ORAL HISTORY TRANSCRIPT

DEAN F. GRIMM
INTERVIEWED BY CAROL BUTLER
PARKER, CO – 17 AUGUST 2000

BUTLER: Today is August 17th, 2000. This oral history with Dean Grimm is being conducted for the Johnson Space Center Oral History Project at his home in Parker, Colorado. Carol Butler is the interviewer.

Thank you very much for talking with me today and letting me come out to your home to visit with you.

GRIMM: You're quite welcome.

BUTLER: To begin with, maybe you could tell me a little bit about your background leading up to you becoming involved with NASA and the space program.

GRIMM: How far back do you want me to go?

BUTLER: Maybe how you got interested in aviation and aerospace.

GRIMM: I think I was raised on the farm with six brothers and a sister. When I first recall being interested in aviation was prior to World War II and I'd see airplanes flying over our farm every so often and had an interest on what kept them up there and where they were going. Then during the war, we got cards in our cereal boxes about identifying airplanes, and then we'd get

little devices sent in other cereal boxes on how to identify enemy airplanes and how to call in and so forth. So that was the very first interest I had in the aerospace industry.

Later, of course, after I graduated from high school I went to the University of Kansas. I originally enrolled in electrical engineering, but the Korean Conflict, as they call it, came around in '50 and I enlisted in the Air Force at that point in time. A lot of my friends were getting drafted, and I decided to choose my own branch of the service. Since I was still interested in aviation, they give you aptitude tests. During the aptitude tests they said I would be a good candidate for an aviation school. I think it was because they had a shortage of aviation candidates.

So I went through a nine-month airplane and engine (A&E) mechanic school in service. Graduating from that school, my grades and aptitude were such that they said I would make a good instructor. So they sent me to a helicopter A&E school and then to an instructor school. Then I instructed in that area for the remainder of my time in the service, except for a period of time when I went through pilot training in the service.

So coming out of the Air Force I was quite interested in conventional airplanes and helicopters and actually in having gained my pilot's license during that period of time, obviously. I came out of the service, and then worked for a short time with Boeing in Wichita on the line, working as a mechanic. I decided that there must be better things in life to do than to work as a mechanic, and so I reentered the University of Kansas after a five-year hiatus.

You asked as a question here, why I picked this field. Well, the reason why I got into aerospace or my aerospace degree was because my background in the service they gave me one-semester's credit. So in engineering language I said, "I are now an aero engineer, rather than electrical." So that kind of explains how I got into that field. Because at that point in time, my

age was such that I wanted to get through school as quickly as possible and get some gainful employment, try to make some money.

Upon graduating from K.U., I went to work for Convair, which is General Dynamics [Corporation] now at Fort Worth. Well, it's not even General Dynamics; it's Lockheed Martin [Corporation] now. I went to work for them as an aerospace engineer, flight-test engineer on the first Mach-2 supersonic bomber, the B-58 as a flight-test engineer where I was responsible for doing some of the flight planning and on the various flights on a couple of the airplanes I had assigned to me while they were flight testing.

As the flight-testing program wound down and it transferred over to the Air Force out at Edwards, I wanted to stay in the aerospace fields, so I applied for a position at [The] Boeing [Company] in Seattle. I had worked for G.D. for about a year and a half, I think. So I went to Boeing in Seattle and started in their flight certification area. But because of my interest in flying and the fact that our particular unit developed all of the initial charts and graphs and planning for the experimental flight testing that was being done to certify the first jets for airline use, the pilots over in the flight test area and the FAA [Federal Aviation Administration] pilot in charge of the Boeing certification activities asked me to fly with them and to sit behind them to give them the test points which they had to fly. Then later I would be responsible for reducing that data into certification data, which would then be presented back to the FAA for certifying that airplane for airline use.

So as a result of that I did a lot of experimental flight testing with various airplanes while I was at Boeing, hundreds of hours of actual flying experimental flight testing because the airplanes were experimental up until the point that they were given an FAA certificate. That data, of course, that we generated we used as guarantees to the airlines. They bought the

airplanes, and then we did route certification to prove the airplane could do what we said it could do. So that was kind of the background up at Boeing.

After about a year and a half, the work was starting to get repetitive, and I was interested in doing something more challenging so I applied for their supersonic work that they were doing at that time. They were proposing to build a supersonic jet aircraft. This was in '62. Just as Boeing was getting started, [Richard M.] Nixon [?] canceled the supersonic transport project, and I decided that there had to be some things of interest elsewhere.

So I applied at the FAA, Federal Aviation agency, in Oklahoma City, as an instructor, and I taught air carrier inspectors jet certification, air route certification, and all of the things that you do to certify an airline to operate out of airports and for route structure throughout the world. Each one of these air carrier inspectors is assigned to an airline to make sure that the airline follows proper procedures in determining their route structure. So I did that for two and a half years, plus was involved in accident investigations because early in the operation of jets there was a number of accidents.

So from an aerodynamics standpoint and from a certification standpoint, I was involved in that aspect of the accident investigations and actually developed the planning and flew a number of the profiles that duplicated the crashes, except for the final part.

BUTLER: Must have been hairy at times.

GRIMM: It was interesting, because the airplanes at that time, the engines were not what we have now. They were very low-thrust engines, and our thrust rate ratios on those aircraft were very marginal, like 1.01 sometimes. In some cases we had some near crashes while we were

doing some of the duplications of the accidents to actually see what was happening. This happened also at Boeing as well as at the FAA.

During the later part of my stay with the FAA, the Langley [Space] Task [Group] force had moved to Houston. NASA Headquarters made a decision to enlist the help of LBJ, [Vice President] Lyndon Baines Johnson, to move the Space Center there. One of my cohorts who had known me both at Boeing and at the FAA had transferred to NASA from Oklahoma City, and he called me and said they had some job openings there that he thought I might be interested in. So I rented an airplane and I flew down to Hobby [Airport] and went out to NASA and interviewed several people and was hired on the spot in a group which was called [the] Operation Support Section, which doesn't have much meaning as far as function is concerned.

But that particular section was set up to have a number of people who had piloting for flight-testing backgrounds to come in and actually work with the various contractors and NASA in flying all of their simulators and developing procedures that we were going to use for Mercury, Gemini and later on Apollo and Shuttle. So there was about six of us, and we went to LTV [Ling-Temco-Vought, Inc.]—we went to Grumman [Aircraft Engineering Corporation]—we went to McDonnell Douglas [Corporation], we went to [North American] Rockwell [Corporation], we went to the Navy, we went to the Air Force facilities to evaluate and to fly their simulations to determine which ones were good, which ones were not so good and also to start developing procedures for the various parts of each flight segment that were involved in, initially Mercury, and then later of course Gemini, the various types of missions we were involved in. In many cases, inputs to the design of the cockpits, control displays, navigation aids, software, hardware, instrument scaling and those sorts of things.

One of my very first tasks when I went to Houston—and we were not out at NASA at that time, our division flight crew operations division was in the Franklin Apartments there in the south part of Houston. My first job was to take the Apollo reference mission, at that time, which was a large stack of books and to look at the lunar part of the mission. At that time, even though we didn't know what the vehicle was going to be or look like, that I was to review the mission profiles and determine what kind of instruments that this lunar landing device needed for the translunar part, as well as the descent and the ascent and then to provide a scaling for all of the instruments that would be needed for that flight.

BUTLER: That must have been challenging, as you said, not knowing about the spacecraft.

GRIMM: That's right, but an interesting characteristic of my personality is that I have never, ever had a job or taken a job where I felt threatened. I always felt at ease because I said that if there was somebody in this job before me, I was sure I was just as smart as he was and that I could learn the job. If there had not been anybody in this job prior to me, then I had the responsibility to learn as much as I could to do that job.

I've always taken that approach on every job I had. It's always a challenge to me, and I enjoy those kinds of challenges. Some people get very nervous when put in that position, but I've never, ever been nervous in those kinds of positions. I love that kind of a challenge.

BUTLER: It's always good to be challenged.

GRIMM: I offered jobs after I got to NASA to a number of friends that had similar experience to me, and they said that the job that I had was too stressful. Of course the job was stressful. Everybody at that time at NASA had stressful jobs, but some people accept the challenge and then some people don't.

BUTLER: Each person is different.

How did you determine what instruments? What were some of the factors that you looked at to determine what would be needed?

GRIMM: You're asking me something that's almost forty years ago. But when you look at the reference mission and see the speeds that the vehicle is traveling after it separates from the command module—I said after it separates from the command module, but at that time, it wasn't decided that this vehicle was going to separate from the command module.

At one time we had a vehicle [design] that was called a Nova, which was about 500 feet tall, versus the Saturn V, which was 300 and some feet tall. The part that separated in Earth orbit went to the Moon, landed on the Moon, and came off the Moon and came back and then separated from the part that was going to land back in the water. So you had to look at what the characteristics of a particular part of the flight were and look at the velocities and look at your rates and look at your control characteristics and thrust levels that you had to maintain and what types of instruments that you would need to not only evaluate the situation that you're in but be able to control that situation at the same time. That's about as near as I can explain to you what we looked at, because there were very few numbers in this reference mission.

So after that project was completed, I and basically one other individual by the name of Ed Smith and Hebert Edward Smith was the person who had enticed me to NASA and then who I was with him in his group. We worked for a Captain Brickel who was the section head at that time, who is now a retired three-star general. I think he's up at Fairfax, Virginia, and has his own consulting firm as all those retired generals do.

So we ended up going to all these places that I previously mentioned, flying various types of simulations that the contractors had developed, determining whether those were valid. We looked at the visuals, we looked at the instruments, we looked at their procedures, to see how these things might be melded together to actually perform an operational function. Once we determined that there was an operational function to be performed with those procedures or with the simulator, then we would recommend that the crews then use those devices to gain some familiarity with what they were going to be expected to do in the future.

As they got closer to flight, we picked the systems that we thought provided the best capability. Of course the astronauts were quite capable in their own right of evaluating these systems and then we'd use those systems for functional training for the flights.

BUTLER: Would you make recommendations based on these different systems around the country devices that NASA should then build?

GRIMM: Oh, yes, oh, yes. We'd also tell the contractors what we felt needed to be done to improve their simulations.

Can you tell if I'm recording or not?

BUTLER: I believe you are.

GRIMM: Okay. I was just wondering here.

BUTLER: Yes. Everything sounds good.

GRIMM: I didn't want to be doing all this blabbing here and not have it recorded.

BUTLER: Oh, yes. The good thing about this [recorder] is it actually has two different reads, for both of our mikes on it.

GRIMM: Now the next question I had is do you want me just to go right on through to the projects that I did?

BUTLER: If that flows well for you.

GRIMM: Are you interested in those sorts of things?

BUTLER: Oh, absolutely, absolutely.

GRIMM: Okay. Because I could jump to major things like LLTV or the Gemini rendezvous or the first Shuttle payload that we developed in my division or a number of things like that.

Then subsequent to that in applying these simulations, I started looking at the Gemini docking because we knew that one of the requirements for the Apollo Program was going to be a rendezvous and docking somehow and someplace. So Gemini was put into the program specifically to validate the capability to be able rendezvous two vehicles in space and to physically dock.

At that time, there was a number of issues. One, we didn't have any rendezvous procedures that worked. Two, we had a docking training vehicle down in, I think it's 227, the big tall building, I can't remember now. I think it's 227, 225, down on the north end of JSC. The whole building inside is painted black, and we had the Agena on rails that would go forward and aft. Then we had a Gemini cockpit that would go left and right, up and down and pitch and roll and yaw.

One of the things that I did was to do a handling quality study with that docking trainer because at that time we hadn't really decided what characteristics we needed in the control system to allow us to control the Gemini space craft adequately and to dock with the Agena vehicle, which was a passive vehicle, and stabilize with that.

During this exercise, we did a handling quality study and I used Wally [Walter M.] Schirra [Jr.] and Gus [Virgil I.] Grissom and several others of the first seven astronauts including myself and one of our other pilots in our group in our section. We actually did a handling quality study and used the Coopers Rating System, which is a system that pilots use to put numbers on a system on how well you can control a device in certain—as you vary the characteristics of a control system, you get a different feel for how the vehicle is controlled, and that's called a Coopers Rating, and you can just assign numbers to it. You always like to have high numbers. Anything above a five is nice. Anything down towards zero is unstable.

So we did a handling quality study there to define rate command, attitude, hold, direct, breakout forces, the jet logic, cycling of the jets. I can't think of the word I want to use, but it's the on-off characteristics. I guess maybe it's cycling. Anyway, we defined the characteristics that we felt were good and then we provided that to the manufacturer to put into the software and to the hardware because the hardware was adjustable and the software could be changed as well.

As a part of that study, I found that first of all the docking light—we had an acquisition light which was a flashing light on the Agena, which you could see from far off. It's like an aircraft flashing light that you see at night flashing. But once you got up closer to the vehicle, they had a light in the cone that lit up the cone, but in space that cone was so bright that it just blinded you with the reflection. We had a COAS optical sight. The COAS means Crew Optical Alignment Sight, which is an infinity focus device where you look through it but the reticle pattern that's inside of it is transposed to the target so that the target and reticle pattern look like they are superimposed on one another in the infinity focus device. That way there's no parallax and your eye doesn't go from looking at the actual thing right in front of you to the target, which was the Agena way out in front of you. They all look like they are at the same point.

It turned out that the COAS was not designed properly so I took it upon myself to redesign, with the manufacturer, the COAS and the reticle pattern and the lighting in the [Agena] cone so that the crew—we redesigned it so that the crew did not see an apparent difference in the brightness between the reticle pattern and the vehicle he was looking at. We also adjusted the lighting on the Agena so that we didn't have a glare there.

Then the last thing I did was there was no reference to the vehicle, and you couldn't tell whether the vehicle was pointed up, pointed down, pointed sideways. All you could see was the

cones. So I recommended to my division chief, Warren [J.] North, who I have a great deal of respect for. He's kind of one of my heroes at NASA, always was. I don't know whether you've interviewed him or not.

BUTLER: We have.

GRIMM: He's a very interesting individual, and I love him to death. He would probably be embarrassed if he heard me say that.

BUTLER: We had a good oral history with him.

GRIMM: Good. I'm sure he had a lot to offer. If he didn't, then you were shorted.

But I told him that we needed something on there like running lights that we have on aircraft, and he agreed with me. So I then instituted a lighting study. I had a mockup built of the Agena and we put it on a trailer and we picked the time before the new moon when we had no moon on the backside of NASA. There used to be a road down there along that fence, but I think there's a highway there now. I and another engineer went down there at night, and I put little lights with LEDs out off of a computer, an old analog computer. Took those lights and put them at the appropriate places on the vehicle, front and back. I put green on the right and red on the left and orange on the bottom, front and back, so that you could not only see the orientation of the vehicle, but be able to as you were coming up and rendezvousing with it in the real case that you could tell what your orientation was to the vehicle and be able to know your velocities out and then have a perspective in terms of depth or distance from the vehicle so you could

actually slow your approach speed down to a reasonable level so that you could come down and actually engage the docking cone and dock. So that was another little project that I had that I enjoyed.

Actually I did the same thing again on Apollo, because we had [another] COAS [with a different problem] and COAS problems. In addition to that, we didn't have a good docking target. So I worked with Grumman initially and then with [North American on] Apollo to develop a—and I actually did the design of that docking target that we used on Apollo, the target itself and the same amount of work on the COAS so that the crews could accomplish the same thing, the docking part and the rendezvous part. My lighting, my little lights, were carried over, except in this case we got a little more sophisticated. We had a contractor this time, used little LEDs, and because if you put the same power into an LED, red, green and yellow have different intensities just because of the spectrum. To tell you the honest truth, I've forgotten which is which now, but at the time I knew.

They put the proper number of LEDs in each color segment so that each one of them would have the same intensity when looked at by the crew. We put those on on Apollo. As a matter of fact, on that docking study back on Gemini, I found that we needed a light when we got up close on the Gemini. So I came up with a light that almost looked like an old fender light off of a '37 Dodge, and I forget what it actually came off of. I think it was a wingtip light off of an aircraft that was modified and put on the top of the Gemini OMS [Orbital Maneuvering System] system, not the Gemini itself, but the OMS capsule behind it that it was attached to. Put it right up over the pilot's head so that when we got close to the Agena that he could turn that light on have an even better perspective.

That worked out quite well. The little running lights, the docking lights, the overhead lights, worked on Gemini so well that we did the same thing on Apollo and developed these lights and had them installed on Apollo because as it turned out the command module [CM] was going to be the passive vehicle in orbiting the Moon and the LM [lunar module] was going to be the active one. So with those lights on there, and then if need be in an emergency, the pilot in the command module could, with these lights and so forth, dock with the lunar module because the lunar module didn't have lights on it as I recall. Now I could be mistaken about that. That's been so long ago that we put lights on there, but I don't think we did.

BUTLER: That's something we could look into.

That's interesting. There's so many pieces of all of this that had to come together to make everything work. Lights wouldn't be a normal thing that you could think of right offhand as a critical requirement for going to the Moon, but yet it did play such a big role in the docking and making it successful.

GRIMM: All these little things add up.

So I think that was one of the things. Of course, one of the interesting things I found out about it is where Rockwell had put the target on the—or the target was put on the—they actually put a target in the lunar module—I mean in the command module, so that the lunar module could dock. It turned out that somebody had miscalculated the angles and so if they were lined up exactly, the COAS, the reticle, with the—I don't know if you've seen the target.

Have you seen the target?

BUTLER: Yes.

GRIMM: If you've seen the target, if they were lined up perfectly and they tried to dock, the docking cones were misaligned. So it took me quite a while to convince a certain contractor that they needed to correct this. So I actually proved to them that they were wrong, and finally we did reorient the targets so that we did have a match.

BUTLER: Very important consideration.

GRIMM: Right. So that we could actually get a hard dock and latch.

During this time, Captain Brickle had left, and I was given the section by Warren North. When I came to NASA, one of the first, along with some of these other things I was doing, the LLRV [Lunar Landing Research Vehicle] project was coming into being between MSC [Manned Spacecraft Center, Houston, Texas], now JSC [Johnson Space Center], and FRC [Flight Research Center, Edwards AFB, California] now Dryden [Research Center], and [NASA] Headquarters and Bell Aero Systems Company. I'm not sure how I was picked, because there were several other people that had similar backgrounds to mine, flight-test background, airplanes certification, and so forth.

But in any case I was given the project and said it's mine and I had it from almost the time I came to NASA within three or for months until '69, from '63 to '69. I was the program manager during that period of time for the RV. Then the RV was passed off to the operational group at Ellington [Field, Houston, Texas] after I had set everything up, and then I was the program manager on the LLTV [Lunar Landing Training Vehicle]. Then we had the accident

with Neil [A.] Armstrong, and then I was brought back into the picture after that. I had the program again totally until right after the lunar landing. But that's another subject. I'm just saying that was another task I had.

