared, but they did convince me that if you watch these signatures you could figure it out, and it is secret because we said it was. Okay.

So they had us flying—I didn't mind the idea of flying more, you know, equal day and night, because that meant I got to fly more, because I wasn't about to split the time, we'll just double it. [Laughter] So that was a good deal. But then they had this idea they wanted us, whenever we went to a contractor that was associated with the payload or with the people we were working with, they didn't want us to get in our airplane and fly to that location. They wanted us to file [flight plans] to go to Denver, and then refile in flight and divert to a new place so that somebody who was tracking our flight plans wouldn't know. And when we'd get there, we could check in using our own names at the motel, but, you know, just Tom, Dick, and Harry. So, just keep a low profile.

So we went out to Sunnyvale [California], and we were going to a series of classes out there, and this was supposed to be one of these where you don't tell anybody where you're going, don't tell your family where you're going to be, just go. But the secretary got a room for us. So we went, landed at one place, went over to another place, landed out there at Ames, had this junky old car that could hardly run. El [Ellison S. Onizuka] was driving, and Loren [Shriver] and Jim [James F. Buchli] and I were crammed in this little tiny thing, and we're going down the road and looking for a motel. And we didn't stay in the one, the motel we normally would stay at. They put us up and tell us to go to some other place and they had given us a name.

So we went to this other place, and it was very inconvenient and quite a ways out of the way. And as we drive up the road, Buchli looks out the window and he says, "Stop here." So we pull over, and he says, "Now let's go over [unclear] one more time. We made extra stops to make sure that we wouldn't come here directly, and they can't trace our flight plan. And we didn't tell our families, we didn't tell anybody where we are. And we can't tell anybody who we're visiting." He says, "Look at that motel. What does that marquee say? Welcome STS 51-C astronauts," and everybody's name is in it, and you walk in and your pictures are on the wall. [Laughter] Says, "How's that for security?"

But those are the kinds of little—I mean, those are dumb things, but they show that we went to extraordinary lengths trying to learn how to do some of these things. And the *coup de grâce* came when after, you know, "I'll cut my tongue off if I ever tell anybody what this payload is," and some Air Force guy in the Pentagon decides to hold a briefing and tell them, before we launched, after we'd done all these crazy things. God knows how much money we spent on various security precautions and things.

But the flip side of that is that I still can't talk about what the missions were, but I can tell you that I've been around a lot of classified stuff, and most of it is overclassified by lots. I think at best it's classified to protect the owners, you know, it's self protection. What those programs did are spectacular, they are worth classifying, and when the books are written and somebody finally comes out and tells that chapter, everybody is going to be proud. Now, all the things we did for security didn't add one bit, not one bit. [Laughter] But the missions were worth doing, really were. It really gave you—the work was done by others, but just to know that you had a chance to participate in something that was that magnificent is really kind of interesting.

Since we couldn't—on the classified thing, you know, everything was closed now, so we fortunately had a group of guys that were really super, and [Tommy W.] Holloway was the flight director. Tommy's probably been one of my best friends throughout my NASA time. I just think the world of him. So I was willing to leave him with the chores of keeping everybody coordinated and doing stuff. We were trying to figure out—since for the first time the MOCR's [Mission Operations Control Room] not going to be open for visitors, there's nothing to say, nothing to do, you know, "They launched."

"Yeah, we saw that."

"Oh, they came back."

"That's good."

So we were trying to figure out what we can do that would kind of put some interest in the mission, at least for the participants. In the Navy when you go aboard ship, we have lots of protocols and things we do. We have traditions. And so they all come back from somewhere in the past, and we've kept them and we still do them on ships today. So you tell time when you ring a bell, they used to ring the ship's bell because no one had watches in the old days, so they'd ring a bell when somebody thought it was noon or whatever. You'd ring bells to tell you how long you're on watch, you know, so every thirty minutes they'd ring a bell, and then it's two bells, and then three, and when you get eight bells it's time for the next guy to go on watch, and you'd get off.

Then we have standard announcements. If you go aboard any ship that's getting ready to depart port, there are a series of these announcements that are made over the public address system. Specified time is prior to breaking your ties with the shore. And we have the thing called a boatswain's pipe, which is like a whistle. It's shrill, and it carries; its sound carries. The quartermaster of old ships would stand on the deck and play this thing, and it would make little screeching sounds that wind up and down in different patterns, and they meant things. They meant do this, do that, and this was the way of communicating across the deck when you couldn't hear or whatever, and we've kept that tradition. So when it's time to prepare for flight quarters, get ready to launch aircraft on a carrier, the address system will come on with this boatswain's pipe and, "Now hear this," and the boatswain's pipe will call, "Flight quarters. Flight quarters. All hands prepare for flight operations." Then there's a series of these things. There's a checklist, and as you run the protocol on a ship during the day, you go through these things and they announce all kinds of stuff, *Taps* at the end of the day. The ship's routine is done this way.

