ORAL HISTORY 2 TRANSCRIPT

MARLOWE D. CASSETTI
INTERVIEWED BY CAROL L. BUTLER
COLORADO SPRINGS, COLORADO – 10 MAY 1999

BUTLER: Today is May 10, 1999. This oral history with Marlowe Cassetti is being conducted for the Johnson Space Center Oral History Project. This oral history is being conducted by Carol Butler, in Mr. Cassetti's offices in Colorado Springs, Colorado.

Thank you for joining us today.

CASSETTI: You're welcome.

BUTLER: Last time we talked a good deal about your experiences in Mercury, Gemini, and Apollo, but you also worked in Skylab and Space Shuttle. How did you first become involved in the Skylab Program?

CASSETTI: Well, in the early seventies, there was a program that started up while the Apollo Program was in full swing, and it was called AAP, Apollo Applications Program. It was looking at various ways of using Apollo hardware for future space exploration. The program became sort of a forerunner of Skylab.

I had some folks working for me as I was a branch chief at the time in the mission planning, and we had a few of our people working on some of the early concepts. I was supervising them to some extent, overseeing what they were doing, but it was kind of in the—I won't say the backwater, sort of the background of the Apollo Program. So I didn't really spend a whole lot of time and activity in it.

Pretty much at the conclusion of the Apollo Program in Mission Planning and Analysis Division, where I was assigned, we had a reorganization and I ended up as the

mission planning manager for Skylab. At that point in time, it had pretty well gone from early concepts to a funded program, and I had the assignment to pull together the Mission Planning and Analysis Division, resources and work for that. It was sort of interesting at the time, because we were under quite a bit of constraints. The constraint that we had is that everybody was looking forward from Apollo to the Shuttle Program, because that was the next new exciting thing, and everybody wanted to work on Shuttle.

So my division chief, who was John [P.] Mayer at the time, got me aside and said, "Look…we've got to do all this work on Skylab, and nobody wants to work on Skylab. They want to work on Shuttle. And I don't want to be bothered with Skylab. It's a dumb program anyway." He was very negative about it. We've just landed on the moon. Now we're going to put up a rinky-dink thing up in orbit. "I want you to do this and you can't use more than 100 people to do that. That's 20 of our people and 80 contractors."

So I was given a resource allotment which was kind of interesting, because I'd never had that before, even on Apollo Program. We had such a freight train moving along the track on Apollo, that if there was something in the way…a problem that needed to be solved, we just went out and spent more money and got more people and got more brain power working on it, or computers or whatever. But on Skylab it was very constrained, so it was interesting. It was an interesting challenge…even though 100 people sounds like a lot of people, it was really a fairly small work force, a small team working on Skylab.

BUTLER: You mentioned the number of people as a difference. How was the planning aspects and the analysis aspects different from what you did on Apollo?

CASSETTI: There were some very interesting things. First of all, one thing that was intriguing, it was a very constrained mission…The U.S. had [no] experience with any longer duration missions than [fourteen] days. The medical people said, "We can only extrapolate

so far in the future, so we're comfortable doubling the time." So the first mission—no, I'm getting it wrong. The only experience they had was on a fourteen-day mission. I believe in Gemini they flew a fourteen-day mission. I believe there was one that was that long.

So they could only extrapolate, and they were comfortable extrapolating for twenty-eight days. So they said, "Okay, the first mission you fly in can't exceed twenty-eight days. The second mission you plan—" manned missions we're talking about, because the Skylab laboratory was in space the whole time, but the manned missions were three men up, stay there for twenty-eight days, [before they] come back. The next mission, they said, "Okay, if everything goes well and people don't die of heart attacks or blood pooling in their brain," or whatever they were worried about, "you can then plan a fifty-six-day mission." So, manned mission number two was fifty-six days.

But there were plans to man it one last third time. Doctors threw up their hands and said, "You know, we can't double that again. That would be way beyond our experience. The best thing to plan is another fifty-six-day mission." And that's what we did. We based the whole thing, the provisions, the times up there.

Another thing that was rather interesting—I'll jump to another kind of thing that was interesting, is we got a lot of criticism from the press that here the most historic event in the twentieth century, of people walking on the moon, was done at 3 AM in the morning. So they said, "Hey, guys, the next time you do these things, do it when people are up and alive and awake."

So as we were doing our mission planning, we had teams of people and we had different latitudes about, "We're going to land in the ocean. Is it going to be in the Atlantic or the Pacific? We want to do it in light. We don't want to be landing at sea at night," and so forth. Then we said, "Okay. Hey, we want to have this scheduled about six o'clock Eastern time because that's when the biggest news audience is, right?"

Well, wrong. Turns out the people from NBC [National Broadcasting Company] got after my case, said, "What are you doing? That's prime television time. We don't want people watching the landing of Skylab. That's like the 'Heidi Bowl,'" which was something that happened where they preempted a football playoff game to bring in its entirety the movie "Heidi." [Laughter] NBC took a razzing for years, decades later, about the "Heidi Bowl." So anyway, they learned what's important and what's not important, and evening televised primetime is not the time when people want to see programming interruptions for the space program. There were a lot of interesting constraints on the mission. Those were sort of the fun aspects of sort of playing around with all these variables.

There were some other aspects such as the ability to conduct earth resources missions. At that time we did not have a lot of earth resources satellites, in other words, satellites looking down, taking measurements of soil and forests and cities and all those things. One of the guys on our team—I wish I could remember whose idea it was—said, "You know, if we change the orbit ever so slightly, we could have a ground track that repeats." In other words, when it passes over, let's say, Colorado Springs right now, that if you had the orbit precisely in the right altitude, the next time it passes over it will go over the same track over Colorado Springs.

This had a lot of merit with the earth resources scientists that we worked with, saying, "Hey, that would be great," because although the ground track would go over at different lighting conditions as the seasons change and the lighting changes, but it would be very valuable to them to be able to take their measurements and sightings. So we started promoting that.

I got a call from one of the people that we worked with up at NASA Headquarters in Washington, D.C., and he said, "You know, we need to brief Mr. [Dr. James C.] Fletcher," who was the NASA Administrator at the time, and he asked the questions in a staff meeting, "Why are we changing the orbit? You guys are just messing around."

So I had to get on an airplane pretty quick and go up there and explain to Mr. Fletcher what this was all about. He was wildly enthusiastic about it. He was kind of in the dark and really appreciated it and so forth. So there were some interesting aspects to that.

The other interesting aspect that I found is that there was a relationship between Marshall Space Flight Center [Huntsville, Alabama] and Johnson Space Center [Houston, Texas] and NASA Headquarters. NASA Headquarters was trying to get more into the program management, and so we had to include them in a lot of our discussions and a lot of our work, where I don't recall having to do that that much during the Apollo Program, and certainly not at all during Mercury and Gemini. So that was different.