BUTLER: Actually, while we're on that, maybe we could talk a little bit about some of the details of the LLRV and TV. What were some of the differences between the two?

GRIMM: There was a lot of differences between the two. They looked almost identical. If you were to go out to Dryden and look at the FRC, or the LLRV they have hanging up out there, and I guess the other one [LLTV] is in the lobby of Building 2.

BUTLER: Building 2, right there by the Teague Auditorium.

GRIMM: You'd think the vehicles were almost the same. The structure looks the same, but it's different. The cockpit is totally different. The engine has changed. The avionics were completely changed. The amount of actual lift rockets on the vehicle from the RV to TV were changed. All of the instruments were different. The hand controller and the T-handle were from the lunar module and not from model shop rework, because those were Gemini controllers that I got, actual ones for the spacecraft that were flew on.

As I told the gentleman here the other day that was interviewing me for the LLTV because he's writing a book on the LLRV/TV, I told him I either lied then in '71 or I'm lying now, and I don't know which, because I told him the hand controllers that were used on the LLRV 1 and 2 were Gemini VI and VII flight controllers. In my interview with [Ivan D.] Ertel,

I said they were off of VII and VIII flight vehicles, which that's probably more correct since that was very shortly after the program that I did that interview with Ertel.

BUTLER: I'm sure that's something that we can find in the records somewhere.

GRIMM: The ejection seat was upgraded. We put a top on the vehicle and then later cut a hole in it. Our avionics were completely different in terms of their functionality. The jet logic—the RV was designed basically by FRC to conduct handing qualities, to determine how a nonaerodynamic fly by wire vehicle could be controlled. As a result, their main emphasis was on handling qualities and with some considerable amount of thought on how those handling qualities could be transferred to a lunar vehicle if there were going to be one, which at that time hadn't been defined.

So they built in some variability. So they basically wanted to do a variable stability handling quality study, which they actually did. But as we got further downstream, the Apollo Program translated from a Nova type vehicle to an Apollo type vehicle with a lunar module or a LM as they called it at that time. As a result, we knew that it was going to be a smaller vehicle, and that it was going to separate from the Apollo command module in lunar orbit and that it had to have certain handling qualities to go down to the lunar surface and certain handling qualities to come back because it was being staged from the descent stage.

As a result of the initial definition as a lunar module, and then I began to get some appreciation for the masses of the LM, and it's moment characteristics, if you're familiar with that. We're talking about the inertias, the moment of inertias, about each one of the axis, the pitch, roll, and the yaw axis. Once you gain an appreciation for that and you're trying to design

a vehicle to train the crews in 1G gravity, to have that vehicle fly like it's in 1/6G gravity, which you'd be in and around the Moon, and then to have this vehicle that was going to fly in Earth's atmosphere fly with the same control characteristics—at that time we didn't know what all those characteristics were going to be. So I had to build even more variability into the control system than FRC had.

Of course the lunar module had fore and aft RCS [Reaction Control System] jets, one right up in front, one in the back and one on each side. The LLTV, and the RV in that case, had it on left right on each side of the cockpit in front and left right on each side in the back. So we had to devise a different jet logic to control the vehicle, even though their thrusters on the LM were fore and aft and off to the side and ours were here and here. So we're off forty-five degrees in terms of when you fire a system, you've either got to fire in pairs, where they fired front and back, we'd fire two off over here and two off over here [Grimm gestures] to give you the same pitching roll as an example. Then we put a set of backup thrusters on just in case we needed those or needed the extra thrust in case of a problem in training.

So those were the major differences. We had differences in tankage. We had differences in the engine. We had differences in the Doppler radar, radar altimeter, our instruments. Ejection seat structure was something different. Avionics were certainly different. Jet logic was different. Of course since we were using the LM hand controller and the modified T-handle, represented the thrust and weight control for the descent engine, we ended up having to have all of those characteristics in our avionics that would allow the crew to control the vehicle as if he were in the lunar module in the 1G environment.

In order to do this, we had various modes on the LLRV/TV that would allow the engine to gimble. We had an auto throttle on it so that we'd weigh the vehicle at a thousand feet in the

air and we'd stabilize it there. We actually had a weighing capability to weigh it itself. Once it weighed itself, it would throttle the engine to 5/6ths the weight of the vehicle.

We had drag compensation so as we started going forward it would take out the drag of the vehicle to make it as if it were flying in a vacuum, as it would on the Moon. Then it would go into the lunar simulation mode where the vehicle would accelerate up to a certain speed, go into the lunar simulation mode, and then the engine would start gimbling and then the crew would be using two 500-pound rockets on each side of the engine gimble to represent the descent engine. Then he would control that descent engine with his T-throttle and control the attitude with the actual LM controller that I had modified and put in the vehicle.

He was looking at instruments at approximately the same angle as he was looking at them in the LM because I had the instrument pedestal moved over. Of course, the RV had a collective stick, a center stick and rudder pedals, initially. I finally had them get rid of that and do the last part of their studies with the Gemini controller that they'd modified that I'd gotten from either Gemini VII or VIII and a modified T-handle for the descent rockets that we had on the vehicle.

Then later, of course, we had a Pitot tube probe with the wind direction and we had an anemometer on top for velocity because of the accident, I should say, that caused that.

So when you get down to it, there are more differences between the vehicles than similarities. The only similarity is that from an uninitiated viewpoint they look the same. Does that give you a–

BUTLER: Oh, absolutely. That's very interesting that they were so different, because like you said people do assume that there are so many similarities.

GRIMM: See, the FRC was doing one thing, which was great because it gave me initial data on the vehicle. But then I had to do something else because I was told to make a vehicle that flew like the lunar module.

BUTLER: Quite a challenging bit of engineering and planning.

GRIMM: In the whole program there was only two people from NASA on this program, I and one other guy.

During this time, I had either the operation support section or the operation support office, I forget what it was called. The operation support office, and then I had other people that had teams that I supported the crews with. We did the man rating on the two altitude chambers, the first crews that went in there, and actually man rated that chamber with Apollo spacecraft and the lunar module. We had responsibility for the design of the crew station on the command module, and then I had an assistant manager that was responsible for the design of the crew station on the lunar module.

Then at the same time, I had responsibility for the neutral buoyancy facility, the air bearing system, and all of the mockups and trainers. So maybe that's digressing a little bit.

BUTLER: It's good because it shows you had so many things you were focusing on at the same time and each of them had different levels of importance and all played a very vital role.

GRIMM: They were all different. Very different. So we sort of jumped there.

I think that one of your questions here was discuss my work with the operation support section. I think I pretty well covered that in terms of flying the simulations, the lighting studies, the mockups, the docking and rendezvous things, the COAS study, the handling qualities study, defining the scaling of the instruments for the lunar module, and at the same time I had the LLRV/TV project and I was the program manager during that. I was responsible for the budgeting, for the direction of the program, for getting the vehicles built, for the facilities that we ended up with at Ellington.

BUTLER: What were some of the challenges? Obviously, budgeting would have been a challenge at the time. But what were some of the receptivity from astronauts and from others around NASA?

GRIMM: I think the astronauts initially weren't involved in it. I think the big pusher on this was Dick [Richard E.] Day, who was my assistant division chief boss at the time, and Warren North and [Robert R.] Gilruth. When FRC, Flight Research Center, and Paul [F.] Bikle came, who was the director out there at the time, came to talk to Gilruth about this after they'd received Textron's, which is now Bell [Aircraft Corporation], proposal, or vice versa, I'm not sure. Textron, I guess, owns Bell.

But [NASA] Headquarters had seen the proposal and they said, "We don't know what to do with it." They sent it to FRC. FRC liked it, but Headquarters wouldn't give them any money because it didn't pertain to the program. So they came to MSC or JSC at the time, and Warren was interested in it. Neil Armstrong had been selected shortly after that time. Gilruth and FRC convinced, maybe not convinced but saw a mutual interest there with JSC. So JSC

then, Warren and Gilruth went to Headquarters and said, "We'd like to have some study money to have Bell study this more and define the vehicle."

Originally the pilot was sitting on top of the engine. There was no cockpit sitting out in front, and the avionics were—in other words, this was a pyramid. After a while, in figuring out where CG [center of gravity] was, this vehicle flew better upside down than it did right side up. So to get everything back in a proper perspective, Bell moved the cockpit out in front and all the avionics and some tankage to the back to balance the CG. Then even there, we had to put weights on the legs in various positions to balance the crew weight and the vehicle because the crews weigh differently. If you took somebody like Neil [Armstrong] and somebody like Jim [James A.] Lovell, there's probably thirty, forty pounds difference in weight there, this vehicle was very sensitive to that.

So we either move the avionics to the back of the vehicle, back into the side, we could move forward and aft, and left right, and if we couldn't get all of the adjustment to keep the CG in the right spot, because it had to be in about a one-inch spot, that we put weights on the legs to do that with shot bags.

I think I digressed here, but, from some question.

BUTLER: We were just talking about some of the challenges and some of the reactions to the—

GRIMM: Oh, as far as what their thoughts were, I think once they started seeing the concept of the vehicle, and then having the vehicle built, and then seeing its characteristics, one of the interesting things that came out of the FRC flights and the studies were that they had almost no feeling for the attitude of the vehicle.

You fly a conventional aircraft, you have reference with the nose and the wings and so forth in terms of your attitude and to some extent your deceleration rate and you descent rate and so forth as you come in to land. You fly a helicopter, and you still have a fairly good visual reference, and less, maybe, of a pitch orientation with a helicopter, especially if you are sitting right out in front on some of the helicopters. Some helicopters that have a long nose, you would have a better perspective of pitch. A helicopter has a much more apparent angle as it's approaching a flare and then landing vertically, which is what we are going to have to do on the lunar surface, because we can't just go coasting along like we would on an airplane and put our wheels down and land. We might end up in a crater, we might end up on top of a boulder, so we have to basically come down vertically, and know all of our velocities and then the last ten or fifteen feet come down vertically knowing all the residual velocities.

One of the things that they found out very quickly was that in flying the RV out, when they were in the lunar simulation mode and they were buzzing along as if they were over the lunar landscape in a descent and they decided there's a spot that I want to land at, the first thing that happened to them is that they were long past that spot before they could get stopped. The reason why is that you have to have six times the attitude here. You're one-sixth gravity, so you have to have approximately six times the attitude in terms of pitch, with these rockets firing to decelerate you and to null out that forward velocity.

The pitch attitude was very hard to define by just looking out the window of the LLRV and it was on the lunar module as well. That's one of the first things that Neil came and Pete [Charles Conrad, Jr.], both came back and said, "It's good that we have the LLRV/TV to fly because we would not have appreciated how high we had to pitch to null out forward velocities in order to sit down in a particular spot," because you had to think a long ways away and you

had to start the action a long time. Then you had to wait a long time for the deceleration to occur. If you didn't have the pitch attitude, you just had to keep cranking it up to null out that velocity.

BUTLER: It must have been rewarding for you to see that it was so useful.

GRIMM: Yes. Neil said that. It was very comforting to find out that the lunar module flew quite similar in terms of attitude, in terms of handling characteristics as the lunar landing training vehicle. Of course, that's one of the satisfactions that you get personally as a reward other than some little medal that somebody might pin on your chest and say "Good boy, Dean." It's something that you remember long after you're gone from the program. It's something you feel very proud of that you did even if nobody else knows, or very few people know that you did it.

BUTLER: It certainly is something to be proud of.

GRIMM: I don't know whether I've covered your question or not.

BUTLER: You've covered it pretty well.

GRIMM: There are a lot of other subtle differences between the vehicles as well, but I think those were the major things. The major thing that was important to the astronaut was the recognition of the attitude and that they had to refer to instruments rather than look out the window because you really couldn't judge your pitch by looking out the window. The second

thing was to crank up a good pitch angle and hold it and wait to see what the response was as you were descending to the lunar surface to null out your velocity.

In Neil's case, he got down fairly close to the surface and was horizontal, stopped his descent and flew along horizontal just above the place where he was getting the dust cloud because he could see places where he didn't want to land since we was horizontal now. Then rather than have to pitch the vehicle up, it wasn't much of a pitch then to stop the vehicle because he was only going forward at a few feet per second at that point in time. So he could pitch it up at a relatively benign angle and stop his velocity and then set down, which he did with maybe ten seconds' worth of fuel left.

BUTLER: Did you follow the landing very closely? Do you remember where you were?

GRIMM: Oh, yes. I wasn't there. I had told Deke [Donald K. Slayton] that since I had spent the last two years prior to the lunar landing almost totally dedicated to that vehicle, plus some of these other tasks that I had, I was usually out there twenty hours a day, seven days a week for two years because there were always problems and there were always decisions to be made. We had accidents and we had to put a third vehicle in the wind tunnel to determine what our real problems were. There were always electrical and electronic bugs to fix, things that we couldn't imagine happening on the vehicle but it did; such as, the system always switching into backup at certain times when we were flying it. We had no idea why until we finally wondered if that big search radar that Ellington had was causing us a problem. So we had telecommunications division come out and set up a system to measure the electromagnetic pulse we were getting

from the search radar. Sure enough, when that thing was pointed right at us, in flight or on the ground, it would switch our electronic system.

If you believe the readings, everybody out there was sterile.

BUTLER: Well, that's not quite so good.

GRIMM: Because the energy was so strong. What we got the Air Force to do with some cajoling was to turn the radar system off or point it in a different direction and leave our sector clear while we were flying the crews out there. But that jumps ahead quite a ways from your list of questions, if we want to take things in order.

BUTLER: Sure. We can go back. It all seemed to flow logically there, so that's all right.

GRIMM: There's probably some other things we could talk about on the project, but—

BUTLER: Sure. Well, we can always come back to it, too.

GRIMM: You have my orbital rendezvous work with Buzz [Edwin E.] Aldrin [Jr.]. That's a long story. The one thing I'll say about Buzz is that he could come up with more ideas in five minutes than would take me twenty-four hours to shoot down.

He had a lot of good ideas, and some we incorporated into the orbital rendezvous procedures. Buzz wrote his Ph.D. thesis on orbital rendezvous when he at MIT [Massachusetts

Institute of Technology] before he got selected as an astronaut. So that's why they always called him Mr. Rendezvous, if you've ever heard that statement.

It's interesting that Buzz, I don't know how widely he admitted this, but he admitted that after working on the actual orbital rendezvous with me and others during the Gemini spacecraft flight, that he found out that his thesis was wrong, or at least some parts of it were wrong. [Laughter]

BUTLER: It's always a learning process.

GRIMM: I'm sure it is. I'm sure a lot of those Ph.D. theses aren't as meaningful as probably the one he was working on, too. But it's an interesting story about how I got to be working on orbital rendezvous.

I had been flying simulators, and at that time I was flying a number of simulators, both at JSC and elsewhere, on the lunar module simulators or simulators duplicating lunar module characteristics for rendezvous. It was a very crude approach that a number of people were using for rendezvous, and you could maybe only rendezvous maybe once in twenty times and then it was by brute force if you had enough thrust.

On the Gemini Program, it was mandatory that you have an orbital rendezvous on Gemini and if we were going to have two vehicles separate and get back together again on the Apollo Program for the lunar landing. We were six months away from Gemini VI and we didn't have any orbital rendezvous procedures that worked. The simulator there at JSC cratered every time that it tried to rendezvous. Another one at JSC worked part of the time. There

weren't any manual backup procedures to ensure rendezvous if the automatic system had errors in it or did not work.

After flying some of these simulators, I went to Warren North and told him that—well, I'll be nice to some people here, but basically I told him it was a bunch of crap. He said, "Well, what is your recommendation?" I said, "Well, McDonnell Douglas has got a good engineering simulator up there, and I know the people. One of the boys is a good K.U. graduate with me, so I know him, and some of the other guys I got along very well with." This is not to disparage anybody at JSC, but some of the engineers in the simulations group were not engineers per se that were interested in how orbital rendezvous occurred. They were interested in making their simulator work as a simulator, big difference.

I had tried to get the mission operations director division, and they had some good guys over there, and FOD [Flight Operations Division], that I got along with great. But their programs, I wanted them to run programs backwards. When we started rendezvousing from a different orbit and at a distance behind the Agena or any vehicle, you can do certain things presumably to try to do your rendezvous over a period of so many degrees.

A better way to do that is start from the vehicle, have them together and then run the thing backwards and find out where you end up with so that I can make a departure velocity and see where it put me here so that I could see what my corrections were in between on the orbit. They could not do that at JSC. But they could do it on the engineering simulator at McDAC at St. Louis [Missouri].

So I told Warren that I thought that somebody should go up there and run a bunch of these trajectories and find out what the variability was in terms of thrust intervals and increments of velocity inputs or subtracted to put you in the proper position at your correction

points so that you ended up where you needed to be in order to rendezvous with the passive vehicle.

He asked who I suggested, and I kind of shrugged my shoulders. He says, "You're it," about like the LLRV/TV. So I went to MCDAC at St. Louis. Well, first of all Warren went to the program manager who was [Charles W.] Matthews at the time, told him what the problem was. Matthews agreed that if there was this problem, it would probably be a good idea if we put some more work on it. If Warren had confidence that I could come up with something meaningful that it was worthwhile to do that.

He was the Gemini Program manager. He called MCDAC and told them to turn their engineering simulator over to me to do what I wanted to do. So for the next three months I was at MCDAC in St. Louis. We did a number of these engineering runs, and as a result, a number of changes were made to the rendezvous concept. One was that the distance was changed. If you have a delta-H, which is the altitude between the Gemini orbit and the other orbit, if that delta-H is too small here, the trajectory that you have when you're trying to orbit with it, it doesn't take much to miss the upper orbit at all. You want a reasonable intercept angle to get there. If you have too big of an H, you can have a good intercept angle, but you can be either way ahead or way behind. So you have to pick the proper orbital transfer, it's called omega-T. That orbit distance is the orbit from this vehicle is here and you're down here in a different orbit, and you pick that delta-H and this transfer angle that you travel while you're going up in altitude to intercept the vehicle at a reasonable angle so that you can have a very small miss. The reason why you want a very small miss is because you didn't have very powerful thruster on the Gemini's own system, which would allow you to null out large errors.

So as a result of that we changed the delta-H, which was the altitude that we put the Gemini into trailing the Agena. The delta-H was the difference between the two orbits. We also changed the angle between the two from the time you started the initiation of the orbital transfer for rendezvous to the time you caught up with it. We changed that. They had some other things in there such as platform alignment, where halfway through the rendezvous you bring the vehicle down to local vertical to do a platform alignment for fifteen minutes and during that time you don't know where the hell the Gemini is and if you don't get a lock back on, radar wise, you're SOL.

So I eliminated that by proving to the powers that be that the error that we incurred by not aligning that platform during that thirty-minute period for rendezvous was negligible in terms of the amount of thrust it would take to null out that error and fuel that it would take. As a result of that change, we were able to look at the vehicle all the time, both with radar and with the acquisition light that we talked about earlier.