So we went and got hold of the master boatswain for the United States Navy—it's now a ceremonial position, but it's generally a senior chief—told him what were trying to do, and said, "We want to build a tape that has all of these things, but we're going to adapt it to our flight plan, and we'll play it to the ground." So we had built a little tape recorder with this thing on there, and we were going to play all of these things to the ground at the appropriate time, starting on the launch pad when we shifted our flag from the quarterdeck to the bridge, and "All personnel go ashore, go ashore," and subjected the launch team and the MOCR to listening to all these things and bells ringing and whistles blowing and the whole thing scripted out. It gave us something fun to do.

After we had subjected the Air Force to this, when we got to go fly, there was a significant Air Force contingent in the MOCR because they were the only people that could come visit, and so they're all listening to it. And some of them had been to the Naval Academy, so they knew what this was, and they didn't like it. And the other Air Force people really didn't like—"What is all this?"

At the end, after we had done our deployment, I thought, well, you know, we'll wait until an appropriate time when we know at least our part of the mission has been successful in this thing. There used to be a radio station here in the Clear Lake area. It was a classical music station that went on until midnight, and they had an especially appealing rendition of "America the Beautiful." So I got to thinking, we've got a recording of the Army, the Air Force, and the Navy hymns, whatever you call them, and then I scoured around and I finally found this recording of "America the Beautiful." So my plan was, after we'd done all this bell ringing and stuff, and everything was all over, we would then play each of the service songs. Then the idea was to come over to U.S. and put the TV out the window so you can watch us go from coast to coast, and play this "America the Beautiful." So I had this all scripted out. I said, "Now, this is really going to be cool."

Well, as it worked out, we lost com [communications] after we played the army and the navy songs, and the com dropped out. [Laughter] And when we came back, you can hear the teletype at the mid-deck "clackety, clackety." There's a message that says, "You've got thirty seconds, and if the Air Force song isn't on the air, don't bother to come home." [Laughter] I thought about doing it in alphabetical order, and I said, "Nah, traditions are traditions. We'll go in seniority." So the army came first and the Air Force came last, and they were really upset with us. [Laughter] Those are the things you remember.

RUSNAK: Gary [E.] Payton, wasn't he Air Force?

MATTINGLY: Yes. The tape was playing, but the com dropped out. So we knew that had happened, and we backed it up, but, you know, the idea that we were going to create internecine warfare didn't occur until we got our teletype that says, "You'd better hurry. There's a bunch of generals down here that are not happy." [Laughter] Oh yes. But that was a good bunch of people, and it shows that a machine can do all those things.

So it came time to get serious, and since my four-year tour to see the Shuttle develop turned into ten, and my six-month "get ready for the next flight" had turned into closer to eighteen, you know, I was skeptical about what comes next. Much as I enjoy the sights and sounds and so forth, I was ready to move on to something else. The only mission that I really thought I could get interested in was the first Vandenburg [Air Force Base, California] mission, and Cripp was already doing that, and so I decided it was probably best to change assignments.

The Navy had asked me, before we flew, if I was interested in coming back into the regular Navy, and so I said, "Yeah, sure. I'd like to do that." And the first job was supposed to go be the Commander of the Naval Space Command at Dahlgren [Virginia]. They were just starting it. With this delay in our DOD mission, I either had to drop the mission and go back to take that assignment or stay with the mission, and I kind of wanted to stay and finish the mission, because we spent so much time on it, and it was a particularly good one for me because those guys were so good. You know, it was Loren's mission, and I just sat there and drank coffee and watched and looked out the window and played music and just got to be an executive.

So that was a fun mission, and I'm glad I made that choice, but I figured I had lost my job in the Navy, which is the one that [Richard H. "Dick"] Truly took. Then they came back and said, "Well, we've got another assignment running the procurement side of Navy space. How would you like to be program director of that?" So that's what I took, and I ended up—we landed and I went to Washington two weeks later.

So I deviated from NASA for four years, almost five years I guess, and I had retired from the Navy, and then went to work for a "Beltway Bandit" [colloquial term for a government contractor in the Washington, DC/Interstate 495 region] small company that worked for the navy for a while. Then Fred Haise called me. He was the president of the Grumman Space Station Division. What do they call it? Grumman Space Station Integration Division. A terrible acronym. And they were out at Reston [Virginia]. They had had some real trouble with the Program Office that they were supporting, and they were under a great deal of scrutiny, and he wanted to know if I was interested in coming out and helping him kind of pull things together.

So I went and spent several years working on the Space Station in a very traumatic period. That was when we were getting beat up, the whole program was getting beat up for having been late. The president announced—when we landed on STS-4, the reason it was such a big political event, that's when the president announced that we were going to build Space Station, and people had been politicking and working their tails off to get it into his speech.