Also, too, there was an interesting relationship with Marshall Space Flight Center in Huntsville. They were basically responsible for a lot of the mission, the hardware, and so forth. The flight operations were conducted in Houston, so we had the flight control team, which I worked with pretty closely, getting all the procedures down. When you rendezvous and dock with the Skylab, it's got to have certain orbital characteristics. The lighting's got to be such. You've got to have all the contingencies if your guidance goes out or if you lose attitude reference, how can you do it as a backup. So there's a lot of contingencies, "what if" backups and so forth.

Then a lot of the science mission planning tended to be done at Marshall, so we were constantly working between the flight control team in Houston, the mission teams in Huntsville, and at that time NASA had chartered with some airline, I can't remember which. They had an old Electra four-engine prop jet that took off from Ellington [Field, Houston, Texas] every morning and returned every night, and there were many times when I had to go catch that early in the morning, then spend a whole day in Huntsville, and land at the Redstone Arsenal [Huntsville, Alabama]. Wouldn't even go into the airport there at Huntsville; you'd land in the Arsenal. There would be a van or something to pick us up, or if

we were staying a couple of days, there would be rent-a-cars there parked along the grass strip. [Laughter] We commuted a lot between the two. So it was an interesting relationship.

One thing that really, I would say, that made an impression on me was how bureaucratic things were at Marshall. It was very compartmentalized between the various laboratories. They were organized in what was called laboratories. If you worked between the two laboratories, there was no internal mechanism, it seemed, at Marshall to facilitate that. So I would get calls from people at Marshall to call me up to say, "We need this other laboratory to do this," and I'd say, "Well, wait a minute. Why are you calling Houston? They're right in the next building from you." And they said, "Well, they won't listen to us, but they'll take direction from you." So I thought, you know, that's one of the things that's bewildering to explain to anybody, but that's the way they operated.

They operated as independent fiefdoms. They had their own travel bureaus in the different laboratories, I was told. They had their own research budgets and so forth. It was really quite interesting to see, because it was so totally different than the way we did it at Johnson. You had a few people who were in the decision-making role and you would brief them or say, "We need to get this done," and they would see that everybody was working together. It was strange. I'm not saying that it was an impediment or anything, but it was a strange way of doing business.

BUTLER: Were the general interactions between the different parts of Marshall with Johnson, did that part go pretty smoothly?

CASSETTI: It went well. There were some disagreements in terms of how the missions were going to be controlled, how the mission management was going to be controlled, and that finally got worked out. So that when we finally went into the flight operations, we had the flight control team, then in one of the back rooms we had a mission management team, and

then at Marshall Space Flight Center they had what they called a POC, which was the Payload Operations Center, so that they could do the direct science work that was particular to their Center's mission. And we had other science back rooms in Houston. So it seemed to pretty well play together. It seems like no matter how much planning and simulations, there's still a lot of rough edges on it, and we had our share of rough starts.

While I'm reminiscing about Skylab, there was one time where I worked for Bill [Howard W.] Tindall [Jr.] also. He was our directorate chief, and I remember having a meeting just a couple of weeks before the first Skylab mission was going off. We had a situation where the ground software in the Control Center was not ready. I remember Bill getting very white in the face and had all his prime people around, and our prime contractors, and said, "We are never going to not launch because the Mission Control Center doesn't have the right software going in it." We worked that problem out. It was a very long, difficult meeting, but it didn't happen. I mean the software got built and got tested out and checked out and everything. But had the Skylab launched on their original schedule, I don't know what we would have [launched], because the Control Center could not have supported a rendezvous. It was that plain and simple.

BUTLER: One of those many pieces that has to come together.

CASSETTI: Well, you know, people say, "How did you ever get in that [situation]? You did rendezvous during Apollo and Gemini." Well, that's true, but we also went through a major upgrade in the computers and the software and so forth in the Control Center. As people are finding today with trying to get ready for Y2K [Year 2000], it's not as easy a job to take a lot of legacy code, software, and convert that into something that runs on newer machines and newer software and so forth. So that was a good part of the problem, and they got it solved after a few anxious moments, many anxious meetings, I should say.

BUTLER: Luckily it did all come together.

CASSETTI: Yes, it did, indeed.

BUTLER: One of the aspects of Skylab that has been talked about to some degree is wet workshop versus dry workshop. What was the difference there?

CASSETTI: Well, originally, I think when the program was still AAP, Apollo Applications Program, the original concept would be a wet workshop. But wet workshop [was], I believe…it was is the stage of a Saturn II after it depleted its propellants out of the tanks. Then it would be visited by an Apollo command and service module bringing equipment and laboratory racks and so forth through a special hatch into this big sewer pipe of a tank, and then outfitting it that way.

Well, in practicality, although that seemed reasonable, I think when they really ran the economics of it, the number of launches to provision it, it seemed like the wet workshop, which was taking this tank which had been wet, and then you vent it to the outside and, of course, all of the propellants gas off, but after they really worked it out, it didn't appear to be the most reasonable way of going.

The other alternative, which they settled on, the dry workshop, they took a Saturn V rocket, which has got an awful large second stage, and they basically powered it into the sky with the first stage only, and the second stage was all outfitted with the workshop, and that's what stayed in orbit then. That was an easier way because you outfitted everything on the ground. You didn't need to supply it with a series of rendezvous and docking missions that would put things into it. So it turned out to be a better way to go.

The down side of that is that Saturn V rocket is a very expensive piece of machinery to use as a space station sort of a device, but it probably turned out to be a cheaper, more expedient way, and there was less risk involved with that, too.

That whole decision had already taken place before I really became involved in it, but I know some of the guys that were working for me that were doing some studies of various planning aspects, who had been working on the wet workshop idea, and I think that slowed the program. The program went on, after its inception and early funding, it had gone sort of aimlessly, I think, for quite a while, trying to struggle with the wet workshop and the constraints imposed on it, until somebody finally made a decision that wasn't really going to be the most practical thing. So it then became a full-fledged program and decided to use the Saturn V for it.

I think the other thing, too, is that the Apollo Program was really a lot more ambitious than it really turned out to be, and I've heard various stories, but I think the thing that was really prevalent was the fact that Apollo 13 scared the hell out of everybody, especially the decision-makers up in Washington. I'm not saying just NASA Headquarters. I think it was the politicians and so forth. As a result, we really didn't fly many missions after Apollo 13. We spent a lot of money and time upgrading the vehicle to provide extra equipment and so forth to prevent failures, but we really didn't fly too many missions after 13.

Had we not had Apollo 13, I think we probably would have used up all the Saturn Vs in the inventory. There were plans laid out, and I recall seeing that there were some very ambitious plans doing lunar exploration with vehicles like the Rover [Lunar Roving Vehicle (LRV)]. There was even some flying vehicles that would fly around and so forth that were on the drawing board.

There was a program, and I forgot what they called it, it was something like Apollo Extensions or something. I remember John [D.] Hodge had a small project office that looked at these extensions, and it was sort of like extensions. There was a hovercraft kind of a

device that was being promoted in that time frame. Actually, a lot of that was worked in the sixties while concurrent with the Apollo Program, saying, okay, if we're successful and we land there, what next? What do we do after that?