Now this acquisition light that we put on there was bright enough so that as they translated into darkness they could actually see that light blinking. We picked the intensity of that light such that we knew what the distance was and we picked the intensity so that we felt reasonably sure with a little dark adaptation after entering past the Earth's limb where it was dark and there's a little period of time there where you have a gray area. But after that point in time, they should be able to see that acquisition light. That was the whole intent of having it on there. Then, of course, as they approached closer, within a mile, then they could see the cone, that we adjusted the lights in the cone and then a little bit later then they could see the running lights that I put on the Agena to figure out what attitude it was in compared to them so they

could null their velocities up and then come under it very slow and close without having to worry about big orbit adjustments.

During that period of time that we were up there, I had started this. Buzz came up and he was a big help along with a hindrance because he'd come up with some ideas that were just off the wall. It would take me, as I said, twenty-four hours to shoot down something that he thought up in five minutes, because I'm certainly not as sharp as Buzz in that area. Orbital mechanics was not my forte to start with.

But between the both of us, I came up with a set of manual procedures so that in case we lost the platform, that in case we lost the radar, that in case we had nothing but the stars to go by, I guess there were four different sets of procedures that I developed, where it would allow the crew to actually be able to rendezvous.

Of course the key to this was the automatic system was supposed to rendezvous by itself, with the crew putting the thrust in and reading the gauges. But no one had a lot of confidence in that, and there was no way to backup the system if it failed. So I developed all the backup procedures, and actually working with Tommy [W.] Holloway, who is now the ISS [International Space Station] manager, or whatever. He was responsible for developing flight manuals for that particular mission. Working with Tommy, we developed the actual flight manuals for the crew. While I was up there, we brought in two sets of crews. We brought in Schirra and [Thomas P.] Stafford and actually trained them on all the procedures so that if any one of these four things happened, that we could still make a successful rendezvous. We also brought up the backup crew which was Grissom and—[John W. Young]

BUTLER: I don't have that. I can look that up and we can put that in.

GRIMM: I think it was Grissom and somebody else. Actually, for a short time we had [L. Gordon] Cooper and his crew [Pete Conrad] up there, this was Gemini IV, while I was doing this. This was like six months I went up there before the launch, and they [James A. McDivitt and Edward H. White II] were just getting ready to fly their flight.

It didn't surprise me that Gemini—you asked the question in here, was I surprised about Gemini IV? No, I wasn't surprised that they didn't accomplish their rendezvous, because they hadn't been trained and they didn't really understand the mechanics of rendezvous. It really wasn't their fault, but it's unfortunate that somebody hadn't picked up the gunny before, but that's kind of the way things were. Everybody was pressed to do certain things. This was one of the things, even though it was very, very important, not only to the Gemini Program but to our whole space program, it was falling down the crack.

BUTLER: You mentioned that Cooper and Conrad were able to come up and do a little training before their attempt with the pod?

GRIMM: They didn't do any training. They came up and looked at what we were doing at the time, but theirs was in a different situation because they pitched this, as I recall, a ball out of the nose of the Gemini, or out of the back.

BUTLER: I think out of the back, yes.

GRIMM: I believe out of the back. I'm not sure how far away it went. I think it was a mile or so, as I recall. Then they were not able to get back with it. They just flew around it. Of course, if you think about it, if you don't put your thrust vector in the right spot, the only thing you will do is just continue to make bigger circle until you run out because if you were nose to nose and you apply thrust to this vehicle, what you do is you increase the velocity of that vehicle. When you increase the velocity of the vehicle, it moves up.

So a lot of times when they were thrusting toward the vehicle, they should have been thrusting away from the vehicle, theoretically, which would have brought them down at a lower altitude and then they would have closed in on the vehicle. But it seems simple now, but it wasn't so simple then.

BUTLER: Nobody had done it before, and they were used to traditional flying in the atmosphere. Very different.

GRIMM: So the crews, Wally and Tom, and the backup crews, both trained with the automatic system and with the backup procedures that I developed and with these changes in the techniques in terms of the omega-T the delta-H, the not aligning the platform. Again, here's where the COAS change came into effect, you know, that I talked about, the running lights, the docking lights. They kind of all work together in happenstance, I should say, to accomplish that. Astronauts responded very well to it. I had zero problems with it and they were enthused about it.

You say here, what technical problems did the rendezvous training present? It wasn't the training that presented any problems, because the guys were always there. I'd work with the

engineering people after the crews left at 6:00 o'clock at night, and I'd be there until 4:00 in the morning. Then I'd go home and sleep for four or five hours and then be there about 8:00 to 8:30, and then they'd come in about 9:00. Then we'd start working with the procedures that I had developed overnight. That's the way we incrementally trained the crews.

The biggest challenge was that there was a gentleman at Headquarters who had guidance and control division. He found out what was going on and he raised such a stink with the Headquarters director that they came down to JSC and had a meeting with Matthews, and he and the Headquarters director of the Gemini Program. Warren and I came in from MCDAC and with Wally and Tom, Wally Schirra and Tom Stafford. They had this big meeting about whether my rendezvous procedures were any good or not. He said that my procedures had been done empirically, i.e., do one, if it didn't work, do another one and figure out what the difference was, correct that and so forth, and that we had to have a 100-percent guarantee that we were going to rendezvous.

We didn't have a 100-percent guarantee to start with, no matter what.

BUTLER: Not any of it.

GRIMM: Not on anything. He was adamant about that. So before we'd come down, they sent Bill [Howard W.] Tindall [Jr.], who was the assistant director for—I can't remember what the name of his division was at the time that he was in. It's like MOD or something close to that.

BUTLER: MPAD or Mission Planning [and Analysis Division]—

GRIMM: MPAD, MPAD. I loved that guy. I'm sorry that he's gone.

BUTLER: Yes, we're very sorry about that.

GRIMM: His Tindallgrams were just priceless.

BUTLER: If you could hold that thought real quick, I'll change out the tape. [Tape change]

GRIMM: So they had sent Bill Tindall before they had this big meeting at MSC because he was over that group that I had tried to work with for developing the trajectories and procedures and so forth at JSC. They weren't able to, their computer would not do what I needed one, and they agreed with that. Bob [Robert W.] Becker was the guy that I worked with at that point in time, and [Edgar C.] Lineberry.

So Bill came up and sat with the crew and watched them for a day, and he said, "Yep, Dean, it works." So he went [home]. So when they asked Bill, oh, this guy at Headquarters says we need to get [The] Boeing [Company], who was the Headquarters contractor at that time supporting Headquarters, and they did theoretically all these analytical studies to give Headquarters the warm and bubbly feelings. He [the Headquarters guy] said, "We need to have Boeing take six months and run a good analysis of orbital rendezvous and Grimm's procedures and so forth, because we think it's snake oil." So he recommended that the orbital rendezvous thing be postponed, the mission be postponed.

BUTLER: This was already while the Gemini Program is in process now?

GRIMM: Yes, we're like three months from flight on Gemini VI.

So he had this meeting and he made that recommendation and Gilruth asked Bill Tindall what he thought. Bill said, "I don't know how he did it, but the crew has never failed to rendezvous using those procedures." This guy said, "Well, I still recommend that we postpone the mission and do this analysis if we have to to validate these procedures."

I was about at the end of my rope because I had worked a lot of hours and I'd spent a lot of time on this and you could call it snake oil if you wanted to, but they worked. I said, "Well, if that's the case, then I quit."

Wally said, "Well, if Grimm isn't on the program, I'm not flying the rendezvous."

BUTLER: That's nice to have that kind of support.

GRIMM: So they kicked everybody out of the room except for the Headquarters guy and Matthews and Warren and the crew, and they came back and said, "We're going with the mission."

So I went ahead and finished up the training with the crews, went back to MCDAC and came back and developed the flight manual with Tommy and went over and sat in mission control and put on the headsets there and listened to what was going on in case Tom Stafford, who was doing the monitoring and telling Wally when to make corrections and so forth and to be ready in case there were any failures. So he was following right along the charts and Tom says it's tracking right down the line. Then they got the acquisition lights and then they got the docking lights and then they got the running lights and said, "We're here."

Wally said, "The damn things worked, Dean." Then they came back, they gave me something that they signed that I'll always treasure.

BUTLER: That must have been really nice for you, to see all of that hard work come together so successfully.

GRIMM: It was, but it was stressful like a couple of these other jobs that I had always.

This was in '66, '65?

BUTLER: December '65 was the Schirra/Stafford mission.

GRIMM: I'm glad you've got that. "65, and December '65.

See, during this time, I was also doing the project management on the LLRV/TV and crew station on the command module and supervising the teams, supporting the crews. I had teams assigned to every crew that was going to fly, and those teams were out at Rockwell or at Grumman. Wherever the crews were, that's where the teams were. These were about four or five different guys, and they actually participated in the checkout at the factory and replaced the crews when the crews weren't there. They'd sit in for the crews.

They were the ones responsible for working the crew equipment. They were the ones working the stowage, they did all the stowage allocation and keeping track of where everything was at. In general doing all those things that you don't want to have the crew doing because they are what I call grunt work, but necessary work. So we had teams assigned.

Then when I went on to the Cape [Kennedy Space Center, Florida], I had the same thing happen down there, and they were responsible for stowing all lockers, putting the lockers in, responsible for the suits, getting the crews fitted up, taking them out in the van, sticking them in the thing going up and kissing them goodbye. I don't know whoever that old German guy was who stuffed them in. I can't remember what his name was.

BUTLER: Guenter Went.

GRIMM: Guenter, Guenter, yes. I never can remember his name, but yes.

So there was just a lot of things going on. My plate was certainly full during that period of time. I'm sure other peoples' were too, but the one thing that if I ever had to criticize Warren North about was that he didn't trust a lot of people, and you had to prove yourself to him. But once you proved yourself to him, there was no limit to what he would dump on you. [Laughter] And he dumped on me.

BUTLER: I guess proving yourself wasn't necessarily a good thing then, was it?

GRIMM: That's probably true, but I was a glutton for punishment, and of course, like I'd said earlier, I always loved challenges. I was so into this program that I couldn't hardly wait to go to work every day.

BUTLER: That's nice. A lot of people can't say that.

GRIMM: It was that way up until probably the last three years of my time with NASA.

BUTLER: That's really good. That's very fortunate.

GRIMM: Of course, it's been that way at Boeing, when I was at Convair, when I was with FAA, I just loved my job and dug into it and said there's always things to learn and always to grow, always ways to do new things and there almost wasn't a challenge that I wouldn't accept. Fortunately I was in the position where you could do those things, and then I had a boss who had enough confidence in me to let me do it. That's a wonderful to have, because I would say that there's not many people that can say during their professional career that they had a boss who had confidence in them and let them do their thing without much guidance.

Of course, in many things we were doing there wasn't much guidance to be given because everything we were doing was new. It was a one-of-a-kind first-time project.

BUTLER: Never been done before.

GRIMM: Never been done before. And thank God, we didn't make many mistakes.

BUTLER: It all came together so well, considering how little background there was in it all.

GRIMM: So I think that covers the—there's some interesting things that happened during that orbital rendezvous training that I won't get into, but would make for a spicy book sometime. [Laughter]

BUTLER: Talking a little bit on rendezvous, later in the program, after it was proved out for the first couple missions in Gemini, then later they began testing different types of rendezvous, even one that was the direct rendezvous. Were a lot of those procedures based on what you did?

GRIMM: Same basic procedures, except for the delta-H, you know, where we got brave, you know. In this direct rendezvous, for example, where the thing was going overhead and we launched and had to be right on the second and it came in. But the altitude it came in at was very similar to the delta-H that we had previously. Because the speed was different and the phasing different, the concept was the same but it wasn't quite the same in terms of the delta-H obviously or the transfer orbit in terms of degrees to travel before you actually rendezvoused. [Interruption, tape turned off.]

BUTLER: We're on.

GRIMM: As far as problems, I think we've talked about maybe a political problem that we just talked about. From a technical standpoint, I think by the time we did a couple more missions, we finally had the simulator at JSC working right and then, of course, we were using the procedures that I developed for the backup procedures.

Actually on Gemini XII, the last Gemini mission, that's the one that's Aldrin was on, that they had a radar failure on that mission. They actually used the procedures on that mission to accomplish the rendezvous and, of course, it worked.

Now Neil [Armstrong], during his—he was already docked when he had his problem, when he had the runaway thrusters, the stuck thrusters [on Gemini VIII]. So we won't get into that. That hasn't got anything to do with rendezvous.

I think the biggest problem technically we had was understanding how a rendezvous really worked and then getting the delta-H right, getting the transfer orbits right, getting rid of some of the extra work in terms of platform alignments that we really didn't need and then with the proper aids in terms of lighting, the overhead light, the docking cone light, the running lights, the COAS, reconfiguration. Those were some of the technical issues.

Of course the crews were always great, and they always had a lot of ideas. Although they didn't have a lot of time to spend on solutions, they could tell you what the problem was. Of course then it was our responsibility to figure out a solution to the problem and then we'd work it out and go fly the simulation ourselves then to make sure it worked. Then we'd bring the crew in and they'd tweak it however they wanted some procedure or something or other. Then we'd put it in concrete and that would be it.

BUTLER: Did a lot of the procedures hold over as they were all proving out? Did you then transfer them over for Apollo? Were you involved in that?

GRIMM: The concepts were very similar. The procedures changed because the one who actually started working the changes in the procedures and the detail of the procedure was Paul [C.] Kramer. He was the head of the mission planning branch in the division that I was in at the time under Warren North. He would work out those details. But the basic concepts, the crews

now understood what they had to do, and instead of thrusting one way, they were supposed to thrust the other way and understanding the concepts of rendezvous.

We had a couple of astronauts which I was never sure that they really understood rendezvous too well, and that's about all I want to say on that.

BUTLER: That's all right. It is a challenging concept because it doesn't work the way you would think.

GRIMM: No, because people tried to say we could brute force it, and you could have brute force and effect a rendezvous, [if] you had large enough thrusters to overcome the effect of increasing the thrust, if you knew which way to thrust to get the vector right, so that instead of going up you stayed on…course, which meant that you had to thrust [in a certain direction,] if you were going to add velocity in order to stay on the same course.

In hindsight, it's not a difficult concept, but at the time it wasn't understood well. As I said before, we didn't have any rendezvous procedures that worked, automatic or otherwise. At the time Langley [Research Center, Hampton, Virginia] had been working on rendezvous for several years, since they were a research center. They didn't have anything that worked, because I went up and flew their simulators. The Air Force had been working on it longer than that because they had the Blue Gemini, and later the Blue MOL [Manned Orbiting Laboratory] and they didn't have anything that worked.

BUTLER: It's interesting that it, with so many groups working on it that it hadn't come together more before this.

GRIMM: I think part of the problem was that there wasn't the emphasis that it needed to be and I don't know whether at one time you might not have needed rendezvous if we'd have had Nova. There wouldn't have been one. But, again in hindsight, when we talk about staging and separation and the efficiency of the multiple stages and things creates a lot of extremely difficult technological solutions to be made. But in terms of being able to get off the pad and to do all the things that you need to do that that was the right thing to do at the time because our engines weren't that powerful, and they still aren't as far as that's concerned, except for the Russian engines which we've started proselyte off of.

So I think those were the major problems. By the time we got halfway through between Gemini VI and Gemini XII we worked out all the bugs in the simulators and in the procedures and in modifying the backup procedures and trying to do new methods such as the direct rendezvous for example. By that time I think we finally had a good handle on the concepts and what we needed to do for the various types of rendezvous that we wanted to do.

BUTLER: Where you were you? You mentioned with Schirra and Stafford that you were in the control room and following their mission that they were going for that first rendezvous. During the other missions, did you continue to go to the control room at times, or were you doing other things?

GRIMM: No, I was doing other things at that point in time. I had people there in the control rooms but I was not there. I think that Holloway, Tommy or some of his people and Lineberry over in MPAD and Paul Cramer's group from the mission planning branch—that's not his title.

I can't remember what it was—that was in our division, was the one working with Lineberry to develop the different rendezvous concepts at that point in time. I sort of passed it off because I told Warren this wasn't my area of expertise.

We proved our point and had been successful and had backup procedures and it was time for the people who had that responsibility to pick it up.

BUTLER: Of course, by the end of this you had sort of become somewhat of an expert in the area.

GRIMM: More than I had ever envisioned, yes.

But so I think that kind of covers most of the things on the Gemini missions that I was involved in.

BUTLER: You mentioned that you were also involved with the crew stations, but that was primarily on Apollo; is that correct?

GRIMM: Mainly on Apollo. As I said, the only thing I was involved with the crew station was the handling qualities for the docking area and the things I've already covered on the Gemini Program. I was much more involved in the crew station area in Apollo [Command Module and] in the Lunar Module area and so forth.

So I think you asked the question on the next line there about did I participate in actual missions? Only on that one, was I over there.

You asked what my thoughts were when they successfully achieved rendezvous. I had no doubt. I was very pleased, obviously, and I think I even got a commendation, I think on that. Should have been money, but it was only a commendation.

BUTLER: At least there was recognition for your efforts. Did that come from Headquarters? Were they finally recognizing that, yes, your procedures had—

GRIMM: No, that didn't come from Headquarters. That came from JSC. I think Warren put me in for that commendation. At that time they weren't giving out the exceptional service medals, distinguished service medals like they did later in the program. In the initial parts of the programs, only the crews got it. A little later, only the wheels got it. By the end of the program, those things were being given out like stickers for the calendar.

BUTLER: You have a very good method of putting it all together, I guess.

Moving into Apollo then, and maybe we could talk some about you were involved with the subsystems on the command module and the crew stations. At what point did you become involved in this and how much of the design had already been settled on?

GRIMM: I think I was a section chief for not over a year or so when the previous manager of the project support office left to go back into private industry. He wanted to be a Lear jet chief pilot so that's what he went to do for experimental flight testing, Bob [Robert F.] Berry. So that job was up for grabs. I had not been, as I said, a section chief very long, maybe a year. Even

though there were other people who felt they were more qualified for that job, Warren selected me. Of course I always attribute that to the fact that I was the best choice. [Laughter]

BUTLER: I'm sure he would agree with that.

GRIMM: He must have; he did it. In that job is where I picked up the responsibility for the command module crew station, the lunar module crew station, the team responsibilities, still flying the simulations, developing simulations, picked up the responsibility for the neutral buoyancy training facility, the air bearing training facility, all the mockup facilities and training in the mockups and all the stowage. Basically when I say all the command module subsystems, this includes all of the equipment, any stowage and the support of the crews and figuring out what goes where and when the crew needs it coming up with the GFE requirements, Government Furnished Equipment requirements and so forth.