So a lot of time had passed between then and that time, and we really hadn't made a year's progress in a year. The program was really, really having a hard time, and so everybody associated with the program was struggling. So we were trying to pull that stuff together and help.

Bob [Robert] Moorhead by then had taken over the Level 2 Space Station office in Reston. But with all the work packages centered around in different places, it was absolutely the most chaotic, impossible management scheme you could ever—you ought to write a textbook on how *not* to manage anything. [Laughs] We had it, and in spite of people's heroic efforts. If you ever doubt that organization is important, you take really good people and put them in an impossible organization, and you could even ground good people. I mean, it was just terrible to watch people work so hard and do so much and not be able to make things that they knew had to happen, they couldn't make it happen. Then they got blamed for it. It was really an unfortunate period, although it probably had his own reasons. History gets written in lots of places, and you maybe haven't read all the chapters.

But I was there when they were beating the program up because it was going to take fifteen flights to complete this Space Station, and 200 hours of EVA. And that had to stop. That was "irresponsible." [Laughs] Oh, I don't know what the total hours of EVA are today.

RUSNAK: It's a lot more than that now.

MATTINGLY: Oh, that's about one mission's worth, I think, and certainly the complexity of what the people were doing. It was clear right from the beginning that this assembly was going to be just an amazing challenge. And we didn't have enough money to do it all right, and so people were working very hard to find ways to make it work anyhow. It was really an interesting thing, and it gave me a chance to work back with people like—in fact, I saw John [W.] Aaron at this little get-together yesterday, and John looks more relaxed now than I've seen him in many years. He really was under an awful lot of pressure trying to run things from this end. Just everybody was under a lot of pressure.

But one of the good things out of it, going back to the thing I talked about on the Shuttle where we'd gotten the engineering and the ops guys all to form this little team to go work design problems together, Kranz pulled together—he was having trouble getting all of the Centers to pull together, and at that point JSC was still in the watching mode. They had a Program Office here and all, but this hadn't become a big Center project, and it was clear that JSC participation had increased, and Gene pulled together an ops teams to come up with some concepts, and we spent several weeks.

I think it was probably one of the most productive parts of my exposure with the Space Station, because they came up with concepts which were not implemented for a variety of reasons, and yet we're wrestling today with many of the same issues, but there are answers, because people had been down on—it's more painful today than if you would have done it years ago.

But all these things happen, you know, for a reason. I'm convinced that if we hadn't had Apollo 13, we probably would have lost a couple of Apollo flights. I think some of the twists and turns in the Space Station Program may not have given us the most efficient path from here to there, but it may be that each of them played a critical role in allowing the next step to take place. Maybe that's a pollyannaish approach to it, but this is such a complicated business, and we're isolated down at the working level, and people have a very clear idea of what needs to be done and how to do it. As you move further up in these big programs, they become exceedingly complex and difficult, and it's just something that most of us don't appreciate. So it was an interesting, interesting kind of program.

RUSNAK: I've got some sort of broad questions for you, if you don't mind talking for a little bit longer. You mentioned a couple of the differences between the Apollo Program and the Space Shuttle Program, particularly early on. I was wondering if you could compare for me the NASA of the mid-1960s when you came in, with the NASA of the mid-1980s, when you finally left.

MATTINGLY: Oh, boy, that's a good question. There's really been a lot of transformation. I think I would say there were two major transformations that took place, and I've given it a lot of thought as I have tried to explain to other people in my businesses the way these space businesses grow globally. The parallels with the Russian program are really interesting, and it's worth reading some of that literature, because it's fascinating. Some day someone will put the stories together in parallel.

But essentially what happened in the NASA side, at least this is just from T.K.'s perspective of wandering through life, wondering what's going on, we started out in this desperate race to send a signal to the world that we were technologically competent to be a key player. When the Russians put up Sputnik—you're too young to remember the wailing and gnashing of teeth and hand-wringing. "Our educational system let us down. We aren't doing this," and the press would pick it up, and everyone was beating themselves over the head for sins of omission and commission. It was just really a dark period.

[President John F.] Kennedy's decision to go after something that was public and spectacular was probably one of the boldest political decisions I can imagine anybody making. I'd give anything to know how much did he know about the risk he was taking. He certainly had advisors that told him, "Don't do this one." And unlike programs that NASA tries to sell today, I've not read anything—I wasn't around in those days when they were selling it, but I've read nothing that would indicate that there was a big push on NASA's part to get someone to go do this. It was more looking for ideas than "What have you guys got to offer?" and somebody said, "Well, you can do this," and the next thing you know is, "Well, let's talk more."