So I suspect there was a connection between the Apollo Application Program, AAP, soon to become Skylab, and the fact that it had certain hardware it could use. The Saturn V hardware, I believe, was pretty well all geared toward Apollo, and so they had some Saturn IIs, the smaller Saturns, which were then used or put aside for the Skylab Program.

BUTLER: You were talking some about some of the extensions for Apollo and that a lot of that may have tied in with Apollo 13. As the Apollo Program did come to an end with 17, did you expect it at that time? Was it a surprise? Were you ready to move on to the next step?

CASSETTI: Well, you know, there was a lot of, I think, disappointment. I believe I was disappointed that the Apollo Program was basically truncated off there. I could see that it's always been risky business. We were fortunate we didn't lose the crew on 13, but there was really not a good explanation why they didn't go further there. I think by that time Skylab was pretty well along the way, they knew that would be the next program after that, and towards the end of the Apollo Program, there were a lot of things on the drawing boards, like Shuttle. So, yes, Shuttle could be a way, or another space station. I think really in the order it came in, there was really a space station envisioned, then Shuttle was the thing that could realize the deployment of the space station.

So I think in terms of the people working on the programs, we had a lot of things still out there, but there was a disappointment that we didn't have a Mars program or a more ambitious Apollo program.

BUTLER: Did you expect that things would progress as they have, that we wouldn't go back to the moon or Mars in over thirty years?

CASSETTI: You know, looking back, I'm really amazed that we haven't done anything like that. When you put it in the full context of the history in terms of how expensive it is and the hyperinflation that we had in the seventies, and the oil crisis and, before that, the Vietnam War, there's a lot of other events that have gone on. So the space program hasn't gone along in a vacuum. It has had to go along with the rest of what the country is about and what the world's about. But really, at the end of the Apollo Program, there were a lot of things.

I recall being in a meeting. I'm embarrassed to say this. It was like we got a bunch of people in a room and our boss got up at the blackboard, said, "Okay, let's figure out what we're going to do after Apollo. What are some great things we can do? Okay, find a cure for cancer." [Laughter] It was like, wait a minute. What madhouse am I in here? "Okay, a man-to-Mars mission. Okay, we'll put that down." It was a strange thing. We still had a bunch of fairly young people who felt like they could conquer anything, given enough resources, we could do that.

BUTLER: Once you've accomplished the moon, where do you go from there?

CASSETTI: And I really thought quite seriously that we would be starting to put the things in motion to go to Mars, and we did a lot of studies in Mission Planning and Analysis Division on man-in-Mars missions and running some trajectories out there, the time of flight, and how long do you have to store the propellants and all that kind of stuff.

BUTLER: Must have been interesting.

CASSETTI: Yes, it was. I always found that pretty fascinating. It would be a difficult trip. I remember the transit times were very long and the stay times were—we thought of rather limited missions on Mars, so you spent quite a number of months going out there, not staying there terribly long. I don't remember what the stay times were. And then returning back. Of course, the big problems were, you needed hydrogen as a [propellant], as a fuel, and keeping hydrogen cold and keeping it from turning to gas for long periods of time required special insulators in the fuel tanks and so forth. So there were a lot of engineering challenges. I'm sure it would have been a horrendously expensive proposition. I suspect one of these days we're going to make up our minds to go do that.

Can we take a break?

BUTLER: Absolutely. [Tape recorder turned off.]

Okay. Talking about Skylab and contrasting with Apollo, and you mentioned even Gemini, how the missions were very short, fourteen days at the most, but with Skylab you mentioned how the doctors said how far they could predict. But how did you plan for everything that would be needed for such a mission of such length?

CASSETTI: Well, of course, the difficult aspect is the consumables, so while I was the mission planning manager for Skylab, also in the branch I sort of had two jobs. I had my branch chief job and the planning job. In the branch I had, we did consumables analysis, so the consumables were pretty well figured out. We know how much oxygen per day, per astronaut, and various contingencies, and so forth. So the provisioning was pretty well planned and we were pretty well on track on that, as I recall.

The other things that we had to worry about, there was so much scientific observations. One of the major parts of Skylab was not only—I mentioned three sources we were looking at, but we also had a very extensive solar observation program. That had a

large film requirement, all the photographic material. It was a little bit complicated because the film and camera mechanisms were outside in the solar observatory part of the vehicle, so you had to make a space walk to go out there to retrieve that film. Then once the film was retrieved, it had to be stored in a lead safe to keep the film from fogging, due to the radiation.

So there were a number of aspects there in terms of you've got enough film, you've got the logistics. Then the next Apollo [command module] to come up there, you'd load the film on it to return the film back to Earth. We didn't have a lot of sophisticated downlinking of science data because we were limited by the equipment we had, but I think we got some very valuable imaging from the sun in many of the spectra that we can't observe on the Earth. If I got it right, there's an ultraviolet spectrum that our atmosphere shields, so we can't see that except when we get outside the atmosphere. That apparently is a very valuable spectrum for looking at the sun. So there was that.

Talking about the provisioning, one of the interesting things that happened was that during one of the mission reviews, I got up and I was briefing a number of the important people about our Skylab missions and what we were planning on doing. I went through, well, okay, we've got the twenty-eight-day mission and the fifty-six-day mission and another fifty-six-day mission. I remember Chris [Christopher C.] Kraft [Jr.] putting his hand up—he didn't put his hand up when he asked the question. He asked the question, "What the hell you got another fifty-six-day mission for?" And I explained to him, well, the medical people are comfortable with twenty-eight days because it's twice fourteen. He said, "Well, that's a bunch of bull corn, you know. If we're going to all this trouble, we're not going to stop the last mission at fifty-six days. Got to plan on a longer mission." So what's twice 56, but 112 days. Of course, the medical people just absolutely melted when they heard that.

Well, I remember a very heated discussion. Ken [Kenneth S.] Kleinknecht was the Skylab program manager at the time, and I remember Ken—as an aside, I always have liked Ken. He was a very reasonable man. He didn't seem to have a lot of ego invested in

anything, and he heard Chris' question, "Why are we doing that if we're going to all the trouble?" and he started asking the question, "Well, let's see. Maybe we can do that. If on the first fifty-six-day mission the human body can't take it, we'll just cut the next one off at fifty-six days," and so forth.

And the interesting thing, and I think it's a little-known fact, is that the Apollo command module can only hold so much stuff. So what do you need for a 56-day mission that now becomes 100-plus-day mission? You need a lot of food. A lot of food, we didn't have enough room to feed three guys for 100-plus days. So you know what they ended up doing? They ended up stuffing in the command module a ton of these things that I can only describe as breakfast bars. If you remember back in the seventies, there was a rage out—skip breakfast, you just have a breakfast bar. It looked like a chocolate candy bar. In fact, I had one [at the] time, tasted just like eating a candy bar. So anyway, that was for volume-wise. That was the only way they could supply the number of calories and the amount of water. Well, water they kept separately.