This includes, of course, I told you about the teams where they would support the crews in terms of the spacecraft checkout at the factories and then down at the Cape. Then also we were responsible for stuffing all the stowage containers because we had made those removable after the fire and solid versus Raschel netting, which was one of the big problems in the fire. During this time I also had crews that man rated the large altitude chamber and the smaller altitude chamber over in SESL [Space Environment Simulation Laboratory], I forget what building [number] that is [Building 32], that we actually manned those capsules, walked out in a hard vacuum, climbed into the vehicle, shut the doors and then lived in there for seven days.

We actually man rated not only the capsule but the vacuum chamber as well for manned testing. The spacecraft that we had in there had a similar problem, but no fire, as the one they

had at the Cape two weeks later [Apollo 1, AS-204]. We had a lot of water condensation in that vehicle. We had sparks in that vehicle from some of the wiring, but fortunately no fire.

BUTLER: [As] part of setting it up for the manned testing, were you also setting up some safety procedures in case of that type of thing?

GRIMM: We went through a lot of pre-planning. We had an FRR [Flight Readiness Review], which I was involved in, in terms of looking at all the systems and the procedures. How we're going to get the crew in there, how are we going to get them out, which would have been very difficult if there had been a problem, just like in the actual spacecraft, because that was an inward-opening hatch in that spacecraft as well as the one at the Cape.

So yes, we were involved in all of that, including the team that I had in there, which was Neil—no, [Grimm addresses his wife] the guy that rolled you up in a carpet one night at a party.

BUTLER: Well, that sounds like an interesting story.

GRIMM: It was a wild party.

BUTLER: At least everybody knew how to work hard and play hard.

GRIMM: Yes, we did. But what was his name? There's Neil [Anderson] and Joel [M.] Rosenzsweig, who was an Air Force captain who died, and Don Garrett who left the program shortly thereafter. Joe [Joseph A. N.] Gagliano was an Air Force captain who was there just for

a two-year period. I had a lot of those Air Force guys, sharp young first lieutenants, second lieutenants, came in and made captain and left.

Just as an aside, three of those gentlemen retired as four-star generals in the Air Force, and I met some of them here in the past few years. They recognized me, I didn't recognize them, but I was their boss at the time.

Back to the Command Modules here, until Apollo 7, I worked on the Command Modules. Well, I worked on them after that too, but in terms of design. …We had the fire about the time that I was on this program. We'd been working with the placement of all of the switches and all of the various instruments and the scaling on those things and the nomenclature on all of them, and guarding of switches was a big thing. Because of the crew floating around in there up against the instrument panel and so forth, you could very easily throw the wrong switch, which happened occasionally. Figuring out where to store things and how to store them, and of course after the fire we went through a big redesign, I forget what that redesign cost us, but I think it was like a hundred million dollars, as I recall. I don't know whether that's a good number or not, but that's the number I recall.

I'd go out every Monday morning and come back every Friday evening, and I did that for a year, to Rockwell. This was at the time when Frank Borman was the lead out there initially in terms of the design. He had the responsibility for directing Rockwell on all the design changes that we were going to make to the [Command] Module. Later George [M.] Low, who was at Headquarters, came down to be reassigned as the Apollo Program Manager when Joe [Joseph F.] Shea was moved to Headquarters after the fire.

So we worked daily with the Rockwell people out there in defining closeout panels, defining stowage, stowage lockers, modifying the seats, working with GFE in terms of changing

all of the flammable materials during fire tests out at White Sands [Test Facility, New Mexico], changing the flight data material so that the paper wouldn't burn, changing the suits so that they wouldn't burn, getting rid of all the nylon or the Raschel netting that we had had in there before, adding, changing. We did a lot of system redesign as well as that outward-opening hatch. System design and software redesign, more testing on a lot of the various systems, subsystems. As I said the placarding of instruments, the gauges, guarding various things with flip-over guards for switches and other things to keep crews from snagging on things.

So there was a lot of work that was done after the fire during that period of time and up through the actual mission. So I think that covers the subsystems that I was involved in, all of the instruments, the scaling, all of that normal stuff that's associated with all the instrumentation. We were involved in the telemetry instrumentation, instrumenting the various things that we wanted more instrumentation on and so forth.

The spacecraft was gone through from end to end basically in terms of handling qualities, characteristics, software, backup systems, crew equipment, storage, safety items, outward-opening hatch and so forth.

After that was over, I brought in another gentleman to take over that responsibility because I was getting loaded up again with stuff, still [had] the LLTV/RV was on my palate, a big load. His name was Chris [D.] Perner, very exceptional, laid-back West Texas gentleman who was a super, super good guy. He became about three iterations later a division chief of the division I had before I went up to the director office.

That's a long story too, because I hadn't gotten a division yet. Then I moved from flight crew ops over to the engineering directorate and had a division. Then I had a guy follow me who was my assistant chief, who was Don [P. Donald] Gerke, who died of a heart attack about

five years ago when he was at Headquarters. The next guy in there was George [C.] Franklin, who was my subsystems manager on the lunar module. He did all the same things on the lunar module that I was doing on the command module at the time. I don't know if you've ever interviewed him or not, but he would be an interesting guy to interview.

BUTLER: Not yet.

GRIMM: Both Chris and George. They were both subsystem managers under me, very capable, competent people.

BUTLER: It's fortunate that you were able to have people like that to work with.

GRIMM: Yes. It's nice to be able to select people—you couldn't do that now, but you could back then, the people that you'd like to have work on these types of assignments. So I think that covered that.

The most difficult part, the question here you have, of working on these subsystems was since this was a crew station, one of the most difficult things was working with the crews. The crews had definite ideas about things and for the most part they were able to get their way, although we did have some very interesting discussions about how to implement certain things in the crew station.

The other thing was that we were on a tight schedule during this rework after the fire. Money was always an issue and the changes, there was always an "Is this mandatory?" Is it a safety issue, safety flight issue, or is it a crew issue or is it a system issue and you had to define

what it was and what the impact was if you didn't get the change. Then you had to go before a change board individually each one of us and justify to the program manager who at that time—now is George Low—and justify these changes. Earlier in the program Borman was making changes before George Low came down from Headquarters where he was the associate administrator assigned to this job.

Obviously you never got to interview George Low or maybe Ertel interviewed him, but he was a very exceptional individual. Young guy, he wasn't much older than I was. He emigrated with his parents from Austria. I was trying to think of the school he went to, [Grimm addresses his wife] remember I was telling you the other day. It was Rensselaer [Polytechnic Institute] that he went to. A very sharp individual. Then he went to work for—what's the center at Cleveland? It's Glenn now, but it was Lewis [Research Center] then. He was so sharp he got selected early in the program when NASA became from the old NACA [National Advisory Committee for Aeronautics] under [Robert C.] Seamans [Jr.] and went up there as an associate administrator, and then deputy administrator. Then after the fire they wanted somebody with a good technical command of the situation as well as administrative management to come out and manage that. He actually lived out at, had a cot in an office out at Rockwell, and lived there twenty-four hours a day for the better part of a year.

He was out on the floor at night and during the day and he looked into everything. He knew more about that spacecraft in total than any of the rest of the people in the program by the time we were ready to fly again. As I said, a very exceptional young man.

BUTLER: That's one thing with the oral histories, that even though we haven't been able to talk to him, we have been able to learn a lot about him and his contributions.

GRIMM: So I think that kind of covers that.

While we are talking about Apollo, do you want to jump to the fire? I think you had a question here.

BUTLER: I know you've talked a little bit about some of the redesign here and obviously that was a difficult time.

GRIMM: Right. After that. [Interruption-tape turned off]

BUTLER: Okay, we're going.

GRIMM: Apollo 204, and I didn't remember that being the name, was the fire down at the Cape. What had happened there after that fire, was there were a lot of people concerned about their political careers and their butts and Rockwell and some NASA folks in particular. Before the accident committee board got totally formed, Gilruth sent Borman down to be the representative from JSC even though this was the KSC [Kennedy Space Center]. KSC basically has responsibility for the launch but JSC was still responsible for the vehicle and the crews.

So the board was formed under, I think, [Floyd L. "Tommy" Thompson] who was the director of Langley at the time. Borman was the technical interface—who ended up being the technical interface with the board because most of the people on the board were external to NASA or at least external to the space program. So they wanted somebody who was technically knowledgeable and Borman was a good systems person.

He always had an authoritative manner about him, so I guess they figured he was a good one to be down there. He started having a lot of problems with various organizations trying to maybe slant the direction that the investigation was going and also to find out what was going on, even though they had no legal business to find out what was going on at the time that the board was working.

So as they started to go to grid in the spacecraft and get ready to move things out, there were even more problems. Borman said that he needed somebody down at the Cape that he could trust. So Deke and Gilruth had a short conversation, and Deke called me up and said, "You're it." Of all the people that he could have chosen, there were a number of other people I suppose he could have. But they decided to choose me and so it was my responsibility to go to the Cape and take over a hangar down there and then [have] responsibility for [the CM] after they had put the grid in the spacecraft to photograph everything, and then to also use this metal framework to remove the crews in the seats and then to get to everything else. You can't get in that spacecraft in a vertical position without standing on everything.

So we put in this metal grid that was built very quickly to allow them to remove the crew members and then to start removing things piece by piece. It was my responsibility to take possession of everything and to lay everything out in a grid format so that they could locate everything in the spacecraft in the hangar, so everything would be relative to everything else three-dimensionally and be able to have access to it in case they needed to have work done on it or to take items out someplace for what I call forensic inspection and examination.

So that was why I was down there, and that's why I was chosen, as best I can tell you. As far as my previous background with the FAA in terms of actual investigation, I don't know that that had anything to do with that. It was more my knowledge of the command module and

the subsystems and what was everywhere plus the fact that I think that they felt that I was the one [or] at least one of the people that they could choose who could not be compromised. There were attempts at that while I was down there.

BUTLER: That's unfortunate.

GRIMM: That gets back to some other things later on here, where you said why did I leave NASA, and I'm not going to go that direction because it has to do with some of the people that are still at NASA.

BUTLER: Sure.

GRIMM: So I think that pretty much covers it. I was down there for almost three months, I think.

BUTLER: Must have been a tough job, although it must have been good to know that they could rely on you. That they did rely on you in that way, it must have been hard to get through.

GRIMM: Well, it was. Of course, I knew the crews quite well, since I've worked with them for probably three or four years with Gus and on the Gemini things and the training and the backup training on the rendezvous. Of course I saw them on a daily basis because I was in the same building with them and I processed all the changes that they wanted since I was the subsystem manager on the Command Module and the Lunar Module. I signed off on all the proposed

changes, and I went and pitched those changes to the Change Board to Low, and I always put out a weekly letter to all the astronauts letting them know what was going on in terms of activities related to the spacecraft changes, getting their inputs on changes and trying to take a total overview of the crew organization to the change board and presenting it to the change board, to Low's board at the time.

You asked what was the most difficult part of the job for me. Well, it was trying to make sure that nothing within the building got compromised, physically or otherwise, and making sure that I kept Borman informed of what was going on. Of course, I assisted the accident board members who wanted to have a technical tour of all of the parts of the spacecraft and so forth. Then I'd write up daily reports of any sequence of events and what came in from the spacecraft and so forth so the board knew what was going on through Borman. It all went to Borman and then to the board.

So that was most of the activity associated with that job. It's hard to believe, but we had some Headquarters people come through there and some of them wanted souvenirs. I had to practically break some knuckles to keep their hands off of things. During that period of time I was offered a few bribes by various organizations, as well, which that's as far as I'm going to take that subject too.

BUTLER: Sure, sure.

GRIMM: Does that cover what went on down there?

BUTLER: I think that covers it pretty well.

GRIMM: Let's see. From there we jump to, this is kind of backtracking, because we went to the fire and out at [the North American Rockwell plant at] Downey [California] for the factory for that year after that. Then I got, as I said, Chris Perner on board and [George] Franklin was very capably managing the lunar module stuff at that point. I had some good people on the trainers and mockups and the water tanks, and some other people that were working the man rating and manning the spacecraft and the altitude chambers.

I was working the LLRV/TV also during this period of time.

BUTLER: You mentioned a couple of the different systems and the mockups and the simulators and the trainers. You mentioned that the water tank, the training there. Were you also involved with some of the testing like where they would have the astronauts in the suits and try and simulate the one-sixth gravity for that?

GRIMM: Oh, yes, oh, yes. That was what the water tank, what we did at the Boeing facility, put mockups in the tanks, and then all of the activity was in my organization.

Then we had a group in our organization that was actually a shop, and they had a very exceptional person who could build anything. He built that for me [Grimm gestures to a space shuttle model] when I left the organization. But he could build a mockup with all the functionality that you needed to do the training that was required. He had about twenty-four people working in the woodworking and machine shop. That we made everything there to support all of our training activities with the mockup and the neutral buoyancy facilities, because the neutral buoyancy facilities had a different function than the mockups that we had in

the 1G in the 1G trainer, in that it had to be floated, had to have flotation and a lot of the functionality that you'd use for storage maybe or some other function that you didn't have to use or couldn't use because when you put the crews in the suits, of course, they had to be weighted in all three axis so that they didn't spin like a top or something or other. They had to be weighted with weights around their waists, around their arms, around their ankles to give them not only neutral buoyancy, but they also had to be able to be vertical in the water rather some other angle.

Then of course we had divers in the water all the time because we had to make sure that everything was safe too. We monitored their work and then if they needed assistance we'd work it. Because in the tank as well as the ones in the trainer, we were always working procedures, working bugs out of the equipment, working bugs out of suits, out of mockup cameras, handling all of these things that you have to work with while you're in that sort of activity.

I think about somewhere in this period of time, the organization was split up. I was going to say split up, but it wasn't at this point in time. This was still back in '67, '68, '69.

So, as I said, I had teams of people that were supporting the crews at the factory and down at the pad. I had teams of people supporting the crews while they were doing their neutral buoyancy training. I had another crew of people that were supporting the 1G trainers. I had, of course, Chris Perner and George Franklin supporting the crew stations in both vehicles, another set of crews, two sets of crews that were doing the manning of the [altitude chambers]—we did it twice, as a matter of fact.

First of all, we man rated the altitude chamber and the [006] spacecraft in a chamber? Then the LM, I forget what the number of the LM was that we had in there. LT[A]-8 sounds good anyhow. You might want to check that.

BUTLER: We can check that one in the papers, too.

GRIMM: LT-8, and we manned that on at least two different occasions, checking out various aspects of the procedures, suits and systems. Then at the same time, I had another group of people that were working experiments and a number of us were still flying simulations. So that was kind of a smorgasbord of activities that I was doing while I had that organization. That was the Operation Support Office under Warren [North].

BUTLER: It must have been a unique challenge for you in a way to balance the engineering, which had been your training and your background with all this management, and to make the two mesh.

GRIMM: I never considered it a problem. A lot of people that worked for me, worked with me, some of them to this day would accuse me of micromanaging the organization because I looked into everything. But by the same token, what I told some of these people was that when I can see that you're doing your job, you will no longer see me. But if you manage your job like you're supposed to, then you won't have to worry about me micromanaging your part of the organization.

BUTLER: That makes sense.

GRIMM: That's exactly what happened. I said, "As long as I see problems with your organization, you're going to see me looking over your shoulder. When I no longer see problems, you won't see me." That's kind of the way I operated, although I had a very good knowledge of what was going on in all of these areas, mainly because I was interested. Some people do it from a management standpoint and never get their hands dirty. I was out there, I'd be walking through the organization at midnight.

I've got a hard hat up there that they painted red, and it says "The Chief" on it. The reason why they had that hard hat painted red is because they were surprised so many times by me, unfortunately in many cases, that they gave me that hard hat. I would wear it so that they could see me coming from a distance. [Laughter] So I've kept that hard hat up there.

BUTLER: That's pretty good.

GRIMM: So I guess then for the next couple of years, even though all these other things were going on, I would spend a couple hours in the office every morning and have a staff meeting every morning like at 7:00 o'clock, get a status of what was going on, and find out what things I had to be doing, and then also be involved in the LLTV project at that time because we were getting the [LLTV] vehicles in, we were trying to get the facilities up, we had Neil's [Armstrong] accident.

The LLRV program had been under [Joseph S.] Algranti under an engineer that he had. As a result of that accident, they decided they wanted to change management, so they put

everything under me again, both the RV and the TV. So we flew the RV for a while and because there was so much—well, another long story.

They wanted to, somebody had decided, I think mainly the crews as I recall, didn't want to be traveling back and forth from MSC to the Cape as they approached the flight, which is a good philosophy. So they wanted a facility down there with an LLTV down there. So I started working with the Air Force people, because this would have to be on the Air Force side by the skid strip and went in off of the skid strip. So I started putting together a management plan and working with the facilities down there and our facilities people to put in the requisite hard facilities there such as the H_2O_2 tanks and hangar and all the fixed facilities that you have to support a vehicle like this, that's this sophisticated.

We had pyros and we had an injection seat, which was some more pyros, we had JP-4 fueling, we had oxygen on the vehicle. We had H_2O_2, 92-percent pure, which is very explosive if it comes in contact with any contaminant. You drop an eye dropper, one drop into a bucket with dirt in it and it explodes. So it has to be very careful the way you handle it. You have to have a lot of cleanliness, all of your tubing and everything has to be super clean. You have to have people in suits with breathing apparatus and so forth because of the toxicity. There's a lot of requirements that you have associated with a vehicle like this that people are probably not appreciative of. A lot of people thought, "Dean, just go build this vehicle, build the flexibility in. When we get the LM, we'll tell you what the requirements are. You tune in the requirements, the crews will come out, kick the tires, jump in this sucker, and learn how to make that transition and pitch-up maneuver and come to a hover and land. Nothing to it. Piece of cake."

BUTLER: Not quite that easy.

GRIMM: Not quite that easy, that's right. We were limited on budget, and the schedule was way too short to do what we did. So I spent a lot of time, as I said, after Neil's accident, he said, "What happened?" "Well, Neil, you ran out of nitrogen there." One of the things that we found out is that when you fill those tanks, you pump nitrogen into those tanks, those tanks get very hot because you're pumping this gas in through an orifice. You find out that you don't get the tanks full.

One of the things we learned is that we put wet towels on there and kept the tanks cool the whole time we were filling them. We filled them at a lot slower rate and then you let them cool down and then you'd fill them some more, then you'd let them cool and you'd fill them some more. So you ended up with full nitrogen tanks. Those are the two little things that look like two little male elements at the back end of the vehicle. Those are the gaseous pressurant that we used to pressurize the large H_2O_2 tanks that are the sides of the vehicle, those big large tanks. That nitrogen gas forces that H_2O_2 out through the lines and to the thrusters. Thruster's very interesting, it's a very simple device. It's got a platinum catalyst bed inside of that little thruster. The thruster is adjustable from twenty pounds to ninety pounds, and when this H_2O_2 hits this platinum catalyst bed it decomposes into steam and water. You get your thrust basically out of steam. That's what, if you've ever seen movies of the LLTV, this big clouds is this hot steam coming off this catalyst bed and coming through this little orifice nozzle, which provides the thrust.