But out of that came some conditions that are terribly important. One was, it was a political imperative. All of us kids thought we were out looking for Ferengi [reference to *Star Trek* aliens] traders and running down Borgs [reference to *Star Trek* aliens] and stuff like that. That's not what we were doing at all. We were filling a political imperative that says, "We've got to restore confidence of the rest of the world and ourselves in what a democracy can do in a visible way, and we've chosen this to go do it."

Now, along with that imperative, which the confluence of the technology had reached the point where we could now throw intercontinental ballistic missiles, that gave us the technology that says, "With just a little-tuning, you can go to orbit. And as we learn to do that, now we need some other things." But it came time for as weapons got bigger, we needed bigger launch vehicles. But the technology to do that stuff, yes, it was crude and we still had to work with it, but we did it. I mean, it was done. There were no inventions necessary. Now it's improvements.

So the technology was available, the political will was there. Because the political will was there, the funding, while it was never just given to the program, [NASA Administrator] Jim [James E.] Webb, you read the stories about his exploits, he worked for his money. But the impetus was there, and so while we got going on this thing, you had the most exciting program in the world. Recruitment was just, put a little bitty ad in the paper that says, "We're interviewing people to work on Apollo," and, you know, the lines go to the county line. I've heard General [Bernard A.] Schriever give a speech about what it was like to hire people when they were starting the ICBM [intercontinental ballistic missile] days, and he says, "There was nothing to it." He says, "We had the most extraordinary people in the country pounding on the door, and they didn't care what you paid them. They just wanted to work on your program." And Apollo was the same way.

These conditions don't exist today, and they haven't for a long time, but in those days—hell, we were all young kids. What was the average age in Apollo? Twenty-six in the flight control world or something like that. You know, it was kids. And if we'd had any money, we would have all paid it to be allowed to go do what we were getting paid for, because it was a national thing, and so you had all of this support, and it was "Go do something."

The other thing was, we had a goal that anybody could understand. "We all read the calendar. We'll know when the end of the decade is up. We'll know if you met that schedule.

Go and bring me a [moon] rock." We didn't ask for the origins of the universe. We didn't ask you to cure AIDS. We said, "Just go bring me a rock and hand it to me, and if you can do that, you were a success." Now I'm trivializing it to a point, but a program, to be successful, has to have a clear objective that's so unambiguous that all of us working on it know what it is and what it's not, and nothing gets in the way of our objective. With that, you can then start in and say, "Now, if there is the financial resources to allow it to happen, now all you need is good people." And I just listed how you got all three of those in Apollo.

Those planets haven't lined up since. And I don't know if—I don't know. Going to the Moon was easy to pick as a goal because it only took a few days. You can see it. One of our problems with Space Station is, it's not hanging out there in the sky to look at every night. If you know where to look, it's big enough, you're going to be seeing it, but you have to look for it. But going to the Moon, there was something different. Every day was some activity, some excitement.

But before Apollo was finished—well, by the time 13 flew—that part of the movie was pretty good—by the time 13 flew, we were showing live television of launch reentry and maybe landing on the Moon. Everything else was videotaped. "Yeah, we wouldn't mind watching it, but not during *I Love Lucy*. Or, "Don't interfere with my soaps." Because it had lost its magic, and it lost the political drive because the risk for every flight was the same. They didn't come down because you kept flying. The marginal gain for each additional flight was getting to be less and less at a horrendous rate, especially when viewed from the political capital side.

We had demonstrated to the world, you know, "The Russians are out of it. We have won this race hands down. They're not even on the final lap. Don't sully that image by having an accident. You have lots to lose." And since the goal of the people paying the bills was not science or Ferengi traders, it was "Beat the Russians," and we did. Don't jeopardize it. Very, very logical response. It was devastating to a lot of us to think, "How could you stop? We've got hardware. We can do this. How could you not fly?" But that was the motive.

So there was that, and the other thing that happened that carried over into Shuttle was, the people that did Apollo was the same core of people that started with Mercury and then Gemini, and stayed right into Apollo. A continuous stream expanding all the way. Each time the programs got bigger, we brought on more people, and the same hierarchy just moved up, and this little tent that we're building just keeps going up and there's more underneath it. But this superstructure is largely unchanged. Now, sometimes you fit some extra people in there, but by and large, you've got the same leaders that started out working together back in the Task Force days, and they've grown up together. The people that stayed are the ones that liked it and were good at it and accepted in this little community, and the people that weren't kind of disappeared, and we don't know who they are because they aren't here.