But the dehydrated foods that they had, that they had used since the Gemini and Apollo Programs, to get that amount of bulk in there, you couldn't have provided enough meal. It was basically a calorie concept. So what do you do? The answer is, really, you send them a bunch of candy bars and you eat candy bars for 100-plus days. I mean, can you imagine that? That must have been difficult. I've never heard the postmortem on that. [Laughter] But it was something else.

BUTLER: I'm sure they were ready for something else to eat when they came back.

CASSETTI: Oh, yeah. I can't imagine that. But that was the solution, for us to fly more than the prescribed number of days we had originally planned. There was a literal problem.

The thing that had to be managed then were the storage lockers in the Apollo command module, where you had stuff tied down and packaged and so forth. There was a lady that worked for Crew Systems Division, and I don't remember her name, but she was, I believe, a clinical nutritionist. She may have been an M.D., but I think she was a nutritionist. I remember in the review meeting we had where she produced one of these—I call them breakfast bars. [Laughter] It was like, oh, my God, these guys are going to eat these things for 100 days, three meals a day? I think they had other food interspersed, but I think that was the bulk of their diet.

BUTLER: Wow.

CASSETTI: Oh, that was incredible.

BUTLER: Some dedication there.

CASSETTI: Yes. You had to really want to fly in space to do that. [Laughter]

That and changing the duration of the mission. We were pretty well along the way at that one question by Chris Kraft saying, "Why the hell are we flying another fifty-six-day mission after the second mission?" That and the conflict with prime television time were a couple of our real challenges. [Laughter]

BUTLER: Quite interesting challenges, at least.

CASSETTI: [You think] mission planning has to do with trajectories and astrophysics and everything? No, it was other considerations.

BUTLER: TV and candy bars.

CASSETTI: TV and candy bars. Right.

BUTLER: Looking at Skylab and the missions as they flew, and even the planning and building up to the missions, what lessons can be learned from Skylab that either were or should be applied to future programs?

CASSETTI: There were a couple of things that I know Skylab made some breakthroughs in certain areas. First of all, the way we did the Mission Control Center, the Mission Control Center computers, was different than we'd ever done on Apollo or Mercury or Gemini. There was more of an interaction between the ground computers and the flight control team, so you had more flexibility there. That was a big thing, because in the previous eras, there was always a physical separation between what we did. As I understand it today, with flying the Shuttle missions and also on Space Station, there's much more of an interactive, so the people on the flight control team are basically on line. But Skylab made a big contribution towards making that one step further.

Now, there's also a very funny aside on this. We had the opportunity to operate the world's most expensive calculator, and what it was, in trying to get the requirements from the flight controllers to program the mission computers, they said, "What features do you want?" We're talking about the early seventies here. People did not have pocket calculators. Those were fairly expensive, $100 or so, devices, and the government, heavens forbid, would ever buy anybody one. So they said, "If you could give us something on the screen." The controllers now had keyboards, so it wasn't just punching up buttons on the display panel that said I'm going to switch from this fixed display to this fixed display. It was actually they were able to do some hands-on keyboard input. So they said, "Well, I've got a keyboard here

and you've got a screen. If I need to multiple 3 times 522, and divide it by 6, why don't you give us some rudimentary functions like that?" They said, "Great thing."

Well, that turned out to be an awful expensive proposition. It took a lot of programming time, and also because the system was networked—and we're talking about the crew in the early days of computers, that once you typed in "3 times 623 divided by 5," and you hit "enter," it took quite a number of minutes to get the answer. When you think about it, are you going to sit there and wait minutes for that answer to come up? No, you're going to hit "enter" again and you're going to hit "enter" again out of frustration. It's sort of like people pushing the button on the elevator. One push is all you need.

Well, that was one thing that they found in the simulations before the mission, was absolutely intolerable. It brought the whole system to its knees. The whole mission control system was because they had so many terminals, they had so many people on line, and they did not have a good real-time operating system with priorities and so forth, so the mission-critical stuff got slowed down just like the silly stuff, the five-function calculator stuff. That really caused a real problem with the system, and that on top of the other woes of getting a lot of the legacy software together, really there was a lot of concern. That was something that we had to learn how to manage this computing power for a long-duration mission.

Another funny thing I recall. [Laughter] The first day of the first mission, I was in the Control Center, and it was frantic. It was the first time we got the crew up there, the Skylab was crippled, and we had all this problem with the heat in the vehicle and everything like that. I remember being in the Control Center probably from early morning to fairly late in the evening, and then all at once the whole computer system, the ground computer system, goes down. The entire thing. And everybody's, "What? This is the end of the world." And they said, "Oh, no. This is our planned checkpoint."

I'll never forget, Gene [Eugene F.] Kranz was, I think, the mission director, and it was like you'd never heard somebody scream. "You don't bring the whole computing system

down for some stupid—" A checkpoint is when you stop and you store all the data. It takes about half an hour or so. Wait till the crew is asleep. Wait till everybody's done their work. It was like, "No, we're going to do it at eight o'clock every night, we're going to do it." That was their plan. Oh, I tell you, it was lucky there was not murder committed. It was like driving down the freeway and somebody reaching over and turning your engine off, saying, "Okay, it's time to change the oil." [Laughter] You don't stop driving in the middle of the freeway to change the oil.

BUTLER: Certainly not.

CASSETTI: So there were a lot of things we learned on that. Neil [B.] Hutchinson was the flight director on that, and Neal came unglued. I couldn't believe it either. I was aghast that they would—the guy was head of the mission computers, "Okay, it's time to do a checkpoint." And everything was stopped. It was like pulling the power on the building.

Let's see. Other lessons learned. Well, some of the positive things that we learned is that on previous missions, on Apollo we didn't notice it too much because once you got away from the Earth, you had large tracking dishes pointing to the spacecraft, so you were pretty much, after they did the translunar injection burn and started pulling away from the Earth, you had pretty complete coverage of the Apollo command and service module, but on the Mercury and Gemini Programs, we had limited tracking stations around the Earth. Also because we had some in countries that weren't friendly to us, where they were changing. There was a station in Africa, and I remember we had that during Mercury but not during Gemini because all at once we went out of favor with that country. Nigeria was it? I'm not sure whether it was Nigeria. Kano, Nigeria? It may have been.

Anyway, one of the things that we had was more continuous coverage with some of the satellite relay, and so that was good. We were more in contact through that. So our

tracking and communications was upgraded so that we weren't always hanging on to the next pass over at the next ground station. So that was a big improvement.

I think the other thing that we learned to do more was coordinate the science and the mission and the crew, but I think one of the lessons learned about Skylab had to be that the crew could only do so much during their waking days, and so the more you relied on the crew operating equipment, taking observations, this or that, it really became a problem. I think the resource that we really ran out most of the time was physical crew time. It took longer to do things like simple calibrations. I'll say simple calibrations, but things, okay, you've got to calibrate this instrument, and then you use this instrument and log it and record it and so forth, and then you secure it for the day. Well, that sounds well and good in a laboratory environment, but I think, in the weightlessness in space and so forth, they just didn't get the utilization of the crew.