So once it gets to that point, it's very safe. It looks scary, but it's a very safe compound. It's a lot safer than hydrazine or some other bipropellant material that you'd want to use to be around crews, which is toxic. I mean some of the other material is toxic.

So what I determined shortly after that accident was that we were trying to fly the RV and trying to put together the TVs. We were limited on resources, we were limited on facilities, and at the same time I told Deke after exploring all of the considerations down at the Cape on the skid strip that there were too many things that would restrict our operation down there. The Air Force being the first one, because of their safety requirements and their operational requirements. Then Air Force and NASA using the skid strip to land on, you had all kinds of constraints there. It meant more facilities, more people, splitting the technical people, splitting the operational people so that we'd have to be training in more places. I said, "We just don't have the total capability to do it and we don't have the time."

I recommended that we cancel the activity down there and Slayton and Gilruth agreed. So we did that. The next decision I made is that I can't fly the RV and TV, operate one and be building the other three at the same time, because we had two RVs and I'd purchased three TVs with this completely difference design that I talked you about.

So I made the decision that we were just going to ground the RVs and go with the TVs. That caused a little delay, but at least we were then able to put all of our emphasis and our manpower into the TV. To me it made sense at least, and to both of the other people that I talked to that I had to convince because the TV had the characteristics that we needed built into it or adjustable so that we could those characteristics as a LM into it so that we could train the crews.

The RV would get us a small sampling of what they needed, but would not give them an exact thing that I felt we'd designed the TVs to do. So as a result of that, we grounded the other RV and proceeded to put together two LLTVs, which we did, and which we started flying. We had quite a number of test flights on the TV. The day before we were going to have—the same day.

The same day Joe [Algranti] was going to fly this vehicle and we had the second vehicle ready to fly, and Neil [Armstrong] was going to fly that vehicle. Well, that's the day that we had the accident. So obviously, we didn't fly the second vehicle.

You say, what happened. Well, what happened was that we had a wind restriction on the vehicle and we instruments on the vehicle, Pitot tubes and anemometers. But between the ground and the altitude we had a wind shift and it wasn't noticed at the time, apparently not noticed. So as Joe accelerated to the velocity he was supposed to go into to go into lunar sim mode and to do the lunar descent simulation, he encountered a wind that was not a tailwind, it was more like a headwind.

So we exceeded the moment capability of thrust out of the thrusters to control the attitude. In other words, the thrusters were firing a hundred percent down, and the wind was pushing hard enough on the vehicle that the force exerted by the wind was more than the force of the thrusters to control the attitude of the vehicle. So the vehicle pitched up and rolled, ninety degrees on its right, and Joe was trying to correct the lift and unfortunately that command continues to build as long as you hold the stick in. Well, eventually the vehicle got control of itself, but now all that input that had been made came over so hard that it rolled 180 degrees. It went from ninety degrees right to ninety degrees left.

By that time he was putting in the other control to the right. Eventually it came back, but by that time the vehicle had built up a good descent rate and the vehicle was totally in control, except for the descent rate, when it hit the ground. The control system had done what it was supposed to do to stabilize the vehicle. Basically Algranti ejected out of the fireball. He said, when we took the film and analyzed it, it was around six-tenths of a second before the vehicle hit the ground. But the vehicle was coming down at approximately 160 feet per second. So he actually ejected before it hit, but when I was standing there looking at it, it looks like the thing hit the ground and fireball and he came out of it, but in fact he was coming out of it as it hit the ground. But your eye just couldn't pick it up that quick, but the film did.

So when you say how did this accident differ from the first one, I think I've explained the differences already.

BUTLER: Sure.

GRIMM: Wally Schirra was the local board chairman, and we had Headquarters people sitting in on it and then people from Headquarters second-guessing it. There was talk about Headquarters canceling the program. Crews, Neil and Pete and Wally, who hadn't flown them but was the board chairman, Gilruth, North, Slayton, there was a number of people involved, including myself about do we have an inherent design problem in the vehicle.

Well, the answer was no, we didn't have an inherent design problem, but we did have an operational problem and we had to impose more stringent requirements on how we flew the vehicle because we knew the limitations of the vehicle. Or I certainly did. I think we transmitted that information to the crews. So as a result, we made sure by getting an Air Force

theodolite [and balloon] team out and they sent up balloons half an hour before flight and I think we did it at five minutes before the flights. I think we did it half and hour, fifteen minutes and five minutes before the flight. So that we knew what all the winds were aloft to a thousand feet. Then, of course, we did one right after the flight, because believe it or not, we had a lot of wind changes in that thousand feet in a period of five or ten minutes because we flew early in the morning when everything was calm, no thermals, and hopefully no thermals and so wind sheers. However, we did have inversions and we did have wind sheers within that thousand feet occasionally.

So that the ground was saying that the wind is in this direction and at a thousand feet it was in another direction. So after that, besides the satellite [meteorology] team…[the] Air Force had a [helicopter] rescue crew out there every day to do a crew rescue in case the vehicle crashed, as they were there when Joe ejected, and they [also] used the vehicle for fire suppression due to the [rotor] blast, plus they had fire suppression capability onboard the helicopters, [as] well, in terms of foam and so forth and rescue people in the rescue helicopter. Then, of course, we had two fire trucks on the ground.

Then we took the third vehicle, which was basically the frame, we're now down to two vehicles. We took the third vehicle and took it to Langley and put it in the wind tunnel and validated what I think we already knew, which was the fact that if you yawed this vehicle to the right with the hole on the [left], and the right-hand side of the vehicle closed in, that that just acted as wind vane which tended to turn the vehicle. Well, based on our jet logic that we had put into this vehicle to simulate the lunar module, we did not have enough thrust to counteract that torque or that moment.

So the design that I'd had, which was to put a top on this thing and close in the sides, including the front, was probably not the best idea that I ever had. So as a result, we cut a large hole in the top to let the air out and to prevent this large pitch and yawing moment. The pitch wasn't so bad, but the thrusters had to handle the pitch and yaw at the same time and it made it very difficult for the thrusters because we had the thrusters set down at a lower limit to simulate the torque to inertia ratio that the thrusters had that were on the lunar module. Even though we had more capability, we didn't have the system set up to use it because we were trying to simulate the LM.

We had a backup set of rockets on there, but unless you went hard over on the hand controller, that didn't come into play. Of course, this happened very quickly, this upset condition, and that's what caused the problem.

So from then on we measured the wind incrementally. We put extreme strict limits on how much wind there could be for first flight, second flight, third flight, fourth flight, how much wind we could have at altitude, what the forward velocity could be max, if there was any crosswind, and modified the cockpit to take most of the top out and did not use the front Styrofoam piece that simulated the window view. Took that out. We did a number of test flights, checked out the system with Algranti and Bud [Harold E.] Ream and said we are ready to fly.

After about a month going around and around the horn, Gilruth got Headquarters to agree with that. Headquarters was all for canceling the program. They actually told Gilruth, "If you fly this vehicle, it's at you own risk." Gilruth essentially sent a TWX [teletype transmittal (pronounced twix)] back to Headquarters saying, "Tell us something we don't already know,"

which said he had confidence in the fact that we knew what we were doing, as much as anybody could know what you're doing with a vehicle like this.

We did the test flights with Algranti and Ream, and now we're about a month prior to flight, the lunar landing. So I called Neil at the Cape and he was down there doing spacecraft checkout. Neil Armstrong, we're talking about. I said, "Neil, I think we got all the bugs worked out." He wanted to fly the vehicle. He had told program management that it was a requirement for him to get so many landings in the LLTV prior to the go-ahead for the lunar landing. He felt that strong about it. He had flown the RV quite a bit, and had flown the TV, as had a number of the other astronauts.

As a result of the decision to fly and my calling Neil, I told him we needed to have him up there on a certain day. I can't remember what day it was now. He thought he could work it in his schedule. I said, "If God willing and the creeks don't rise, maybe we can get you enough flights in over this weekend and the next three or four days, if you can spend that much time with us, to give you the confidence that you feel you need to tell the FRR board, which was just getting ready to convene, that you're ready to go as far as your training is concerned."

So he flew up that Friday, and he was under a lot of stress obviously, from a lot of different sources. Of course, I was too. I think everybody on the program was. But I was getting calls from Senator [Clinton P.] Anderson's aides, and I was getting calls from Representative [Olin E.] Teague's aides, each one of those were head of committee in their respective branches of the government for NASA.

I was getting calls from program management at Headquarters every day. If something happened on the vehicle, quality would tell their boss who was another director, that director would call Gilruth and Gilruth would know about it before I did. This would be in the middle of

the night. So I would have to, if I got home at 10:00 o'clock, I'd be back out there sometimes at 11:00 or midnight or 2:00 o'clock in the morning and be there for the rest of the day.

Be that as it may, we overcame all those little disturbances in the program and Neil came up. The best I recall, we had never gotten more than two flights in a day because of either a vehicle problem with the checkout or with the vehicle or with the wind, weather. But the first day he got there, they got in three flights. The next day, we got him four flights. Then on top of that—I don't know who did it. I still think Gilruth did it, but I can't at this point in my life remember for sure who did it. They set up a press conference out there. So we had all of those people in our hair in addition to everything else we were trying to do, which was get Neil trained.

Well, anyhow, we pulled it off. He got his flights, he came down, he said, "I think I feel comfortable now, having these many flights this close together." We'd moved him up in terms of different things to look for to get him closer and closer and closer to the lunar descent and the velocities and so forth. So we had the press there and Neil got right off the vehicle and went and talked to them, as if it was a matter of fact thing. It wasn't matter of fact for any of us, including him. He didn't like to talk to the press anyhow. So the press left then and we had our little debriefing with Neil and he left.

I told everybody to wrap up the vehicle because it was going down for a couple of weeks. I had stretched the time that—we were supposed to do a certain number of checks on this vehicle periodically, just like you do on an aircraft. I had postponed some of that stuff that theoretically was mandatory. So I told them wrap it up, stick it in the hangar, we wouldn't fly for two more weeks at a minimum. We had some mods that we had to make that I'd postponed and things that we were just getting by the skin of our teeth on the vehicle.

Then I went back and sat in the office. Everybody else was going out and having a big beer bust. They asked me if I was coming, and I said, "No, I'm not coming. I'm going to unwind," and I had something else to do anyhow. I was waiting for a call from Headquarters, and it came about an hour later. It was General [Samuel C.] Phillips, who's the director of the Apollo Program. He said, "Dean, I've had a patch put through from the airplane to the ham operator at Andrews [AFB, Maryland] and he's calling [you] on landline and I want to know what happened today because we're on our way to the Cape, all of us and the management here, on our way to the Cape in G1, [and] G2, whatever it was." G1, I think it was, they call it the Grumman airplane. "For the FRR tomorrow and make a decision on whether we're going to go for a lunar landing here next week." And he says, "We've got to know how Neil's doing on this training."

I said, "Well, General, he had three flights yesterday and four today." That's the best I can remember in terms of flights. "He had his last one today at whatever time it was and he's satisfied that he's got enough training and he's ready to go as far as this vehicle is concerned." General Phillips said to me, he said, "Well, Dean, if you could keep—" I probably exaggerated the term, but I said "bucket of bolts," but I think he probably said, "If you can keep that thing together long enough to give Neil seven flights and he feels comfortable with it, then we probably won't have any trouble making a lunar landing."

BUTLER: That's nice.

GRIMM: Then, of course as I said earlier, Neil came back as Pete [Conrad] did similarly [and said] that they felt the LLTV training was essential in their having a good feel in what was

happening and how to handle the view out the window and the pitch and the control of vehicle to null out the velocities for landing.

BUTLER: An important part of their training.

GRIMM: Of course, you said was there talk about canceling the program. Obviously there was. As I mentioned, MSC people were supporting the program, obviously they did. Gilruth was a little antsy about it, but the crews and Deke said that they thought it was mandatory. Of course, Neil was one of the foremost sponsors of that. They knew it was risky, but everything in the program was risky. So they were willing to take that risk. Of course we had proved that we had a good ejection seat on the system.

BUTLER: It certainly did work.

GRIMM: It was supposedly only qualified for 120 feet per second vertical descent, and I'm sure Joe's was about 160. So we know that it worked quite well.

Everything on the vehicle was a modification of something. Some of it was commercial hardware. Very little of it was mil spec [military specifications]. Some of the stuff I wouldn't even want to tell you where we got it [from] to put it together, because it was such a unique vehicle that we just got it from every place. The engine was modified, wasn't made to run vertically. We modified it to run vertically. The ejection seat that was modified, weighed initially 150 pounds, we knocked off a hundred pounds practically and put on a different rocket off the rails. We did just so many things in terms of just the instruments and controls and

displays and the avionics that had basically three analog computer systems operating the vehicle.

So to my knowledge, it's the first "successful," in quotes, fly by wire, nonaerodynamic vehicle that's ever been built. There had been other vehicles, and we lost three vehicles, but we never lost any crew and more to the point, no astronauts, which would have been very devastating to the program, had we lost anybody, even more so if they had been astronauts.

We ended up with two TVs after Joe's accident, and then we lost another one with a, believe it or not, product improvement on the vehicle.

BUTLER: Before you tell me about that, if I could change the tape real quick?

GRIMM: Sure. [Tape change]

BUTLER: Tell me about the LLTV incident, which actually was a result of changes that were being made.

GRIMM: As I think I mentioned on the previous pause here, the cause of the next accident was as a result of a product improvement by the manufacturer of our alternator/starter, which was a combination device on the LLTV. This particular new alternator, I can't recall all the details on it, but I think it had more capability in terms of power.

But one thing that we didn't know was that if the alternator failed, we had batteries on the vehicle at backup to power with enough electricity to get us down on the ground. Of course

we didn't have much flight time, anyhow. Our total flight time was like seven minutes on this vehicle, of which only two minutes were in lunar sim mode to landing.

To make a long story short, this alternator had residual voltage in it when it presumably wasn't operating, so the residual voltage in the system was enough to keep the backup system from switching in and going on batteries. So it didn't let the system switch to go on battery, so that the electronics would work and therefore the pilot flying the TV, which was Stu [Stuart M.] Present, had no control. So we lost the vehicle because of that, quote, product improvement. It's one of many times in the history of technical things in the United States, where product improvements have come back to bite us in the ass.

A lot of times if you have something that you have problems with but it works, you're better off to keep it unless it's so bad that it's a safety of flight type thing. Our other system was not a safety of flight. We could have very easily have continued to use that system and not changed it out. But I was off the program at the time, and I don't know what decision I would have made had I been on the program, because once Neil is down and I had told the ground crew and the other program manager who was coming in to follow me what needed to be done on the vehicle, and I had signed off everything over to him, which was Charlie [Charles R.] Haines, in '69, I told Deke that I had had it. I had been on that program as long as I could stand it, I had done what he wanted me to do. I was totally stressed out, and I wanted off of it. I got off of it.

I took a month's leave and when Neil landed on the Moon I was sitting in Colorado Springs [Colorado] in my brother-in-law's apartment. I was a three-pack-a-day guy those last two years. I had made a promise myself that when Neil landed safely on the Moon, I would quit

smoking. At the instant he touched down, I stubbed out my cigarette and have never smoked again.

BUTLER: That's great. That's wonderful.

GRIMM: That's just a little aside. It doesn't need to get in this.

So I needed that month break. I told Deke I was taking off on a month and I didn't care what happened. I needed a break because I'd been on that program basically as I said, twenty-four hours a day, seven days a week, with no leave, no nothing. My children didn't even know where I was at because I was coming home after they went to bed and I was long gone before they got up, so I didn't see them for months at a time. They'd ask my wife whether I was on a trip or whether I was at NASA. But that's the way it was for a lot of people. I wasn't the only one in that position.

So anyhow, after I got off the LLTV program, it obviously continued for another year and a half with one vehicle. It was very successful and they concluded that program. The Smithsonian thought so little of that vehicle that they said they didn't want it when it was offered to them. They still don't have it. They had it up there for some anniversary, and then it was that Marshall [Spaceflight Center, Huntsville, Alabama] wanted it. JSC let Marshall have it for a couple of years, and then it went to Headquarters for some anniversary, whatever that was. Then, finally, JSC's got it back, I understand. The RV that was flown very few times is back out at Dryden, FRC as I called it.

So I think that concludes it unless you have any other questions on the RV/TV.

BUTLER: I think that covers it pretty well.

GRIMM: May be more than anything you ever wanted to know.

BUTLER: Oh, no. I've certainly learned a lot from it because there isn't a lot of good information down about both programs and about some of the intricacies behind them and the challenges. It's been very informative.

GRIMM: From that point on, I had started already before I left the TV program, started working some aspects of the Skylab program. At that time, JSC didn't have any trainers and we had simulators but no trainers. Skylab was such an interesting mishmash of modules, none of which lent themselves very well to a simulator like the command module simulator, the AMS, the Apollo Mission Simulator, or the Shuttle simulator or things like that because other than a control system it had very little in the way of very sophisticated controls in it.

So I had a number of good arguments and discussions, maybe is a better word, with Reg [Reginald M.] Machell, who was the head of an organization within the Skylab program office, and at that time Kenny [Kenneth S.] Kleinknecht had transitioned from the Gemini Program to the Skylab program as a program manager at JSC. I had a number of conversations with Kenny.

At that time we were having a real dogfight with Marshall, because Marshall had built a water tank down there that was an out-and-outright misuse of money allocated by Headquarters. Within this hangar they had built this forty-foot deep by, I believe, 100-foot-diameter, or eighty-foot, maybe it's a hundred, whatever, water tank. It was their intention and had always been

under [Wernher] von Braun to eventually not only have responsibility for the booster but to take over the manned functions as well and crew training.

They built this water tank under the guise that they needed it to evaluate their systems. At one time the Skylab part of the program was going to be at JSC, but Headquarters, because of von Braun and other political activities including the senator from Alabama, decided that we should not only have Marshall responsible for the engines and the booster, but they should have a role in the manned activities as well, i.e. being taking an S-IVB tank and putting partitions in it and letting them do some human engineering, human factors in it and build some of the crew interfaces, i.e. all of them if they could get away with it.

So where did that leave JSC with crew training? Well, because there was no Skylab simulator per se, although you could come up with a panel that was in the multiple docking adapter that controlled the environmental functions and the electrical functions in the vehicle, and you could build another panel that simulated the control of the optical telescope. Those were what I can say were very minor simulations. Of course we still had to have the AMS [Apollo Mission Simulator] because we had to go up and rendezvous and dock with the multiple docking adaptor that was the interface with the command module for the Skylab.