So, all the way through Apollo we were building this thing. When Apollo was over and we did the Skylab thing, which didn't generate a lot of political support, ASTP got some political support, but it didn't generate any—I mean, it was just flying off some hardware and it really didn't do a lot for us. The Shuttle stories, what I've been able to read, it sounds to me like the political decision to fund Shuttle was at least strongly influenced by the fact that the aerospace industry was in a major depression, and there were no new weapons systems and things coming along to employ it. The aerospace industry has always been known to be cyclic, but it was really in a downturn across the board. It wasn’t Douglas is up and Boeing is down; it was everybody's down. So I've read reports—I can't attest to these but they make sense to me, and other things in the same books correlate, that there was a strong interest in maintaining aerospace expertise.

And so what political support the Shuttle had amongst the people that give money was, “Yeah, let's keep the industry alive,” and you go do work by states. In Apollo, the best I can tell, while we capitalized on doing work in different people’s states, that was a matter of pride, not a matter of bribery. In the real world of most normal programs, you know, I'll get your vote because I have work in your state, district, whatever. So it started having to consider the political ramifications of placing contracts and work in selected areas, and doing things that were essential to make the program go were not necessarily the technically best answers, but were necessary. That's in contrast to the kind of decisions in Apollo where everybody knew that the job was so hard, that only the best or right answer was even considered. It was too hard to do it any—technically too hard. We won't get the performance unless every piece is optimized for the purpose of doing this mission. Now pieces have to be optimized in the Shuttle era for the purpose of keeping the program alive, as well as—I mean, a necessary condition is that it has to fly, but that's not a sufficient condition to be a success.

We hadn't seen that kind of influence in the Apollo days. It has an insidious effect, because people in Apollo could clearly say, "I know I'm working on the critical path to go to the Moon and bring a rock back, and nobody has made a decision that doesn't enhance that." Never have I seen them decide to put something on here because it's made in New Mexico. Now you start seeing artifacts, and so the purity of that drive is something that managers try to keep honed in, but it's not long before bright people catch on to what's around them, and they play the same game everyone else does. I mean, it's just—if they weren't bright enough to do that, you wouldn't hire them. So they do that.

The Shuttle—we talked a bit about the technical differences. The Shuttle was a massive systems engineering integration job, the likes of which I don't think have ever been challenged. I don't know how it compares to the Station when it's all done, but I tend to think the Station is more of a challenge in the assembly than in the design, but I'm not that familiar. But certainly in Apollo the mission design was the challenge, and getting it all there just physically built, but the engineering part was not nearly as challenging as the Shuttle. So there was a significant difference in trying to maintain that communications which allowed the software to be the glue. In Apollo you could let everybody work their own piece. KSC could do their piece, Marshall could do their piece. There were places we had interfaces, but they were physical interfaces, and you could sign ICDs [interface control documents] between organizations over hardware, and it was relatively straightforward.

Once you got into Shuttle, every tradeoff involved everything, and, boy, you just couldn't anchor things, and one piece would change, and it required a tremendous understanding of each other's job. Pretty much, now in the design world, you have to do what the MOCR does every day by exchanging all this information in some organized way. Only works because they're all tied together on a common communications loop. Well, the problem with working a distributed program that requires this intimate integration is you need to have it co-located.

We used to joke about it, but you could see the difference when you'd walk from Building 30 to Building 15. That duck pond introduced corruption in the communication channels. We're talking yards. Now you start moving people around to other cities, and important parts are done by other Centers. So when they got to the Space Station Freedom, we had built this terrible, terrible challenge, still had to be integrated.

So in the Shuttle era, the environment we were working in, the challenge we working on, changed, and in the beginning of the Shuttle era, though, we still had the same people running the show, for the most part, and they were still young enough that they recognized the challenge was bigger, and they said, "Yeah, we'll go do this. Succession is where we're starting to think about rather that just let it happen, but I'll bring these people along and I'll coach them."

Everybody thought that it was going to be a four-year race, including some of the managers. So what really happened was, all of these folks, if they started back in the ICBM days and went through flying Shuttle, all of these leaders had been the same ones at each step of the way, and the new folks had generally been deputies and staff people, maybe run little projects and all, but they had never been in the line decision-making world. They'd been participants.

But there's a big difference in sitting in a room where a decision is made and being the one that's ultimately accountable for the decision. It's insidious. You can't see it, but I can guarantee you it is profound. It changes your whole frame of reference, and you only know that when you've done it. You can't learn it by reading books and watching moves or anything else. It's something you learn, and some people are not comfortable, and some people thrive on it, but it's a difference. And yet without any of us realizing it, because we all worked together, we had groups of people who had achieved levels of responsibility and authority that had never had the responsibility.