I think Skylab showed that for the Shuttle Program, we had to rethink about all these activities we put on the crew. Yet on the other hand, we found that they could do a lot of troubleshooting, that if you had all remote-control devices and something breaks, you'd be better served to have somebody who can repair something on board. I think a lot of that went over into the Shuttle Program, where we did do things like EVAs [extravehicular activity] to repair rendezvous with other disabled spacecraft and repair, the Hubble [Space Telescope] repair mission, and those kind of things. I think a lot of that genesis came from Skylab to some degree, where we found that we could use the crew to do that.

BUTLER: I know we're drawing close to three [o'clock] at this point. I don't know if you—

CASSETTI: I can go another half an hour longer.

BUTLER: Would that work?

CASSETTI: Yes. How about you?

BUTLER: That's fine with me. We could tie off a little bit about the Shuttle at that point, if that works.

CASSETTI: Sure.

BUTLER: As Skylab—you mentioned some of the aspects of Skylab that could apply to Shuttle, and Skylab had its three successful missions. Apollo-Soyuz came along, but Shuttle was in development throughout this whole time frame. How did you first become involved in the Shuttle Program?

CASSETTI: Well, early in the planning, there was an activity going on by—I think I really would attribute it to Max [Maxime A.] Faget. Max was the head of the Engineering Development Directorate. I really think that Max was the guy who dreamed up the idea of a reusable launch vehicle, and he really got very engrossed in that, and basically sold the idea to the rest of NASA.

I think the way the progress of it had been, though, is that there was a move afoot to do something of more of a permanent space station than what we had done on Skylab. So there was a Space Station Program going on, and we had some Phase A and Phase B contracts to do some preliminary designs on that. It really became apparent just to supply that Space Station with launch vehicles, it would be a very expensive proposition. So at that time the thought of a reusable launch vehicle like a Shuttle was envisioned.

I recall being in a meeting with Max Faget where it was a totally different topic, and I think Max was ordered to be there by whoever the Center director was at the time. It may

have been Dr. [Robert R.] Gilruth. It may have been Chris. Well, maybe Chris Kraft. No, I think it was before Chris. Anyway, Max was—I was sitting not too far from him, and he was doodling on his pad. He wasn't paying one bit of attention to what was going on in this meeting. I mean, the guy is a consummate engineer. He was drawing up these designs for all sorts of Shuttle configurations.

Well, so here we are in the early seventies, and NASA is proceeding with the Shuttle Program of some type. They've got a couple of contractor teams looking after—one team was led by North American [Rockwell Corporation], the other one was led by McDonnell-Douglas [Corporation]. This was all going on about the time that Apollo was still flying.

Well, it turns out that Apollo 13 happened. This is a true story. You're familiar with Apollo 13. The lunar module [LM] really became the lifeboat for the crew, and basically if we didn't have the LM there, we would have lost the crew because the command and service module was pretty disabled. So the president of Grumman Aircraft [Engineering Corporation] at the time approached—and they were headquartered in Bethpage, Long Island—and they went to their senator, Senator Jacob [Koppel] Javits of New York, and they said to him, "Look it, we just saved NASA and the crew of Apollo 13 with our wonderful spacecraft," the lunar module, which they built. "The next big space program after this, manned space program, is the Shuttle and we're frozen out of that. We're not on anybody's team, and we're going out of the manned space business after Apollo's over."

Senator Javits picks up the phone, calls up the NASA administrator, and all at once Grumman gets this contract to do a different look at the Shuttle Program. We have these two big contracts going on already in competition, McDonnell-Douglas and North American, and now Grumman gets awarded this smaller contract to look at some Shuttle alternatives. They were teamed with the Boeing Company, and it was put under Max Faget's organization.

For some reason, and I don't recall exactly, I didn't volunteer for it, but somehow I was selected to be the program manager for part of the study that Grumman and Boeing were

doing on a reusable Shuttle-like vehicle but it was called single-stage-to-orbit. I was assigned to that, and got together—I believe what had happened then is I basically was doing it as my other duties would allow me to do, sort of was a dual assignment, but I worked with his organization, with Faget's organization and so forth.

It was interesting because the Shuttle configurations that both the other teams were looking at involved a completely reusable vehicle. It had a booster stage, which was a big stage with wings on it and it had a second stage which was like a Shuttle, also a winged vehicle. The booster stage would only take it up part way and then it would turn around and land back at the Cape. The other stage would go into orbit.

Well, it turns out that that configuration became a very large vehicle and a very complicated vehicle, and the cost estimates for pursuing a vehicle like that was pretty horrific. The vehicle that we were looking at in this Grumman-Boeing study turned out to be also a big vehicle, because to go into orbit with one vehicle took an awful lot of propellants. It became an enormous vehicle. It became bigger than what the other teams were looking at. But then we said, well, okay, we don't need to look at a single-stage orbit; but let's look at a stage and a half orbit. So we put some large solid rockets on the side of it, and it became a much more reasonable-size vehicle. So they were pursuing that.

Now, there was a lot of politics involved in this, and there were a lot of people who saw this as a way, as a study, as a way of derailing the Shuttle Program. So I know on a couple of occasions when we briefed Chris Kraft, who was then Center director, he was fairly—I won't say critical of it, but I could certainly tell that he didn't welcome this, that it was just another way of adding more confusion to the mix. Now, eventually the vehicle that North American and McDonnell-Douglas proposed were basically that kind of configuration except that they'd gone one step further and had the drop tank on it, the external tank. So there was that.

Interspersed with this study that I was leading on the side—as an aside, I should say that a lot of people didn't receive that study very well, and so there were a lot of people that questioned all the results that came out of there. So there was a lot of study teams to look at the costing models, the structure models, and all the things that went into development of this stage and a half to orbit. The term "Don't shoot the messenger" was aptly applied to that scale.

But interspersed with this activity that I had going there was also involved in the review of the two prime contractors who were in competition for the Shuttle Program. So there were many times that I went to review meetings at Downey [California], North American, then Downey, for their configuration, and then McDonnell-Douglas in St. Louis [Missouri] for their configuration. So I was seeing all of this. In fact, there were some people that suggested, "Wait a minute. Cassetti's heading up this other study, and we're showing them our results here. Isn't this giving ammunition to the enemy camp?" Wait a minute. We all work for the U.S. Government, remember?