It was very interesting. The crews, apparently it didn't make any difference to them where they trained. They didn't care whether they were at Marshall, in a 1G trainer, or in the neutral buoyancy facility, or where, just so they were getting the training. Well, I and Deke felt that JSC should be the central repository for crew training, so I prevailed on Reg Machell and Kenny to have a prototype flight vehicle, in terms of the S-IVB stage that Marshall had more than one of, made them outfit it with all the functions that they were going to put in the flight vehicle which they had intended to use for their own purposes to train the crew, and we put that

on a barge and shipped it here. That's why you have that vacated barge dock down there at the end of the road.

So we had the Corps of Engineers come in and dredge a channel all the way from Kemah up there and built that boat dock, and then special GFE and loaded it off the barge, rolled it down the road, and tore down the side of Building 4 there and I put it in.

We got rid of the—I can't even remember what the trainer was in there that I tore out to put that in there. I wonder what was in there, probably a bunch of mockups, mockup trainers that we'd had in there before for the Apollo Program. But we took that in there and then had to disassemble that S-IVB in sections to get it in there and to stack it up and then built the walkway. That's the same system that's over in Space [Center] Houston right now, or whatever that thing's called.

BUTLER: Yes, Space Center Houston.

GRIMM: Yes. So I had that built. Then I had [The] Martin [Company] get approval through Kenny again, and Machell, to build the multiple-docking adapter. Then I had a mockup built—and I forget who built that—of the Apollo Telescope Mount [ATM]. We laid all that on—the multiple-docking adapter and the Apollo telescope, laid it on its side, and then the Skylab vertical. There was another piece in there. What's the other piece? Maybe that's all there is.

But, anyhow, we put all that together in that high-bay area there in the south side of Building 7 and used that to train. We were running into the—and we still had the water tank problem at Marshall. The crew went down there a lot to train. All we had was a little twenty-by-thirty-foot water tank in the back part of 7 that I had moved up from Building 227, which

was in that building prior to the Gemini docking training. We disassembled it and moved it up to Building 7 and we were doing in it during the Apollo Program, during all of our EVA neutral buoyancy, EVA training and so forth and Gemini training.

But obviously that thing was not suited for Skylab activities and crawling out on the LM telescope mount to do the film replacement and all of those sorts of things that we had to do on Skylab. So I started the process of getting another water tank, which took me several years, which we put in the rotunda of what used to be the centrifuge. That worked for the later part of Skylab and ASTP [Apollo Soyuz Test Project] and some initial stages of the Space Station development work. Now I understand they have a huge one out at the Sonny Carter [Neutral Buoyancy Laboratory] thing, which that building was built at one time to be the staging area for the ISS. When that went down the tube, they needed to figure out something else for it. So that's when they put the full-sized facility in the ground there to do the neutral buoyancy training for the ISS. Of course Marshall is out of the loop, I think, now in terms of their water tank.

So that's kind of a little history on mockups and trainer.

BUTLER: There certainly have been quite a few different mockups and trainers and simulators all along the way.

GRIMM: Oh, yes. We had a bungee trainer at one time in Apollo 7 so that the guys could bound along like they did, and they were by springs. You heard about that, the 1G Bungee trainer that was in Building 7?

BUTLER: Heard a little bit about it.

GRIMM: Of course we had the air bearing system that Ed White tried to train on for his [EVA] device, which is now that same air bearing thing which a guy by the name of Johnson came up with. But those [steel] blocks that I put in storage at one time and then moved those over to that building, whatever that building is called now, where the big mockups are at.

BUTLER: Building 9.

GRIMM: They used that air bearing facility there. It's the same facility that we had built back in '64 so that the people could stand on pads and move themselves around with this little nitrogen thruster that Ed White used to do his EVA.

So almost everything we did at NASA was part-task. Part-task here, you'd break it up into little-bitty tasks and try to build something that would do that. Very seldom were we ever able to put something together to simulate the whole thing from end to end, that included our fixed based simulators, the Apollo simulator, AMS, the LMS [Lunar Module Simulator], Skylab simulators, Gemini simulators, they were all part-task in one way or another, just like the LLTV.

We had a simulator for the LLTV in Building 4, a little fixed base, so that the crews could get used to all the controls and displays. It had an old B-52 visual system put together that I got from Hill Air Force Base [Utah]. We modified that and scrounged some analog systems to drive the display so that when the crew made an input the picture changed and they could flip switches and go through all of the motions they needed to get familiar with it. They spent about

ten hours in that simulator before they ever got out to fly the LLTV. The LLTV [simulator] was a simulator's simulator's simulator. [Laughter] So that's what we had there.

BUTLER: But it's what you needed.

GRIMM: That's what we needed.

As a part of the Skylab, we finally got the trainers built and in and then we started working with all the experiments. So all of the experiments, instead of Marshall doing them down there, we did them all at JSC in that Skylab trainer that I had moved over. The same thing was true for the multiple docking and after then for the LM Apollo telescope mount.

So we had a number of experiments which my organization was responsible for. One was the flying jet shoes. Another one was the backpack, where the crew flew inside of the Skylab. I don't know whether you heard of that or not. And a number of others that I and people I had assigned in my organization were responsible for managing those activities. In addition, of course, we had a lot of the medical folks had a number of experiments such as the treadmill, the Lower Body Negative Pressure [LBNP] device and, of course we had all the food servicing things.

The crews actually went through living there, except for sleeping in the hang-up bags. So our mockup was very representative in terms of practically everything that you could do in 1G. Remember, we had a window that looked toward Earth where you could attach a camera and we did those experiments with wooden ones and with a real one, but without the weight in it. We had an airlock that you'd expose to the sun side, where you put out that. We had all

those experiments. The crews actually went through the process of unstowing those out of the containers, putting them together, going through the protocol as if they were actually doing it.

I actually had a team of people go through every experiment and every living function in the Skylab, in the MDA and on the Apollo telescope mount, had it filmed professionally and gave Kenny a set of the film. The program at that time had a set of film, so he had two sets of film. There is another set someplace. [Laughter]

So those are some of the things we did on Skylab. We worked with the crews when they had to go out, mainly to Martin here to get on their simulator, which we strapped a guy on and then he could fly his hand controllers and simulate the same thing as his backpack, which was a precursor to the EMU [Extravehicular Mobility Unit] backpack.

Then about the same time as doing that, we started to work on the ASTP mission. The people in that workshop that I had told you about that we had built a mockup of the ASTP so that the crew could practice hooking the vehicles together and going through the airlocks, opening the hatches and going into the Soyuz and so forth. So that was the main function that we had with that one, plus the experiments that the crews performed during ASTP. There weren't a lot of them, but one of those experiments was managed by the division that I was in later when I moved over to E&D [Engineering and Development Directorate], which we had responsibility for, which was to find out if there was a third oxygen molecule in space, I think was—and I'm not sure about that. That doesn't sound, but it had something to do with the third spectral line of an oxygen molecule in space which is validated by this experiment. So there were a number of experiments developed for ASTP, and four or five of those experiments were managed by my organization that I was involved in over experiments. This was in addition to E&D.

BUTLER: In all those planning for the experiments, both on Skylab and on ASTP and the training for them, were there any surprises as they were training or trying to, as you said, unstow it, put it together, put it up and running, that prompted any major change? Or did it—

GRIMM: No. You work out, as I mentioned earlier, just like I and other people in my initial organization went and flew simulations and then we developed the procedures and we changed things and manipulated them and changed hardware and so forth until we were reasonably satisfied we had something that was workable. Then we'd bring the crews in and the crews would add those inputs.

It was an evolutionary type thing so that I don't think we ever ended up with something that was a total flop or that we had to completely redesign. It was more of incremental changes that we made right up to flight on a lot of things as we learned more and more about the experiment and how the crew could operationally interface with it and control it, whatever it was. That's how you do a reasonable program. Not something typically like we did with LLRV/TV where everything was rush, rush, rush, where we never had enough resources, never had enough people, never had enough money, never had enough time. But we did it, and without loss of life, which I think is a big credit to the program, considering how risky it was.

So those were the major things that we did in Skylab. About that same time, the organization that I was in, flight crew operations director[ate], flight crew support division I was in, was getting very large. Some people…thought it was getting too large for Warren [North] to manage. We had 650 people, which is a large organization. We had two assistant division chiefs, Pete [Carroll H.] Woodling, Jim [James W.] Bilodeau, and we had myself.

So it was decided at the director level that we should split the organization into pieces that were presumably more manageable, although all they did was take Bilodeau's organization that he had under him and his branches and that became a division. They took Pete's organization that he had with all the simulators and made that a division. Then they took all the stuff that I had and made that a division, and moved Warren on staff as an assistant director to Deke. A lot of politics [were] involved in that whole machination that went on, and I'm not going to address that.

But it became a procedures division which Bilodeau had, a training division with Woodling had, and the flight crew integration [division] which I had at that time. That was probably at the end of the Skylab and at the start of the ASTP as I recall. That went on for a couple of years.

Skylab program was interesting in one respect in that on the first launch we had the micrometeoric shield ripped off and in the process it ripped off one of the solar rays and pinned the other one down without ripping it off, pinned it down with a piece of shrapnel of the remainder of a piece of metal had hooked the wing so that it couldn't fly out and then the solar rays deploy. With the use of some scanning cameras and tracking cameras at the Cape and some classified Air Force cameras on the ground and otherwise, we were able to see exactly what was holding that wing down and the nature of it to the extent you could see it in actual size, which was a six-inch piece of metal holding that wing down.

So one of the people in my organization at that time, because now all of the GFE equipment had been transferred under me as part of this reorganization, which meant all of the cameras, the pencils and paper and film, you name it, anything that had to do with crew equipment excluding the suits was under me in this division that I had.

So Jim [James A.] Taylor, who was a section head of one of the crew equipment sections, went down to Sears and bought a pair of tin snips and modified those to be able to work them with a gloved hand and had Pete go out and do a little experiment to see if he could work those things to cut that material, because we got samples of the same material that held that wing down. That was the instrument that he took out, or the tool he took out, when he went EVA to—that was the first thing he did when we finally got up there was to go out and cut that piece of metal loose and then stand back because that wing went out and then the solar ray deployed.

Of course the next step was because we lacked the—the micrometeoric shield was also our sunshield. Now we had no sunshield, so the telemetry said that the temperature in the Skylab was getting to the point where it was going to ruin all the film in the film vault that we had up there. All the film was going to be sent up at one time in this big aluminum film vault. It was supposed to last for the thirty-day mission, the sixty-day mission, and the ninety-day mission. It was getting to the point where the film would be hazed and be unusable for any scientific work if we didn't cool that compartment down. So one of the things we had to do was to figure out a way to put out a sunshield that would be over that vehicle in some way.

One of the men [Jack A. Kinzler] over in—I guess he was the division chief of tech services, was a handy guy, I think in a lot of respects in terms of mechanical things. He came up with a device, which was basically a collapsed umbrella, only a big one and sort of like a fishing pole so that once you pushed the umbrella out and extended it and the fishing pole, you could just continue to go out.

However, the problem was that what were we going to hook the fishing pole to and how were we going to get it out there? The thought was that we were going to have the crew go out

and carry this as a bundle under his arm in EVA and figure out how to string it from some point to some point to some point to give us the shade that they needed.

Because the sun-looking airlock was sun pointing, and we had our trainer unit there but Marshall had a prototype unit that they used to qualify that system with for a number of experiments that got put out of that airlock area. This box was about yea long, six feet long, maybe a little longer, and so I told Kleinknecht that Marshall had a box that was the prototype that with a little finagling could be flight qualified since it'd gone through all of the environmental testing. If Kinzler could shove all of his umbrella device inside of that thing, we had a pole that was already made with a seal where this pole could be hooked together and shove the experiments out the door.

Well, instead of that, we would pack Kinzler's umbrella expandable device inside of that package, and if that thing would fit inside the command module, we could launch that. They could take it up, hook it up to the airlock, and without doing an EVA, actually extend this umbrella out and it would automatically expand like this automatic umbrella and we would all have our shade. They took me up on my suggestion, and Kinzler worked his part of it and I worked the other part, the box, and the stowage with my people. And that's what we had on Skylab as our first shade.

Now, that thing was pretty flexible and the sun was getting to it, because this was done within a thirty-day period. He was supposed to launch shortly thereafter, you know, Pete was, and his crew after the Skylab was put up in the next three days or something like that, maybe a week.

But in any case it was a short period of time. It turned out to be like thirty days and we were approaching the peak limits on a bunch of things in the Skylab. That device served for that

thirty-day mission, plus I believe the thirty-day gap that we had between the first and second missions. The second group went up and strung another one, manually, EVA on the outside of the other one, and that then worked for that mission plus the thirty-day gap plus the next ninety-day mission on there.

So there were a number of little things like that that we did on Skylab, but that's the one that comes to mind as an interesting little project that I was involved with along with a number of my people.

BUTLER: Certainly a very important project to keep Skylab functioning.

GRIMM: So you said here, Skylab, what other responsibilities? I think I've covered the number of things that I've done along the way.

BUTLER: Sure, you covered Skylab pretty good.

GRIMM: Then you've got here, after Apollo XIV I became the chief of flight crew integration division. I think I've told you about it already the work in there and what the primary responsibilities were of these numbers of teams that I had and these people who did these various different things.

BUTLER: You covered that pretty well, I think. We talked about the Apollo Soyuz.

GRIMM: You said how was it similar and how was it different, and I think we've covered all of those things.

We worked, as I've talked about, on Skylab's experiment integration package. I think we've already covered that and how I got involved in it. The main reason I got involved with it is because I will take credit for the fact that we did get the training transferred from Marshall to JSC, that 1G training. We already had the simulator training, but had I not pushed that all of that work would have been at Marshall and the roles and functions of the centers at this point in time might be different than they are now. That's just conjecture.

BUTLER: I think it would have changed a lot.

GRIMM: They certainly would have gotten a lot of experience. Of course, they did anyhow because Marshall put together the floors with that grid pattern. They put together the handrails. They put together the food lockers. Of course, JSC actually did the food. But they put together the sleeping activities, the trash dump, the water tanks, the storage lockers in the upper area, those sorts of things. They did the environmental system. They did the scrubbing system for the CO_2.

BUTLER: The lithium hydroxide cleaner?

GRIMM: No, the molecular sieves. The molecular sieves is what we had on Skylab because that was a continuing thing. You had two banks of the molecular sieves, and you would work one bank until all of the sieves were filled with the little CO_2 molecules, if you can imagine them as

little jellybeans that wouldn't go through the hole while the oxygen did. So that scrubbed out the CO_2 until they got full, then you'd close that off to the interior and you'd open up the other one and operate in. Then you'd open this system that was presumably saturated and vent it to the hard vacuum, and it would suck all the CO_2 overboard. Then it would be cleaned, and then you could have that one ready as your alternate scrubbing system for CO_2. That's a simplistic way of describing that, but I'd even forgotten about that.

BUTLER: Interesting system.

GRIMM: So as I said, they were involved and got a lot of initial work done in human factors, assuming that they were going to continue in that. But there were some changes in management, changes in Headquarters and I think that for the most part has sort of gone away, that JSC is still recognized now as the crew interface and the human interface to the spacecraft, and Marshall is mainly the engines and the module and so forth.

But there was a lot of politics involved, and they had a very vocal spokesman for themselves by the name of [J. R.] Thompson down there. He was a branch chief at the same time that I was probably equivalent to him. He was a very vocal guy. Later he became the manager for the Shuttle engines for Marshall, and later when the *Challenger* accident occurred he was on the accident investigation board. He had by that time retired and he was working for Orbital Science Organization, he was the vice-president, I believe. Then he went and either chaired the board or he was next on the board. I'm not sure which one he was.

Then he came back to NASA as the deputy administrator on that job, and now I forget where he's at. He's not in NASA anymore, but he was a very aggressive individual. He was

even more aggressive than I was. I always had in a backhanded way hand it to him. But he had a lot of support for his position from his management down there, and I sometimes had to really work on that. Reg Machell, in the program office, and I don't know whether you've interviewed him or not.

BUTLER: Not yet, but we're hoping to.

GRIMM: He was not what I would consider an aggressive individual and had to do a lot of convincing. One of the things that we started on was this attachment to the end of the manipulator arm that the crews stand on and has a pedestal with all the tools and so forth. Well, he thought that was a bunch of crap. We had to work on him and the program manager for damned near a year until George Franklin finally showed that as just a foot restraint, and then we kept adding on to it and adding on to it.

Now it's a mandatory piece of the system, so that the crew doesn't always have to tether himself and control his body and all the other problems he has when he's handling large pieces of equipment out there, such as the Hubble Telescope replacement-type things where it gives the crew a very stable platform and all of these tools at hand to do that.

So those are a number of things of the types of things that we when we were in the crew area, and even when we weren't in the crew area, when I was in the engineering area and George was still in crew organizations, we really had to fight for all of those things. At the time people would say, "That's not very important," or "We don't need that." Like, "We don't need a window in Skylab that's optically clear." But once it was and we put a large camera in that

window and we took all those neat pictures, we had the same problems coming up in the Shuttle.

"You do not need an optical window in that side hatch." "Well, it's been very valuable." Guess what, comes around to the ISS, "Who in the hell needs an optical window in the ISS?" Well, there is one now, but it took a lot of work by some very dedicated people to get an optical window in there and it's going to be very, very useful for a lot of different reasons.

That's probably one of the criticisms that scientists have of NASA as an organization, because they think it's engineering oriented and engineering run and we don't listen to the scientists. In many cases that's true, and in many cases it's tied to cost. Other times, it's tied to whatever whim the particular program manager has at the moment. A lot of people would be surprised to see that many of the astronauts, even just the operational piloting types, see a value in a lot of those things that the program doesn't see, mainly because it's schedule or cost that's involved.

Just like the inward-opening hatch. We, I say we, I wasn't involved. It was Warren North and the crew looked at that activity and went and pitched to the program manager, whose name I have never said yet and I'm not going to, said, "It's too costly and it's too much of an impact to put an outward-opening hatch in there." So we didn't, and what it cost us was three astronaut lives and a hundred to two hundred million dollars. It's just in rework, not considering the rework and the module we lost and everything else.

So people attach price tags to things, perhaps when they don't have a good appreciation for crew interfaces and the safety of operation. That was the thing of course that I and my group of people always looked at. We always looked at what makes it operationally easy for the crew to work with this device, what do we need to make it safe for the crew to operate with this

device, and thirdly, what do we need to do to this device to make it functionally useable or scientifically useable and get data back. It was kind of in that order, and that's the way you have to put your priorities. But sometimes we had management who would just worry about cost and schedule and not worry about these other three items that I've talked about.

Where are we here?

BUTLER: Talking about and mentioning the window in Skylab and such, was this when you began to become involved with the Earth resources work was during Skylab and as you were looking at some of these experiments? Or did that come later?

GRIMM: Your question is how did I get involved with experiments, or how did I—

BUTLER: Specifically with the Earth resources package?