There was always a safety net, because the way especially JSC, you know, Dr. Kraft and his organization, nothing happened on this campus that he wasn't aware of. He would approve of things to the extent that he would allow it to happen, but if he felt we were taking a wrong turn, that was going to stop. There was this group of people that had this extraordinary background and the confidence and the experience to use it. I remember Dr. Kraft on STS-2 leaping out over his console when they were playing around trying to get the APU [auxiliary power unit] restarted in time, and he came in there, and he just stormed down, took his headset off, and said, “The launch is canceled. I'll see you in my office in an hour,” and walked out. Well, he didn't even have the authority to do that, but thank goodness everybody—and Dr. Kraft was looking around and listening to people, and he knew, “There's confusion here. Nobody knows what they're doing, and they're under pressure, and the clock is ticking, and it's not worth it.” That's the entire space program sitting out there. Why are you taking any chance at all with it? Quit.

Well, he also has an engineer's intuition when things are right or wrong. Like John Young is perfect for that, and the difference is, Kraft can generally tell you why. John may have a hard time articulating it, but you’d better believe his instincts, because, boy, are they good. So you had people that were running this program in the Shuttle in the beginning, that they knew each other. I don't think another group could have built the Shuttle, having looked back and seen what it took to bring it to flight. They all retired within a time frame of, what, eighteen months. Man, the exodus—people had been working thirty years 24/7. They had a ball, but there comes a time when you “I don't want to do this anymore,” and there wasn't another new program to turn the juices.

Now it's trying to learn to convert this into a routine and get it out of R&D [research and development], and these are not the kind of people that thrive on that. So now you've got a group of people that have moved in. You've got a political system that is not endorsing what you do. You've got a lot of political capital that's being spent on various things just to keep program support going, and so it tends to defocus the individuals. Now where do I fit? What we used to worry about, and they seem to have solved the problem, but how do you get people up for one of these complex missions day after day after day? How do you do it?

Kranz used to go out and create crises a day or two before launch and get his teams all spun up. "You know, we're not going to get off the pad if we don't figure this out." Finally I caught on after getting sucked into those things for long enough. I said, "You know, he does this intentionally. If there isn't a crisis, he'll create one because that's how he can get people's interest focused and get it running." And I since have accused him of it, and he said, "Yeah, I did that." [Laughter]

But do you see what's different? The purpose isn't clear today. You know, you've seen one show, you've seen them all. I don't mean that to be sacrilegious, but we've got to learn to look at it as the cats that are out there at the Texaco station do. Do they care? What is it to them? They don't have this excitement. So we've lost the backing, we don't have the political capital, and in accommodating all this, it's been very hard to keep people's focus on the programmatic imperatives of doing important things.

And then from the years since then, you know, the Space Station came along, and it was an orphan for the longest time. It was almost like a WPA [Works Progress Administration]. Now when they finally got around to having to put it together, then once again, the guys that are doing the ops really slugged it out and got it going, and what they're doing is spectacular. I mean, what a magnificent accomplishment. But we're still struggling with relevance. Having the most magnificent engineering marvel is a great sense of satisfaction to those of us that build them, but that leaves unsaid what it is we're going to do with it.

A lot of us still want to go to Mars, but the government has changed. In the Apollo days when we had the fire, people would call and say, "Hey, guys, it's a tough job. Don't give up." If you have a fire today, the hearings will go on until your kids are out of college, and they will place blame on everything. We've created an environment in the government—it's not just NASA, it's the entire government—that is risk-adverse. If you take a risk and you win big, you won't even get a footnote, but, boy, you make one black mark in someone's eye, and the political fodder just goes across the board. I'm regretful that that condition exists, because I've seen what happens when humans don't have that constraint, but it's a very natural part of society and life. It's what we've got to learn to live with, because that's the world we're in, and the government has to think about its role, because if its leaders can't take a risk, how do the kids that are building this stuff, how do they ever get anywhere? How do they do anything but get frustrated?

The new administrator says, "Well, we've got to find a way to get young people interested again." That takes thirty seconds, but he doesn't have the tools. You say, "I'm going to let you guys build and run something," they'll be here beating down the gates. You say, "Join my bureaucracy and you can show viewgraphs." Right. "Thank you, sir. I'll try selling shirts at Macy's."

I mean, the world is different, and we keep trying to say it's like it was. Apollo was this unique confluence of events. Shuttle changed—the selection of the Shuttle astronauts was the first one that started to stress social skills and the kinds of things necessary to play on the kind of teams that are in place now. You need it. That's not a criticism; it's a reflection of a change in focus. You don't need to be a hot stick. We don't talk about it, but you could probably push the autopilot, and this thing would be just fine, but we don't say that, that's career-limiting. But it could happen.

All organizations, as they mature, have got to find some way to either have a sunset law that wipes it out and starts over, maybe with some of the same people, but thrown into a new environment, into a new setting with a new task, then they can go forward. But as long as we have this legacy of "This is how you do it," that's powerful and it's overwhelming, and we will not ever change it if we have a choice. That's just human nature.