And there were a lot of strange undercurrents going on at that time, and so it was either fortunate or unfortunate that it went the way it did, but eventually—before I get sidetracked, a point I had, North American was the prime contractor on Apollo. They had a ton of people working out there. I would go on different visits to their plant at Downey, and you could tell that place was a bustling activity. Well, during the Shuttle competition, they had gone from thousands of people working there, to just a few hundred, so the place was like a ghost town. It turned out that they had re-leased a number of their buildings there to the city of Los Angeles [California] or the county of Los Angeles, I believe. So I remember going into one area, and we were doing a review, some sort of a midterm review on their configuration, and one of the guys whom I'd known from the Apollo days was taking me from one part of the building to another one. He was showing me, "All those people are gone. But the good part is, you've got the best of the best, the *crème de la crème,* of our

engineering team, so we'll do this great job on Shuttle if you pick us." He was giving me a little sales pitch. So it was very interesting times. Here it had gone from this real beehive to a ghost town, and, of course, they ended up winning the competition for the Shuttle Program, and then it, of course, was ramped up.

Interesting historical notes. Since I used to work, until quite recently, for Boeing, which bought Rockwell, North American Rockwell, the former, they are basically shutting down the Downey facility and moving the people and so forth out of Downey to Seal Beach and Huntington Beach in California. But I remember going there in the Apollo days and talking to some of the old-timers there, and that used to be, in the Downey facility, a major aircraft production facility during World War II. Guys were saying they'd roll them out of the hangars there and take off at the runway and deliver them to the front.

BUTLER: Quite a history.

CASSETTI: Quite a history, yes.

BUTLER: It will be interesting to see what happens.

CASSETTI: Yes. I think the buildings are going once again back to the county or to the school district or something. I don't know. I think those are government-owned buildings and facilities. A lot of plants that go back to World War II, where the federal government went in and built factories, the government owns the land and the buildings. In fact, where the Shuttle external tanks are built in Michoud [Assembly Facility, New Orleans, Louisiana], that goes back to World War II as a large tank production facility, and after the war they had this big, big building under one roof, and they ended up making the tanks there.

BUTLER: That's an interesting bit of history, too.

CASSETTI: Well armed for Trivia Pursuit. [Laughter]

BUTLER: That's right.

CASSETTI: If you still play that.

BUTLER: Absolutely. During mission control and the Mercury and the Gemini and Apollo and Skylab, you were involved in all this. You talked some about how with Skylab you vamped up the computers in the Control Center. For Shuttle and for the computers on board Shuttle, and even in the Mission Control, it was so different than what happened on the earlier programs. What were some of the differences there, and were you involved in any of that?

CASSETTI: Well, actually, the assignment I had eventually, that was in 1974, was that I was—one of the management things that were done during Shuttle is that North American-Rockwell had the Shuttle vehicle, but the computers and the flight software were done by IBM [International Business Machines], kind of on an associate contractor basis, but also under the management of NASA. So we formed a new division called [Spacecraft] Software Division. Dick [Richard P.] Parten was the division chief. Dick called me up one day, and I think it was pretty well winding down in—we may have been still flying Skylab at the time. I forgot when we last—no, I'll take it back. We had finished flying Skylab. I think I was doing some of the mission planning for Shuttle at the time.

Dick called me up and said he was forming a new division and wanted me to lead up one of the branches there that was involved with the integration of the hardware and the

software. So it was like one of these things were, gee, I don't know that much about computers at all. I mean, I use them, but I don't know anything about what makes them work. But I've always found that when somebody offers me something, I should really look at it very favorably, and so I took him up on his offer. Although I enjoyed what I was doing, I was also looking forward to doing something else.

So I got really immersed in the Shuttle avionics. In fact, there was a time where the Shuttle avionics, the whole electronic system in Shuttle going out to the end effectors and the data buses and the computers and the devices they call MDMs and so forth, was all under the management of North American. So I found that in order to keep up with what they were doing, that I literally had to get on an airplane every Tuesday morning, fly out to Downey, go to a late-morning meeting there, and stay and have meetings, and either go home that day or the following day.

I did that for some time, and then as my organization grew and I had a guy then who had a section that was involved in that on a day-to-day basis, I basically turned it over to Charlie [Charles W.] Floyd. Then he got on a plane every Tuesday morning and flew out there. But I still run into people who, "Oh, yeah, you're the guy who used to come to our meeting all the time from Houston." [Laughter] I ran into a guy recently who was with Rockwell, that remembered me from those days.

But it was an extremely complex program, not [just the] computer program, but the whole—the Shuttle was the first vehicle we ever flew that absolutely depended upon computers working on board. The computers were the brain. If the computers were to go out, it would not fly. There was no way. On Apollo, Gemini, Skylab, and everything, there was nothing that the crew couldn't do that if the computer went out—and they did, often—or the control system or electric power or whatever, that they could still get back home safely. But with the Shuttle, from the start it was a fly-by-wire system, as they call it, which depended upon computers sending out electric signals to actuators and moving engines

around, or control surfaces, or opening payload bay doors and so forth. So the flight software was very complex, the equipment that it ran on was very complex.

So it was quite a learning experience for me, because I was not a computer guy, and I was not really a software developer. I had done some rudimentary programming, but along the lines of my engineering work, and that is anything that would be involved in flight software. So it was quite an experience, and we were in the thick of things because every decision that was made on the Shuttle usually affected the avionics, affected the flight software, and there were incredible political battles fought between different opposing camps.

We at the Spacecraft Software Division promoted a couple of things that were unheard of, and that was using a higher-level language for the programming, and the other thing was using a structured approach, design approach. In the days preceding this, programmers ended up sort of dreaming up code. There was not a lot of planning in design of the codes, surprisingly enough, and IBM, to their credit, were really leading the software development industry in something they called structured programming. Structured programming is, you design it from the big picture and then you start breaking it up into smaller [pieces]—you start refining the definition of terms.

The people we worked with at Rockwell, or North American, were totally, absolutely, diametrically opposed to that, and they would literally fall on their sword to prevent that. They claimed that software development was an art, was not a science, that you couldn't put that kind of structure to it. They had done the fire control system for the F-111. It was a very successful system. They wrote it as an art form. I'm probably exaggerating, but that was the way they felt, and we had endless arguments with them.

We both sort of got our way. We pursued a lot of our work in a structured manner with good documentation and a sense of you know where everything fits together. They were given the charge of doing a backup control system, guidance and control system, so

they did it their own way. They also were totally against using a higher-level language. They said everything had to be program machine language and anything else was a waste of resources. So that they went off and pursued their own thing with the backup system that way.

It was some difficult times. A lot of arguing. Some very contentious issues involved in that. Fortunately, I tend to be a compromiser, let's get everybody together and see if there's a common ground that we can pursue. So instead of getting confrontational, I try to figure out, okay, this meeting is only going to last a half a day, and when we get out of it, we're supposed to figure this out. But it tried my patience at times. It was a great deal of learning problems, because I think the team at Rockwell had never—most of the people that we worked with did not work on Apollo. They worked on the airplane programs, and they were used to doing things without a great deal of government oversight or insight into what they were doing. They basically called their own shots and handed the government the bill. And we weren't going to do the Shuttle Program that way. It was very difficult for them to abide by that.

BUTLER: It did all come together eventually and has been working pretty successfully.

CASSETTI: It has, yes.

BUTLER: Your role—actually, I think I'll change the tape here real quick. [Tape recorder turned off.]