GRIMM: I was involved with them because, since my function was the flight crew integration function. Then I had a number of people assigned to follow every experiment that the crew was involved in. In most cases before the crews ever got involved with those experiments that our people had looked at those experiments, evaluated them, gone through preliminary procedures, done the experiments themselves, whatever that was, and developed the first time lines and procedures before the crews got involved, just like we did in the original one I was talking about when we'd fly the simulations and evaluate them and develop procedures and so forth and work out some of the bugs and then get the crews involved for their evaluation.

We did the same thing with all the Skylab experiments. So as I said, I had people assigned to groups of experiments, medical experiments, solar experiments, Earth looking experiments, interior experiments and so forth. So that it was their responsibility to make sure that all the safety aspects were looked at, all the crew aspects were looked at, all the time lines were developed, the procedures were developed so that we could give all those things to Tommy Holloway's group at that time to integrate into a set of procedures in a total time line for the missions to accomplish.

About that time…the FOD got disbanded, the FCOD [Flight Crew Operations Division]. I don't know whether you heard of that or not.

BUTLER: Some.

GRIMM: The way you say that, I'd be really interested to know what you know about that, but let's let it suffice to say that it was disbanded. A lot of political overtones associated with that. As a matter of fact, it was specifically political overtones that caused that disbandment of the flight crew ops directorate.

As a result, [Eugene F.] Kranz, I believe, was the director of FOD at that time, because I believe [Christopher C.] Kraft [Jr.] was the director. So they wanted all the mission planning and procedures work in their organization, mainly because they saw how good Tommy and that group had done. Because it got to the point where FOD used to be at the consoles and trying to do the flight planning, but when they got in a pinch they'd ask Tommy to come over and sit in and to assist them in their work during the mission, and it got to the point where he actually had his own console there and operated pretty much as a right arm of the capcom, in terms of

passing out procedures and so forth although Tommy was very good at working with the FOD systems people. So that's how that organization for it went.

The training organization, FOD didn't want the training organization with all the simulators and things like that. As a matter of fact, they were almost trying to build their own simulator organization themselves and they accomplished that to some degree. Again politics were involved. But for whatever reason, and I'm not even privy to this one, that they didn't want that organization. So it was going to stay in a flight crew organization.

My organization was split in three different pieces. One part stayed with flight crew. One part went to another division in E&D. The other part went to the organization I eventually went to. I have to be careful how I say this. There was some discussion about who wanted what, who wanted who and why.

I will say this, this is the only part I will say, is that in my discussion with Max [Maxime A.] Faget, he called me over and said, "I've got a couple of openings in my organization as division chief, and I'd like for you to consider it." I asked him why was he considering me because the whole thing was separated from my organization. His comment was, he said, "Well, I have watched you over a period of time, and I have had other people evaluate you and I've polled all my division chiefs about what they think about you and others." His comment was that their total evaluation was that I was probably the best manager at JSC. That was more than he could say for some people, including some in his own organization, and that he would be glad to offer me one of these several positions if I wanted to take them.

Well, it is kind of like being hung out to dry when your organization's disbanded and parceled out and you don't have the benefit of any input. So I went to talk to this one other gentleman in another organization under Max and I decided that there were better things in life

I'd rather do than fight with that individual for the rest of my career, and so I took what Max considered to be the lesser desirable option. I took this other division because he was moving the division chief out of that organization for reasons I won't go into, and said, "That organization is yours." But he said, "It's a hell of a mess, and you do whatever you want to with it, but don't bother me with it."

That's just the kind of direction I like. So in about a year's time I reorganized that operation. It was split in five different buildings at JSC including a piece that I was eventually to get and bring over that I had in my old organization, which was all of the GFE crew equipment excluding suits and camera gear and all that sort of stuff and the design group which I really wanted because you can do a lot of things if you have your own design group. And some of the shop equipment. I wasn't able to keep it all. That went to another organization.

But over this next year's period I physically booted two other divisions out of Building—I forget which one—17, 16, it was two buildings over from the auditorium.

BUTLER: Okay, it's one of those.

GRIMM: Maybe 14, I can't remember. But some of these people wouldn't move, so one weekend I told them if you don't get your people out of this building by such and such a date, the next day when you come to work, all your stuff will be out on the lawn. They did not believe me and that's exactly what happened. So I vacated their desks, their books, their everything, and stuck it outside. Of course, I told Max what I was doing and the assistant [directorate] chief that he had, Bob [Robert A.] Gardiner.

Bob Gardiner said, "I don't care. Go do it." He said, "These people need to get their facilities aggregated and I've been telling them for months…what to do, and they wouldn't do it." So of course they went bitching to Bob, and Bob said, "Tough, you're out of there. So you figure out what to do with your stuff now."

So here I had five groups who were pieces of five previous organizations that had never been integrated. So I spent a year putting them together, integrating them, getting them to talk to one another, reorganizing them, having them all in one building. At the time I ended up with a building that had the accumulation of stuff from Gemini, Apollo, Apollo-Soyuz, had the measurements systems and calibration lab for the Center where all the instruments for the Center come in. I inherited that when I inherited this lab. I inherited an IR [infrared] group. I inherited a microwave group. I inherited the GFE group, and I inherited a couple more groups and all of the aircraft Earth resources operations.

None of it was working very well, and the building was full of obsolete equipment. So I spent a month inventorying. I don't know if this is of interest or not, and you can eliminate it if you want to, but I'm just going to tell you anyhow. [Laughter]

BUTLER: It's interesting, absolutely.

GRIMM: So I just spent a month inventorying the entire building and making everybody in that building justify every piece of equipment that was in it. When they couldn't justify it, I said it's surplus, and I called up facilities people. I can't remember who handled all the surplus equipment on the site, back in the back forty someplace. L.C. somebody, was the division chief. I surplussed all that equipment. We physically ripped it out of the building and set it outside and

had somebody haul it away. The rest of the equipment that we needed, which were the small vacuum altitude chambers and all of the MSCL equipment, measurements and standards equipment for calibrating all the equipment on the Center, I aggregated it back in the high-bay area. Then we put people in all those rooms.

Then the next thing I did was it was such a dirty, filthy place that I asked facilities to paint it. They wouldn't paint it so I had my support contractor buy fifty gallons of paint, and over one weekend we painted the whole building, which irritated a bunch of people. Painted the whole building, and then I appropriated carpet and without authorization from facilities carpeted and made two carpeted rooms and put pull curtains between them so that we could have different meetings at different times. I put in a music system so that we had elevator music in the offices, segregated smokers, and in general cleaned up the place, raised morale, hung nice pictures on the walls of the space program, and so forth.

That was just the start of getting things going, and then I started working on the technical aspect of the program. Most of the programs were in fairly good shape except for our microwave program and our infrared Earth resources operations. At that time I still had responsibility for the Skylab experiments. That division had some of the responsibilities, and then I transferred the rest of them over. So we continued to monitor or build and develop experiments that were to fly on Skylab and subsequently ASTP with a group of people.

In addition there were five airplanes at Ellington. We had a C-130. We had a P-3. We had a Lockheed Electra. We had a U-2 and we had a B-57 and we had a couple of helicopters and then we had some ground systems. All of these were to support an Earth resources division that was over in the science directorate and Goddard [Space Flight Center, Greenbelt, Maryland] and Purdue University [West Lafayette, Indiana] and a number of other universities in

developing the science of predicting crop productions and many other things, salt infiltration, bugs, crops growths, area growths, forest, infestation of bugs, inventorying commodities. All of these things were done with ground-based systems on the ground to get ground truth, helicopters for a little bit higher, C-130s and P-3s for a little bit higher, up to 30, 40,000 feet, and then the U-2s and the B-57s for up much higher.

Then the ultimate thing was to support Skylab when it flew and to take all this data and aggregate it and process it. I actually then built a computer processing facility that hadn't existed before I arrived, ended up with one of the biggest ones in the Center, except for the main processing mainframes over in ISD [Information Services Division], so we could process most of all the data that we accumulated on all of these vehicles nonflight, and then also some of the flight data we processed from Skylab. So it was a top-to-bottom iteration of data and then correlating all that data top to bottom so that then you could do an evaluation of whatever resource it was you were looking at.

The problem with all of that was that a lot of the equipment we had was obsolete, wasn't well organized, we couldn't make changes fast enough to support different investigators and science investigators from all over the United States and universities and so forth, or even our own. Everybody was pretty parochial so I made the decision that we were going to modify the C-130 and the B-57 and the U-2 and put in a system where we could do like a snap-together system.

In other words, if I wanted to fly a completely different mission, if I wanted to fly a camera mission today and I wanted to fly a UV [ultraviolet] or IR mission tomorrow on a B-57, I wanted to do it. Well, it took us maybe two weeks to do it before or maybe a month, because these things were hard mounted in the payload bay of the B-57, as an example, and in the nose.

So what I did was I had an interchangeable nose built for the B-57 and put different instruments in each nose, so that we'd run the dolly under the nose that night, take the dolly off, stick a new nose on, had a patch panel built in, run new cables back to the payload bay where the computer was and where our data recorders were and repatch it and we're ready to go as for the nose.

All the instruments that fit in the payload bay underneath were hard mounted again. I said, "That's never going to hack it." So I took the doors off, I had tech services build me a bunch of pallets, one six-foot pallet and some three-foot pallets and hooked up a cable system so that with a dolly we could run under there, hook two cables or four cables to the dolly, crank it up with a crank, cinch it in place, do a patch panel, check and patch all the instruments into the patch panel and to the recorders, and we're ready to fly the next day.

So we did that on the B-57, did the same thing on the U-2. We ripped out all the fixed installations on the C-130, built a new nose on the 130, put in a scanning radar system, which they said couldn't be done, and ripped out all the fixed installations inside the cabin, put in rollout cabinets with all of the control systems and recording systems and crew stations inside the C-130. Put all of our instruments on quick hangars that we could stick under the tail or on the ramp door or on the wings so that we could reconfigure those airplanes totally, and we could be flying in South America yesterday, land at JSC that night, and one day later we could be in Alaska on a completely different mission.

So that was some of the fun and games that I had with that organization in the experiments systems division that I had formed and so forth. Another thing I didn't like is when I first started out working for NASA, we had NASA engineers doing all the front-end work. So

we knew what was going on all the time and used contractors to do the handwork, the hands that you didn't have because you didn't have all the hands for resources.

Over a period of time, we got away from that philosophy across NASA, where we hired contractors and we became managers. I don't include myself in that category. Our people got upgraded, and instead of flunkies, 9s, 10s, 11s, 12s, 13 grades, they become 14s and 15s. They got to the point where they didn't know how to do anything except monitor contractor's work and monitor the contracts. So we were gradually losing our technical capability. That's not just in my organization; it was across NASA. It is across NASA now even more so than it was when I was there.

You're losing a lot of old heads, or you've already lost them, like me over a period of years, and they haven't been replaced because that philosophy is not there. I say.

BUTLER: You're not the only one to say that.

GRIMM: So what I told my guys in my organization is you're going to use your contractors to implement stuff, but you're going to do the initial brainwork, you're going to do the planning, you're going to do the budgeting and you're going to see that it get built and we're going to use the contractors to do whatever we want.

So I gave several of my branch chiefs this directive. I said, "I want you and your people to use this design group that I have here, and I want you to design your side-looking radar. I want you to design your IR instruments. I want you to design your camera systems. I want you to design all of these things that we're going to do and put on these airplanes to fly, because I

want you guys to have that knowledge back in this organization. If you don't agree with it, then you're free to transfer to any organization that you like in the Center or out."

Some of them took me up on it and they left. That was fine with me, because I didn't want those people in my organization. I hate it when a contractor can do or did work that I don't understand, and not only that, that I'm not in a position to understand because I haven't been following it from a technical standpoint. I didn't think that's what NASA was organized to do. We had some other gentlemen at the top like [Daniel S.] Goldin who think differently, and I certainly don't agree with him on many of his philosophies but he's the administrator and I'm retired so it doesn't make a hell of a lot of difference what I think as far as he's concerned.

Speaking of him, he's gotten rid of a lot of people who have my same philosophy and put in people who at least espouse his philosophy or follow his line of thinking.

BUTLER: It's certainly changed a lot from the early days.

GRIMM: Oh, yes, it has. I think you can tell that from the way I've described what we used to do when we first started in the programs way back on Mercury. That was one of the first tasks I had when I came on the program, other than the LM instruments, was to work with John [H.] Glenn [Jr.]. It was doing a manual reentry simulation of Mercury, and that's an interesting thing to do.

Scared the hell out of me when I did that because I said I don't want to be an astronaut if this is what you've got to do. But it was one of these things where you actually got in there and did the engineering yourself and understood what was going on. Then when the crews flew, you understood precisely what they were doing, which I think is a good thing.

So I think I've talked about this, didn't I? I was recognized for creating a rack system to carry the experiments on the C-130.

BUTLER: Yes, we talked about that.

GRIMM: But that applied for the same work on the U-2 and the B-57. Interestingly enough, after we did all these things and were a tremendous success, including using that side-looking radar in the nose of the B-57, we mapped all of Alaska. They are making a big deal out of this one that just flew where we mapped the world, but I mapped Alaska way back when, when we didn't have GPS [Global Positioning System] or anything else with side-looking radar. I actually did the data analysis and data correlation and distribution of the data in my organization. That's why one of the things that I did to develop this large computer lab that I put together that people said I shouldn't have, but they said that about a lot of things that I did.

But anyhow, after we were a tremendous success doing this Earth resources stuff with the airplanes, there was a lot of complaints by Langley and especially by Ames [Research Center, Moffett Field, California] that we were doing work that they should be doing. Then Langley got into the act with Wallops so they sent the U-2 and the B-57 to Ames. They sent the C-130 to—where did they send the C-130 to? It might have gone to Ames, too. They sent the P-3 to Wallops. I forget where they sent the helicopters. Anyway, Kraft agreed and they disbanded our total organization there, and on to bigger and better things.

At the same time, we were working on Shuttle. Since we weren't working Earth resources and Skylab and ASTP had come and gone, and I started looking at what Shuttle payloads we were going to have. We were assigned by the program office to develop a small

organization that had the proper clearances to support some national organizations and work with Headquarters and those organizations to develop and fly those payloads on Shuttle.

In the process of looking at this activity, I thought, "Well, now, why can't we fly a package that's related to things of interest to OSTA, as an example, or OAST?" I'm not sure those are the same; they're not, are they? OAST is Office of Aeronautics and Space Technology. OSTA is Office of Shuttle Transportation; is that right?

BUTLER: It sounds right. I don't, unfortunately, have the acronyms here.

GRIMM: I can't remember. It's been too long.

BUTLER: I can check that. We have copies of old phone books, so I can pull those.

GRIMM: Okay. So anyhow this had to do with Earth-looking experiments. Not necessarily Earth resources, but Earth-looking. I got our guys down to brainstorm. We sat down in a meeting and we brainstormed a number of things over a period of weeks. I said, "Well, why can't we get a pallet," although Marshall had dibs on the pallets again. Here's Marshall again getting into the act to placate—and of course at that time they had somebody at Marshall who was at Headquarters in a position to divert work to Marshall. So they had the pallet design responsibility.

But I said, "Why can't we get a pallet, and why can't we develop a package of experiments that looks Earth-looking, such as the large-format camera as an example?" Good story about that. But that large-format camera, I don't know whether you've heard of it or not,

that did fly, twice, but there was so much politics associated with it because it was part of the K[H]-11 Blackbird satellite program that was classified. Lockheed built the system and launched it for a national organization.

We sort of slid this camera out from under the umbrella of classification and said we wanted to fly it. Well, I had two problems. One was the classification. The second one was that the gentleman in Headquarters who we had to get authorization from by the name of Pitt Thome had committed to JPL [Jet Propulsion Laboratory, Pasadena, California] that we wanted a thematic mapper [TM]. This camera would conflict with this thematic mapper that he wanted to fly. So his attitude was we were going to kill this camera so that it wouldn't deplete the funds or interest from the scientific community. I was just as determined that we were, and so was the project engineer I had on the project named Bernie Moberg, who was a fanatic when it came to this camera.

This was a 24-inch focal length camera, which probably doesn't mean much to you. The lens weighed 600 pounds and almost two feet in diameter and had the capability, was totally color corrected, no streaks whatsoever, and could take phenomenal black and white, color and UV color corrected pictures and very sensitive black and white with a resolution if it were allowed by national organizations of less than three feet at that time, which is even pretty good now.

So that was a big problem, so I fought the battle of that at Headquarters. Finally we got approval to go build that system, which we did and we flew it. Then Pitt Thome deep-sixed the system, said it doesn't have any scientific merit, although we mapped two-thirds of the world between the sixty-degree latitudes or fifty-seven fifty-seven that we were flying in Shuttle.

Maybe not quite that high. It was a good portion of the civilized world that we mapped when we didn't have cloud cover, and with different kinds of film.

It was all stereoscopic because this was a moving Shuttle camera where the film moved while the vehicle was moving. So you got a picture here and then so many seconds later we got another picture at a different angle because we had it on a rocker so that the camera would look at the same spot and therefore with two pictures looking at a different spot from a different perspective, you get stereoscopic perspective and enhanced altitude of the landform.

As a result of our pushing, over his objections, we sneaked a few questions to a friend of ours, a legislative aide on one of the senators who was interrogating this gentleman on a Hill review and got him to admit that this was a good thing to do and got the funding for it that way. He accused I, and Bernie, of manipulating the system, and if he ever proved it then we were fired on the spot.

Fortunately there's never been any verbal proof of that until right now, [Laughter] which is still kind of funny.

BUTLER: Well, it certainly sounds like it was a very useful system.

GRIMM: It was. Of course that thing is rusting away down at New Orleans, at Stennis [Space Center, Louisianna]. We spent twelve million dollars on that system, fantastic system, and because he hated it so bad, it never flew again after two flights.

That's kind of the breaks of the game. But in any case, we continued and that was one of the things that flew on its own separate pallet that we finally got it on. Bernie managed the

camera and Curt [James C.] LeBlanc and Jack [Jackson D.] Harris managed the pallet and the integration of that pallet with Rockwell and the flow through the Cape.

But the other pallet was actually a pace finder for all pallets that went through the Cape in terms of flow, because our OSTA pallet was the first actual-sized pallet. The Air Force pallet that flew on the first mission was not. It was just an instrumentation pallet with a single post and yeah wide with a lot of instrumentation. Ours was a full-sized pallet.

We actually then worked with other centers and other experimenters to put together the package. We put together the SAR package, the one with the big antenna. JPL found out what we were doing. They went to Headquarters and got Thome to assign them the responsibility for the recorder and the evaluation of the data, but we still had the responsibility to put the hardware together and to get the antenna built by Ball Brothers and to put it in there as a fixed angle.

We had put together the whole package, and I went to Headquarters and sold it not only to Pitt Thome, but to the associate administrator for OSTA and got the funding for it. I sort of got my proverbial you-know-what in a crack because the associate administrator called up [Chris] Kraft and says, "Hey, that was a great presentation that Grimm made up here, and I assume you're 100-percent behind this." And Kraft says, "What are you talking about?" And he told him, and Kraft sort of hesitated and says, "Yeah, we're 100-percent behind it." The guy says, "Good, you got the funding. Grimm's got a good plan there, and you got the organization to do it, so everything's authorized."