So the challenge for today's management is to find a way to take the people which are just as motivated, just as bright—well, probably brighter. I mean, gosh almighty, I look at what some of the folks around me do today, and it's just—you know, I just thank God that I'm not graduating from college today, because I wouldn't be able to get a job. We've got people stifled that can't do anything. A twenty-six year-old, average age, or whatever the number was, it's under thirty—sending people to the Moon, making personal decisions about what to do, where in our world can you do that today, even in the military today, unless you get in a war zone. You know, it's the nature of government, our form of government.

I think our challenge is to find a way to return to people the environments where they can use these things, because there's enough history that shows we are the most productive during the first twenty-five years of our lives. My son's going to get out of residency, and he's going to get his Social Security check the same day he gets out of residency. God, I can't believe he could go to school forever, and it's not like he doesn't want out.

How do we do this? How do we capitalize on that? That's the challenge, and if we're ever going to make the space program do all the things we want, we've got to find some of these more pragmatic steps. I chose to go to the commercial world because with my NASA experience and with my Navy experience, I became convinced that as long as the government is in the environment it's in today, which I certainly can't change, you can't build the kind of programs that I want to build. If you say, "Let's go send someone to Mars," I can't do that commercially either, because that bill is too big. It's *Field of Dreams*. It's a wonderful movie. It's a lousy business plan.

And so we've been struggling, and since I left, I've spent almost all of my time now trying to find ways to make the commercial base profitable, because when they are profitable, there will be money to invest. When there's money to invest, then we can grow, and it's not a bee-line five-year plan to Mars. From my perspective, I just made the observation, I reaffirmed it since then, that if all these things that I really want to see happen and always have—I still do, but I won't get there by signing petitions to Congress saying, "It's criminal we aren't going to Mars." You've got to create a way to make our business relevant and stimulate the economy with a different kind of design, and it's actually more fun than the other things.

So, the world changed, and we should never try to say, "Well, why can't you guys in Shuttle do it like we did in Apollo? Why can't you guys in Space Station do it like—?" Because those are three different eras, maybe more, maybe four. But it's different, and the things that changed were not the people, it was the environment.

RUSNAK: I think in that you wrapped up a lot of questions I had, actually. But if I could just pause to ask you two specific questions related to Shuttle development. The first is related to the decision to have the first flight of the Shuttle manned versus unmanned, and what your position on that was in the Astronaut Office.

MATTINGLY: I think, from what I recall about that—I don't remember that being a—I mean, it was a significant decision. I don't recall that being a contentious decision. I think the Astronaut Office will always opt [to] go manned, but I think in this case the engineering solution was the same. I think that the JSC position was, "This is the only way we can go, because this is such a complicated vehicle, that building an automated sequencer, and building it to go without a person may be as challenging in the test and checkout area as just trying to make sure you don't make a big mistake."

So my recollection is that while we recognized this was a departure from practice, it was a uniform belief that this is the right thing to do. I think it was politically—politically, I mean in the Washington arena—a note of contention or debate. It goes back to this business of how much risk can you take? But I don't think it was because someone thought that we should not do it the way we did. It was, you know, I'd hate to have my name on the piece of paper that said "That's okay," because what if they go wrong? Fortunately not everybody is timid, but I mean, it puts a lot of pressure on folks. So I don't think that was an issue down here. Chris may have a different impression.

RUSNAK: And a similar sort of question. The Shuttle originally was conceived without any capability to do extravehicular activity, so I wonder if you remembered anything along those discussions, the inclusion of that capability.

MATTINGLY: You know, that's interesting. I just swore we had the airlock in there. The airlock was not inside the Orbiter; it was on the Spacelab. I don't know if it was called Spacelab then, but it was on the laboratory piece. It was part of the tunnel, and it was an external airlock. I do remember when we got around to going through the debate about bringing it internally. That's a good question, because I don't recall not having an EVA capability. But I do remember when the airlock came from being a patch in the payload bay to being an internal piece, and that was, I thought, fairly early in the program, because it seems like everything we did after that—I mean, somewhere after the first year or two it seemed to me like that was a given. I know a lot of people groused about the weight of it and so forth. But I don't remember that.

RUSNAK: Those are all the specific ones I had, so if there are any other remarks you'd like to make before we wrap it up, I want to give you that opportunity now.

MATTINGLY: I want to thank you for putting up with my rambling, and I hope your task isn't as hard this time as it was last time. [Laughs] But what you're doing is really important. I remember I used to go to Aaron Cohen during Shuttle and say, "You know, we really have got to get somebody in here to sit down and just sit in all the CCBs and take minutes and record history as it's being made, the decision about why you did it, who presented the arguments, and what were the compelling arguments." Because I found when you go back and look at history, and you're bound to be seeing this, you're going to hear from the participants, and they aren't the same story. They're bound to be different.