CASSETTI: To make the Shuttle cost-effective, it had to fly often, to get the cost down. The more you flew it, the less expensive it would be. At that time—and we're talking about the early seventies, late sixties, early seventies—this country had several expendable launch

vehicles. The Air Force were flying their satellites off of Titans and Atlases and a few on Deltas. Then NASA was flying its own scientific satellites on those vehicles, too. So part of the agreement that was forged at the administration level—we're talking about the [President Richard M.] Nixon administration at the time—was that for the Shuttle Program to go on, we would have to shut down these other expendable launch vehicle programs.

So the Air Force had to give up what was their Titan 34D Program, which was the launch vehicle they used, and they had to agree to fly Shuttle. Well, because the Air Force was responsible for national security missions, they would also fly those on the Shuttle, and NASA would fly their scientific satellites off the Shuttle.

In addition to that, there were a lot of puts and takes between the Air Force and NASA, and I was involved in a lot of that. One of them was, the Air Force has classified missions that required large [orbital] plane changes, which meant that if you took off and did a once-around mission and returned to the landing site, well, the Earth has moved 1,500 miles in the amount of time that you've gone one revolution, so in order to return to that same landing site, you would have to fly through the atmosphere and literally pull the Gs and do the cross-range flying to get back to the original landing site.

Now, that posed a problem. I said Max Faget was in on the original design of the Shuttle. Well, he had a Shuttle that had wings more like conventional airplane wings, a mono-plane wing. You can't pull those kind of loads with that kind of a wing at high temperatures, so that really forces you to a shape very similar to what the Shuttle is today, a delta wing, or a modified delta wing, where it's a lifting body kind of a thing. It's kind of like an airplane, but it's really not an airplane in the true sense, the wings. So basically the Air Force said, "Hey, you guys want us to be partners with you, you've got to change your configuration to meet these requirements." Well, that caused a bit of consternation. I know Max was not too happy about that.

The other thing that the Air Force did was they agreed to outfit Vandenberg Air Force Base [California] to launch the Shuttle on complex SLC [Space Launch Complex, pronounced “slick”] 6. They poured millions of dollars into that endeavor, and, of course, it was never used. They also did some other things. They developed an IUS, an [Inertial] Upper Stage, solid upper stage, to be used for launching some of these satellites that would be deployed. So they did everything. They weren't really passive partners in this. They were proactive and did these assignments.

There was not a lot of money passed between the Air Force and NASA. It was all done really *quid pro quo*. So, yes, they built Vandenberg, but we didn't charge them for putting delta wings on the Shuttle. So there was a lot of that put and take, like I said. I got involved in that in a lot of the tradeoffs that we were doing, a lot of the studies we were doing on the configuration of the Shuttle, and then as I got into the flight software business, some of the mission requirements, for national security missions the Air Force felt it was imperative that the Shuttle be able to do something called "launch on demand." In other words, a national security problem arises, they want to be able to haul a satellite out to the Cape or out to Vandenberg, stick it on the Shuttle and fly it at fairly quick notice. There were a lot of things that we did in the software that would not allow that, so we had to figure out a lot of work-arounds or a lot of ways to accommodate that.

Then there became the issue about, okay, the Air Force flies these classified missions. Where do they do that? So the thought was, well, within the Johnson Space Center, we'll take some of the computer systems, primarily, and some of the work areas, and we'll make them classified facilities, and we'll do that by special provisions. So I was very much involved in that project. That project was done under something called "controlled mode." In other words, the computers were in a controlled environment, so you could do classified work, even top-secret work, and the data would not be compromised or nobody would know

what was going on. That involved shielding the rooms, restricting the data inflow and outflow from the rooms in the buildings.

The Air Force was charged—I think one of the few times they were charged for anything was in this control mode. But in addition to that, it was envisioned that as the Shuttle Program started cranking up and we were flying a lot of missions, that it made sense for the Air Force to plan and control their own missions. So that's at a point in time, we're still talking about in the mid-seventies, when all the Air Force missions were controlled out of Sunnyvale, California, in something called the "Blue Cube." It was a classified facility. They did most of the command and control of their satellites from there, and not the launch control, but the launch monitoring in the early orbit work.

So when it was thought, okay, well, the Air Force is eventually going to fly their own Shuttles and they're going to train, form, and simulate, and so forth, it was thought that, well, they could go do that in the Blue Cube. But, unfortunately, it became apparent to people that really took a hard look at that, that the Blue Cube is sitting right next to the intersection of two major freeways in Sunnyvale, California. Anybody with a bazooka or a hand-launched grenade could take the whole facility out. I mean, there's these radar dishes and this building. And those were the days where terrorism was a real threat. So there was the terrorism concern. Here's a single-point failure. You've got a national security mission. You're flying the Shuttle out of that building? The other thing was the building lies right on the San Andreas fault. [Laughter] So, not a good thing either.

So they said, "We've got to go look at another site someplace else." So there was a site selection group that went out, and they picked what later became Falcon Air Force Base, now Schriever Air Force Base right outside of Colorado Springs here.

So as that was going on, I got another call from Dick Parten. I was in another assignment. I was involved in the institutional computers in the—I'm sorry. The Shuttle ground computers for the post-flight analysis and the institutional computers. I was involved

in a branch that was doing engineering on that. So I got another call from Dick Parten, and this was circa 1982, and he called me up, said, "Look it, I've been right involved, in the middle of this thing with the Air Force, and I need to turn that over to somebody to be the project manager on that. Would you be interested?"

I said, "Sure." So I went over and worked on the staff of the directorate staff, leading a project. The project was funded by the Air Force, another transfer of funds. This was a ten-million-dollar project. We had upwards of 120 people working on it for one year. What we did was, we took the people from all the various organizations at Johnson Space Center that were involved with Shuttle planning and control, and said, "Okay, what if we build a Center in Colorado Springs to do the planning and control of the Shuttle? What do we need? What's necessary? What do we need? Of all of the investment in the software, the legacy software that we have, what can we transfer into that? How can we do that? Where does it make sense?" So that's what the study did.

We were doing that basically under the auspices of Brigadier General Don Kutyna in Los Angeles. He was funding this study. So he was basically my boss for that program, because I was basically acting like a contractor with a contractor team, and we were delivering him a product. So that was an interesting program because I had worked with the Air Force very closely on Mercury and Gemini, and really had been, since the Gemini Program, a little bit in the flight software, but then this one was basically going out to meet with them, to review progress. Then they said, "You know, we have something."

They called the Center outside Colorado Springs the CSOC, the Consolidated Space Operations Center, because in addition to flying the Shuttle, planning and flying the Shuttle out of the Shuttle [Operations and Planning] Center, [SOPC], they were going to have some satellite operations out there, because then when they became aware that the Blue Cube in Sunnyvale was vulnerable, they thought, "You know, it might not be a bad idea for our critical spacecraft to have a backup satellite control center here in Colorado, because it will

be a Class-A secure facility. It will be in an area where there's not a threat of earthquakes. It's a fairly safe, reliable facility, so why don't we use that for the backup."