About a second after that call, I got a call from Kraft and he said, "Get your ass over here," and he sort of nailed me to the wall because I hadn't gone through the program office, even though there wasn't an interface for me to go through really. So they created an interface. They created an office to manage me while I was doing the work. That made Kraft [happy]—

BUTLER: That's pretty good.

GRIMM: Well, isn't that the way things happen?

BUTLER: Absolutely.

GRIMM: So that manager really didn't give me a hard time. His name was Dick Moke, quite a character to deal with but he was a lot of fun. Fortunately he was a guy I could work with, because otherwise I would have had to kill him. [Laughter]

BUTLER: Before we go any further, I'd ask if we could go ahead and [change the tape].

[Brief interruption – tape changed]

BUTLER: We're on.

GRIMM: Okay. I'm not going to discuss the experiments in general except to say that we worked with JPL and Wallops, Langley, a number of universities, which were horrific to work with. Not terrific, horrific, because those, quote, "scientists," the P.I.s [principal investigators] thought that all the money that we sent to them was theirs for their personal use. If they missed schedules or didn't provide it on time, just send them more money and solve all their problems. So we had quite a problem in that. We had to, as a matter of fact, in several cases replace the

P.I.'s, which caused a lot of turmoil in the universities because we couldn't get them to provide the work that they had contracted to do.

During the same time that we were developing this first payload for Shuttle, which we did, and as I said earlier it was used as a pathfinder for all the functions at KSC flowing through the payload facility and onto the stack and into the payload bay and so forth. During this same time or about the same time, we had discussed with OAST or OART, I'm not sure which one it was at the time. I think it's OAST, but it might have been OART and then OAST. You know they changed the lettering of those organizations up there. But it was Shuttle experiments, and I can't remember what the Shuttle experiments were called and you don't have it here [referring to pre-interview notes]. Maybe you didn't find it.

But what we did was we put experiments on Shuttle. On one of the Shuttles we replaced the tail pod up on the rear tail with an IR camera. With this IR camera during reentry we could photograph the heat flow across the upper wings and find out what the heating values were at any point on the top side of the Shuttle. We replaced the heat tile at various places on the vehicle with different types of experimental tile. On the wheel-well doors, we actually put a sensor inside the wheel-well to see if we could come up with a device that would give us a measure of altitude because with the plasma flow around the vehicle during reentry, it's very difficult to get an altitude reading and get an update with the radar altimeter on the vehicle.

So there was a whole series of experiments that was funded by and I'll say OAST that we—I was trying to think of the associate administrator we pitched it to. Hinners, I think, Noel [W.] Hinners. He's out here at Wateron [Colorado] at the Lockheed plant as a vice-president of something. But he was the associate administrator. We pitched it to him and we got it approved and then we had to pitch it to the Shuttle program manager and then we had to pitch it to

Rockwell and then we had to worry about the integration of all of these experiments so that it wouldn't affect structures, it wouldn't affect loading, it wouldn't affect heating, it wouldn't instrumentation, and all of these things.

Then we finally got our own recording package installed so that we could record the data with our recording package. That, after I had initially pitched it to Headquarters with Max Faget and got it approved…I assigned it to Don [P. Donald] Gerke. Don Gerke managed that with a group of people in my organization, and Don Gerke was my assistant division chief at the time when I had the experiments systems division. He's the gentleman that I said had passed away with a heart attack about five years ago, who went to sleep and didn't wake up, a terrific young guy.

So that was another activity that we did in conjunction with the OAST. Of course during this, about that time after we'd flown that OAST or OSTA package, whatever it's called, and this Shuttle experiments package, some little acronym that it had—

BUTLER: Do you remember which mission that was on? I can—

GRIMM: Oh, it flew on a number of missions. In particular, this tail pod thing was this big bulbous thing on the end of the tail, so it flew on a half a dozen missions of that vehicle, because it wasn't interchangeable with the other vehicles.

Then about that time, Max was getting ready to retire and both his deputy and his assistant director for avionics, all of them were about ready to retire. I think Max was being encouraged by certain people to retire. So they selected two system division chiefs. One was

Al [Allen J.] Louviere, who had six divisions that he was responsible for, and I had six divisions that I was responsible for. So they brought us onboard. This was about in '79.

That worked out quite well because Max and Alec [C.] Bond who was his deputy and Bob Gardnier who was his assistant director could go do their things in terms of planning and in terms of thinking of new technical ideas. You know Max is the one that basically invented Mercury, Gemini, Apollo, and Shuttle, the concepts, so he's patented them. I don't know if you've interviewed Max or not.

BUTLER: We sure have.

GRIMM: So you know that, or did he tell you that he had?

BUTLER: He did. We talked about that.

GRIMM: He's a very interesting individual to talk to.

BUTLER: Yes, he is.

GRIMM: But Max always let me do my thing, and I was always very salutatory toward the work that I did. As a matter of fact, in our big retreats he would use me as an example, which really pissed a lot of his other division chiefs off, as the way to manage your organization and get things done, which didn't make me a lot of friends with those guys, but for the most part we got along reasonably well.

So we were selected and then I selected a division chief to replace me and combined two divisions, which was George Franklin who had [previously] moved over [to another division] when my organization [FCID] was abolished. He went over to another organization as a branch chief, and then I took over this [Engineering and Development, E&D] division. So when I went up to the director level, and Al Louviere who was the chief of that division came up as the other director, then George became the division chief there and Don Gerke became the division chief [of my previous division].

Later on, those two divisions were merged again, that had been separated, parts of each one of those had been my organization back in the flight crew days. So they brought them back together again, and then George became the division chief and then Gerke went on staff and then finally to the [space station] program office and into Headquarters later on.

In that position, I was responsible technically for the six as Al was for his six organizations. We were responsible for getting the manning together, the personnel, the budgets, all the administrative actions, the management actions, sitting on change boards, worrying about facilities, getting money from Headquarters, selling programs. He worked mainly on the initial studies. He did probably a couple years' worth of [space station] studies, [and while] he did…all of that, while I was managing sometimes part of his organization, sometimes not, while he worked the initial design and development of the Space Station studies.

Then later that was passed off to Clarke Covington who—have you interviewed Clarke?

BUTLER: No, not yet.

GRIMM: —who was in the program and was in our division and then moved to the program office. Then he picked up the responsibility for the Space Station for a few years until politics got the better of him and somebody else was assigned to pick up that function as the manager of the ISS at that point in time.

So the next three years was mainly a study in transition, turmoil and reorganization. [Chris] Kraft decided that [Gene] Kranz needed more people over in FOD, so we were directed to come up with a list of people that Kranz and his division people could select from. We were supposed to give up out of our 900 and some people, we were supposed to give up like 150 people as I recall. So we rated all of our people. We took all of the people that we had rated, and we cut off the 150 bottom people and gave that list to Kranz and to Kraft.

Well, you can imagine what happened there. The crap hit the fan and Kraft said that's unacceptable. Kranz said, "That's a bunch of blah, blah, blah." So Kraft eventually made us do was give him and Kranz our rating of all these people and then we were supposed to pick a certain percentage out of each bracket, the first five percent, the first ten percent, the first fifteen percent, the first twenty-five, and right on down. Then they could select people out of those brackets that they wanted.

So that happened. That caused a lot of stress and anxiety, if you will, in E&D, both in the people that were getting transferred who didn't want to get transferred and then, of course, in our organization. But by that time Max had left, retired, Alec Bond had retired, Bob Gardiner had retired, and Kraft brought in Bob [Robert O.] Piland. Have you interviewed Bob Piland?

BUTLER: Yes, we have.

GRIMM: Okay. It would be interesting to see what he had to say. But Bob's mandate from Kraft was to whip us into shape, whittle us down, cut our contractor resources, cut our manpower, transfer people and in the end take our functional assistant director responsibilities away from us and put us as titular heads under him as just assistant directors only.

BUTLER: Interesting.

GRIMM: I thought so. I guess the least that I can say about Bob Piland is he has one hell of a big ego. That's probably the only thing I want to say about him.

Then after he had done all this to us, Al and I, I think Al and I started looking at what other options were available to us in NASA because that didn't seem to me to be a very agreeable assignment. I don't believe it was to Al either.

BUTLER: Understandably.

GRIMM: Because that said [our new charter] that we could talk to those division chiefs and we could tell them to do what we wanted them to do, or ask them to do, but in the final analysis they could go over our heads and talk to Piland to decide whether or not he wanted them to do it or not.

Piland had been at Langley and was what I call a fair-haired boy there. He was brought to JSC in another fair-haired position. He went to the Earth resources lab, which is now part of Stennis at New Orleans, ran an organization there, a very small organization there for some period of time and was brought back to JSC to do this reorganization after Kraft convinced Max

to retire. So Piland came in with a mandate or a number of mandates from Kraft, which he carried out very well.

So we looked around, and they advertised a couple positions, one at Headquarters, one as assistant director and a director at the center at Dryden [Flight Research Center in California] at Lewis [Research Center in Cleveland, Ohio]. I looked at those jobs and really didn't want to move because at that point in my career I had twenty-seven years in government service plus industry. Then Piland left and got assigned to director of something, because I guess Kraft thought he needed some ass-kicking done over there. I believe that's the way it was and not the reverse.

But in any case, we had a vacancy there. Well, I thought, predicated on our past performance, that either Al or I were qualified to become the director of E&D. In looking at subsequent appointments, I think we were. But we weren't, and they brought in another gentleman by the name of Aaron Cohen from the Shuttle program office. He'd been the Shuttle program manager, which I thought was interesting to go from a program management job to an institutional directorate job. Usually you'd go the other way around if you were doing that.

Aaron came in and Al was exploring his options. I think he left like three months after I did and went to the Space Station program office. But I left, I think, a week or two weeks after Aaron Cohen came in, and for a number of reasons. One, certainly that I should have recognized the politics of selection at that level. There was another reason that I left that I'm not going to go into.

BUTLER: That's fine. Time to move on to other opportunities for you.

GRIMM: Pardon?

BUTLER: It was a good time to move on to other opportunities for you.

GRIMM: That's exactly what I said on my form, I think, that I had experienced a lot of things at NASA and that I was going to explore what new vistas lie out there ahead of me. So I legally, after the fact, and not saying how much before the fact illegally, I secured another job with private industry with a company in Austin, Texas, as a manager in a C^3I [Command, Control, Communications, and Intelligence] program.

Do you know what C^3I means?

BUTLER: Yes.

GRIMM: I worked in that program for a year, which had a certain level of classification. After a little over a year, I moved into a higher classification program, black program. Do you know what that means?

BUTLER: Yes.

GRIMM: I spent a year at Sunnyvale, California. After that year I came back and on that program I was the program director for all engineering on that program. I came back to Austin and became a program manager on another black compartmented program and spent a number of years there. At that point in time, there was some move afoot, and sometimes I had spent

TDY like six months at Burbank on some other black programs. Then they wanted to send me as program manager to Nassau, New Hampshire with another company for assignment for a year, and I didn't want to move back there. So I took a quick retirement from that company and started consulting.

For the next six years I consulted in the aerospace industry, working for Boeing, for Grumman, for NASA, for Lockheed, for McDonnell Douglas, in which I signed contracts of a defined period of time to deliver a defined set of products. When that was through, I was free to go do more work for them if they wanted more work or go take a siesta or go on to another company's work.

To be very truthful, a lot of these jobs I took so that I could do genealogy on the weekends.

BUTLER: Well, that's a good reason.

GRIMM: So my wife and I did a lot of traveling up and down the west coast and the east coast and the south and Europe. So that was a very interesting time, certainly profitable, because when I retired from NASA the pay was minuscule. It's not now. I think the congressmen just gave themselves a raise and the NASA people a raise. I think my grade when I was in was senior executive service, and I think they are getting 125 or 150,000 for that which is doable, decent.

I think we are about through here.

So I continued to work as a consultant for six years and then I had a medical problem. It took me out of the loop for about a year as a result of that. About that time, [George H. W.]

Bush cut all consulting work from all the contractors including NASA, he was cutting back on the budget. Any work that had to be done was going to be brought in house, which everybody did to the extent that they could. So the consulting activity just sort of dried up for a few years.

I've been asked from time to time since that point, since '92, to consult again, but they were offering me a consulting fee that's not commensurate with what I consider my experience to be and it's more in the way of what they wanted to pay us like journeyman consulting fees rather than somebody with some expertise building programs.

So during the consulting I worked on the Space Station for Boeing and Grumman up in Reston [Virginia] when the Space Station was headquartered there. I worked for Lockheed in developing proposals and a program-plan, budget-management plan to fly the large-format camera again. Later I worked with McDonnell Douglas on their section of the Space Station when they had prime responsibility for a certain part of it, which was later reorganized and the management responsibility was given to Boeing.

Subsequently, later to that, I worked with McDonnell Douglas in developing a quick reaction, skunk-works type single stage to orbit program where we actually in the period of eighteen months designed, built and flew a tenth-scale vehicle that we flew at White Sands [Test Facility, New Mexico] to demonstrate the capability of this particular vehicle, which was called the DC-X.

I think that just about concludes my activities before, during and after NASA.

BUTLER: You certainly did have quite an interesting and varied career.

GRIMM: Then your next question here [referring to pre-interview notes], you said, who are the people that I worked with that made a significant impact on me professionally as well as personally. Well, I think, as I mentioned Warren North was the prime one. Slayton, to the degree that he more or less did let me do my own thing over there. I gained a lot of respect for Bob Gardiner.

Bob Gardiner originally said, "I don't care what you do, just don't cause problems and don't bother me." That was essentially what Max said. But later on he gave me some congratulatory salutations, and the same with Max. I think Max appreciated my management capability and my interest in doing things technically within NASA. He used to call me over and we'd have some interesting discussions.

So those are probably the three or four people who influenced my career with NASA.

Of course, as I said, this Ed Smith is the one that got me interested at NASA when I was with the FAA. He and I both had been at the FAA. Then this Captain Brickle [phonetic] at the time, who is now General Brickle, who was a very aggressive individual, more so than I am, I think.

So I think that covers that category.

BUTLER: Certainly a lot of interesting people to fit in with all the different areas in which you worked.

GRIMM: My most important accomplishment in my career with NASA, per your question here [referring to notes], is I consider in the long haul that the Lunar Landing Training Vehicle project management program management and getting Neil trained in the nick of time so that

they could have their FRR and then accomplish lunar landing. That's a significant accomplishment.

The second thing would probably have been developing the rendezvous techniques and procedures and training the crews on that.

The challenging milestone has to be the LLTV and the leading up to the lunar landing. I think that probably answers all of the questions unless you have some.

BUTLER: That covers most everything. I have one last one, to kind of tie things off.

Looking back to when you were first getting interested and first figuring out what your career was going to be, and you've mentioned the cards and the cereal boxes as a child and then working for the Air Force and so on, would you ever have imagined where your career would lead you?

GRIMM: Never in a million years. I had no concept of where I was going to end up. That goes back to when I was seven or eight years old and I used to lay on my back looking at the stars at night and wondering what held the stars up and what was going on up there. I had a very early interest in things like that that I didn't understand, and I'd always hoped that I'd be able to get enough education to understand those things.

As things worked out, I was able to do that. As far as I'm concerned, it's been a very interesting career. As I said, up until the last three years of my time at NASA, my previous experience both in industry and at NASA were very challenging, very stimulating, and the last three years was sort of a drag in the management function.

Consulting was very interesting up to a point. But my wife liked it because she went with me everywhere.

BUTLER: That's a big perk.

GRIMM: But consulting had limitations because you were there at the courtesy of whoever signed your contract. A lot of times you were wanting to contribute more than they asked of you. Sometimes I did contribute, and that didn't go over too well, when I saw the program going in directions other than what I thought it should. In most cases, I was proved right, so I feel vindicated in that respect.

The interesting thing about a lot of those consulting programs is that the reason why they get you as a consultant is that they are very naïve in those areas where you have expertise. Sometimes it's a very hard job to convince those people that they need to do certain things in these programs, because usually you're hired at a management level such as advising them on technical issues, management issues, developing management plans, program plans, systems engineering plans, systems integration plans, systems test plans, flight plans, if that were the case, things like that, new ways to do business quicker. I almost said Goldin's favorite words, quicker, better, cheaper.

But in fact, it was some of these programs, which is the now familiar term of skunk-works, you did things like that with very little supervision, lots of money, and you were able to get the job done and deliver a product that works. In the final analysis, sometimes, that's the key thing. So I enjoyed consulting for the most part and took my wife around, and she saw all

the places that I had seen in the previous twenty-five, thirty years. In the process, we got to travel a lot. You can just wipe this last part off here. [Laughter]

BUTLER: Oh, that's all right. Well, you've certainly had quite a lot of important and interesting stories and contributions to the space program. I appreciate you sharing them with me and with the project.

GRIMM: You're quite welcome. I think sometimes when I talk like this, it sounds like I'm tooting my own horn. As I said earlier, there's a lot of other people in most cases that were involved with these projects that I've discussed that made them happen and a lot of good people who probably may never get the recognition that they deserve.

But as a p.s. to this whole thing, that was one of the things that I always tried to impress on my people. I said, "You do good work for me, and I will do good things for you." I carried that philosophy through the whole time I was at NASA.

I think if you asked Duane Ross to look back at the records, I was criticized by not only people in my own directorate but by the Center's other directorates of getting too many awards for people in my organization, as a percentage of the awards given at any given time.

BUTLER: Not something you would criticize for, I wouldn't think.

GRIMM: Some people stand with their hand out, other people go work for the handout. When I thought my people were deserving, I made sure that I worked hard to get them the recognition that I thought they deserved.

BUTLER: I'm sure they appreciated that.

GRIMM: I hope they did. But that's not the reason; I did that for them because I thought they deserved it.

A lot of places you can spend your lifetime doing good work and never get recognized, and I think it falls to the management of an organization if he has people in his organization that do good work and do exceptional work that they should be recognized, not only from a salutatory standpoint but from a monetary standpoint.

I had people in that second organization that I had that had been in a certain grade level for years, and they were at a grade level that was below what they were authorized to be at. I questioned them about it. They said, "Well, it's because management doesn't think this position is very important, with respect to the rest of the organizations." That falls to the management of that organization as far as I'm concerned.

I said, "If you do the things that I ask of you, then I will see that you get a promotion." Lo and behold, every person that I said that to I got promoted and recognized with awards including the exceptional service medal, the distinguished service medal, commendations, monetary awards, and so forth.

One final word. The thing that I like the most is that one of my managers said, "The one thing that we could always [count on—you were hard on us, but always fair." I couldn't ask for better than that!]

BUTLER: Okay.

[End of Interview]