We find that when we investigate airplane accidents, that three of us are watching the airplane crash, and yet when we tell you what we saw, you'd swear there were three crashes, because it's really hard because our mind goes off, and no one is going to tell us things that they don't believe are correct, but there are distortions in all of our minds. So the only way you capture that is to capture it right at the time it happens.

Now, George has a set of notebooks. He's been writing in little notebooks as long as I've known him. I remember him sitting in the CCBs in Apollo, writing stuff down. Now, maybe he was just writing, "Call Charlie," or something, but I think he's got notes in there that at least trigger for him the memories of what caused it, because so often things happen, and years later we don't know why, even the participants. Well, today if you go and ask somebody, "Why are there two radar altimeters on the Orbiter instead of three? Four of almost everything, three in whatever. And there's two radar altimeters. Why?" You find somebody in this campus that knows that answer to that. You won't find him. And there's a reason. Not very good. [Laughter]

I remember Bob [Robert F.] Thompson when he was in CCB, he called up—what was the guy's name that did the altimeter? Damn, I can't remember that. But he asked him. He had given a presentation on something, and he says, "Why do we had two radar altimeters?"

And he says, "Do you really want to know?"

It's one of the few times I'd seen Thompson kind of be flustered, and he said, "Yes, I want to know."

And he gave him this story about, "Well, you said the whole capability had to weigh less than this. That's all you can fit."

And Bob shook his head, says, "We don't need those things, do we?"

Everybody said, "We do." [Laughter]

Why do you only have one HUD? It's not redundant, and it's absolutely essential for landing. There's another series of debates and decisions.

After watching George Low, I think, was where I got the idea that if I ever got the chance to be a program manager in a big program, I was going to get a historian or several junior engineers, program managers, and force them to take notes for a minimum of a year and write down, "The questions is; the decision was; the reason for the decision going this way is." And just file it away. It would be fascinating reading. Don [Donald H.] Peterson—I don't know if you've talked to Don.

RUSNAK: We haven't yet, but he's in the future.

MATTINGLY: Don Peterson is one of these people that has very, very acute technical insight. He sees something and he grasps it immediately. He's just got this insight for engineering, and the rest of us don't see it, and Don doesn't know what we don't see because to him this is a very clear thing. Don would come in and say, "Oh, this won't work! "

You know, we're all sitting there, "Don, why are you being such a pain in the rear? What's the problem?"

He says, "Don't you see it won't work?"

"I don't see that." No one sees it.

Well, Don is so conscientious and so smart that I got—when we'd have these morning discussions of the Shuttle with the ops and the engineering teams, and we would beat these issues back and forth, Don lost lots. He just was not a persuasive person. Some other people in the office had impeccable records. It must have been a slow period, because I got interested in "I think I'll keep a log." So for about six months to a year, I kept a log about the major decisions and recommendations that we'd made, what led us to make that recommendation. At the time, this was why we made the choice, who presented the case.

And I'll tell you what, Don Peterson had an almost impeccable record of having made the right recommendations. Given the benefit of some time to look back and say, "Oh, that's how it—now I know what he's talking about." Didn't know then. His record for winning arguments was really poor, but it's really fascinating, and that's why you need to have somebody do this, because not only do our memories change, but I just—the other thing that happens, as a program manager you find that when you make someone write down what is the question, that seems pretty simple unless you try to write it down. Just forcing you to write it down may actually change your approach, because when you do, you quickly find that, "Well, that just rolled off my tongue. What's the best way to—?" And as you look at it on paper, it comes across, "You know, that's really not what's important. What I'm really trying to do is something a little different. And what do I mean by 'best'? What's buried in that expression? Best what? Best for what?" We use those kind of words in conversation every day, and it doesn't get people upset. When you try to pin it down, people will get upset when they find what you built isn't what they thought you meant, and then they feel betrayed.

This process of writing down the question, and then "Now, what criteria did I use? What was the reason?" does wonders for making your decision-making better, and maybe the most important thing is it adds to your toolkit of analytic experiences. Even if you made the decision wrong, you've been through this, and when you find out it's wrong, the next time you run into a similar situation, both pieces of data will come together. "I did it this way, but it wasn't right. Now, what's different, if anything?"

So, what you guys are doing is important. It's important. I hope there's somebody that's out doing something like this with the Space Station, because it's not as glamorous, and people will not stay around as long, and there won't be as many—and yet what they're doing in putting that thing together, which has got to be the most magnificent ground-air teamwork, I mean, it blows my mind what little I know from today's work on the Station, to see what they're doing. Those are stories that really need to be recorded now, because those folks—with the way the programs are going and the government sponsorship, the chances of having these people around to come back to twenty years from now and say, "Tell me about building the Space Station," you're going to get blank stares. What you're doing is really important, and I'm sure proud that you're doing it.

RUSNAK: I'm glad you feel that way about our work.

MATTINGLY: Well, you've got a right to be.

[End of interview]