So this concept of CSOC was what the whole thing was called. What was kind of neat was, I got in on the ground floor of actually sitting down with the floor plans and the layouts to several buildings out there, saying, "Okay, you're going to need this amount of space to have your Mission Control computers. If you have a Shuttle mission simulator, you'll have this amount of space, and it's got to be two stories high," and so forth. "If you've got this, you need that." So it was sort of laying out with the engineering and architecture firms out there the way these buildings are going to be laid out.

So the aspect of that was laying out what that Center would be, also what the equipment would be, and so forth, so they would get a feeling for that. It was sort of interesting, they had a Air Force steering group for this CSOC formed at the orders of General Henry, who ran the Los Angeles organization of the Air Force, the Air Force Space Development organization. He said, "We need a steering group and I want people not only from my organization, but I want other parts of the Air Force. For example, they're going to be training there, so we want something from Air Training Command. There's going to be logistics and supply problems. We want some people from the Air Logistics Centers. There's going to be operations and tests, so AFOTEC [Air Force Operational Test and Evaluation Center] will be there. And, oh, by the way, we've got a guy from NASA who's working for us. He ought to be on the steering group, too."

Well, it turned out that the steering group, they made the rules and regulations, they said it would only be full colonels. So they said, "What's this guy Cassetti?" "I don't know. He's a civilian." "What is he?" Well, turns out I was a GS-15. A GS-15 is a colonel equivalent, so they said, "Okay. Boy, that's great. Otherwise, we don't know who we'd get." [Laughter] So it was kind of funny. Everybody was calling me up and saying, "If it's not too much to ask, what grade are you?"

So it was a fun time. I spent a lot of time traveling to different Air Force locations, and sitting through some long meetings, but we got a lot of work done. I think we gave them a good product in which to proceed.

Now, unfortunately, there was some undercurrents. There were a lot of people in the Air Force that were not wild about flying on the Shuttle, so there was a certain degree of an anti-Shuttle movement within the Air Force, that, yeah, they'll sort of go along with it, but first chance they get, they'd cut and run.

There were other groups that felt like the Air Force didn't need their own planning and control center, they could use the NASA facilities. They spent the time and the money to secure some of the facilities that were necessary. That was contrasted between the group and the Air Force that wanted an autonomous operation. They didn't want to be tied to NASA. They wanted to be able to plan and operate their own missions.

There was also an interesting undercurrent, because during this time Air Force Space Command was formed. They were formed in 1982 or '81, late in '81 or early '82. They really grew out of NORAD [North American Aerospace Defense Command]. NORAD is basically kind of a warning facility and, I think, was viewed by the Los Angeles group as, "These guys don't know anything about space. They're just radar operators." So there was a lot of that undercurrent, saying, "They don't really need it. If push comes to shove on the budget, that's a luxury that we don't need to afford. We can do elsewhere."

So, again, there was a lot of political undercurrents that were going on, and it was still proceeding relatively well. Some fits and starts. There were some problems with Congress funding it. There were a lot of contractors that were coming in and said, "Well, we could do this at half the cost of what NASA just told you. Just give us the contract and we'll go do it."

So we had to go out and do battle with those sorts of undercurrents, as well as—I'm trying to think, there was a congressman who had a big investigation going on, and I had to spend lots of time being grilled—interviewed, I should say—by the GAO [General

Accounting Office]. I think it was [Congressman] John [D.] Dingell [Jr.]. He was concerned that we had recommended the Air Force to use certain IBM computers that were going to be obsolete, and was making a big investigation over that. I got questioned pretty carefully on all that. Actually, the people from GAO were okay guys, you know. They were just doing their job. [Laughter] They said, "We don't pick our assignments. The GAO is asked by a congressman or senator to go investigate something they think is fishy, and you're the one for this week." There was a lot of fun, too, involved in it.

That was my last assignment with NASA, and that was in '83. I decided to take an early retirement from them. That was kind of an interesting. To close up the interview—I was working away, and we were in the last throes of working on the SPOPC, and I was enjoying it. Really, it was a very challenging, interesting program that I really enjoyed. So I got a call from a lady in Human Resources [at JSC], and she said, "I just wanted to let you know that you are eligible for this one-time early retirement, because NASA's got this manpower problem, and Congress has just passed something that allows us to offer an early retirement without certain penalties." In my case, I couldn't have retired before I was age 55. I had to wait till age 55 or I couldn't retire, even though I had the number of years of service. So they said, "Because you have the number of years of service, they're waiving the 55 requirement." So I just want to let you know.

I said, "I'm having too good a time with what I'm doing now. I'm not interested." So I hope I wasn't rude, but I may have been. I got to thinking, the rest of that afternoon, I said, gee, I never thought of that. So I called the [lady] back and said, "Just for grins, what would you pay me not to come in to work?"

Then she said, "Well, let's compute it." So she said, "I'll call you back tomorrow."

So when she called me back, it was really a tempting situation, and so I said, "Well, what if I decide to do that?"

She said, "The good news and bad news. The good thing is you're being offered this, but since we're just getting around to calling you and the window for all this shutting down is week after next, you've got to tell us before the end of the week, yes or no, and you've got to be out of here before the end of the next week."

So that was—oh, God. You mean I can't think about this? So anyway, I made a snap decision. I said, well, it's something maybe I should do. And I don't regret it whatsoever. But it was within just a few blinks of the eye, I was out of there. I just had enough time to find somebody to give the rest of this SPOPC to.

I'll never forget, there was a colonel who was the Air Force liaison at JSC, and he was one of the first ones I went up to talk to when I told him, "Hey, I just turned my papers in, and I wanted you to be the first to know, because you're probably going to be the one most impacted by my leaving. I'm trying to find somebody else," and so forth.

He said, "You can't go." He just really did everything he could to twist my arm.

I said, "Okay. Now, you're a colonel. Now, I'm a GS-15 and they're supposed to be equivalent."

He said, "Yes, they are."

I said, "We learned that. Yes. Now, do you know that I have been a GS-15 for fifteen years? What if you were a colonel for fifteen years? What would you be thinking about?"

He says, "I'd be thinking about leaving the service."

I said, "Well, that's sort of the way I am. I figured I probably reached the limit of where I'm going to go, and maybe I should go do something else," which was not a bad decision, because my leaving the government, leaving NASA, really opened up new vistas. I found a company that transferred me to Colorado Springs. So that worked out very well for me. I really do miss working for NASA, but in a way I run into people who stayed on and said, "You know, it's just not like it used to be. It's not the days when we were all twenty-

year-olds and had the weight of the world on our shoulders. It's a different place." So I left it on a good note.

BUTLER: Sounds like you've had quite an exciting career with NASA and even after.

CASSETTI: Yes. Exactly. Yes.

BUTLER: I want to thank you for your time. It's been quite enjoyable.

CASSETTI: Thank you.

[End of Interview]