NASA Johnson Space Center Oral History Project
Edited Oral History Transcript

Jack R. Lousma
Interviewed by Jennifer Ross-Nazzal
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Ross-Nazzal: Today is March 15, 2010. This interview with Jack Lousma is being conducted in Houston, Texas, for the NASA Johnson Space Center Oral History Project. The interviewer is Jennifer Ross-Nazzal, assisted by Rebecca Wright. Mr. Lousma begins today by talking about the Skylab rescue mission.

Lousma: When I was first assigned to the third Shuttle flight it was with Fred [W.] Haise [Jr.]. We were going to be the flight that rescued the Skylab. Has anybody ever talked about the aborted Skylab rescue?

Ross-Nazzal: No. That was actually one of my questions for you.

Lousma: We could start there I guess, because that's where I began with the Shuttle Program, aside from having development jobs before that. Within the Astronaut Office, we were responsible for certain elements of the design development. I guess at one time or another I was involved in all of them, because after the last Apollo flight, Apollo-Soyuz [Test Project (ASTP)], a lot of people left our office. A lot of them had done what they came to do. They had their flights and didn't want to sit around and wait for a long time. I was one of the younger guys in my group.

I didn't know if I wanted to wait around that long or not, but I found some things to do. I was put in charge of controls and displays for the Space Shuttle after [C.] Gordon Fullerton had gotten that started. He went on to fly the ALT [Approach and Landing Tests] missions with Fred. They gave me the controls, displays, and hydraulic systems. I was in charge of that.

One thing that came along was a head-up display [HUD]. The office wanted to explore the idea of putting a head-up display in the Space Shuttle, because they had them in current airplanes, the Tomcat F-14, A-7, and all those airplanes that none of us had flown. So we really didn't know what a head-up display was. We were all "old guys." Somebody discovered that a head-up display was being used in those fighter airplanes and might be of some use in the Shuttle for landing. You know what a head-up display is? When you see a Shuttle flight now, near the end they'll show pictures from the cockpit, it'll show some green numbers and information on the windscreen as you come around to make the final approach. The idea for head-up display is that if you put all the airspeed and altitude information on the windscreen, then you don't have to take your eyes off the runway.

I was asked to explore the notion of having a head-up display on the Space Shuttle, so I worked on that. I went to the various companies that were making the airplanes that had them, or I went sometimes to the military bases where they were flying them. Sometimes I'd fly in the airplane with them, or sometimes I would just fly the simulator. Just to get an idea of what the head-up display was all about. Now they had a lot different uses for it militarily than we did for the Shuttle. I don't remember that they ever had a real landing display, but they used them for weapons delivery, air to air combat, and low-level navigation.

I decided that we could use this for approach and landing because the Space Shuttle is a glider, and you only have one chance to do it right. Any kind of help you can get is probably good. I developed an engineering plan, how to get this involved with the engineers that had to make a decision on a management plan. I looked at all of the options that were available on the street. Even the airlines were thinking about having them at the time. Now they mostly all have them, but there were different types of head-up displays that could be applied and used.

We even rigged up a simulator over near our office where we simulated a head-up display and practiced making landings with it to see if we could do better with the head-up display than we could without it. We were finally able to sell the idea to management. Management of course considered it a big expense and also a retrofit because the *Columbia* was already built or in production, and it didn't have a head-up display. It would have to be retrofitted to the *Columbia* and perhaps included in the newer models, the *Challenger* and so on. So they finally agreed to do that.

When I flew the *Columbia* it did not have a head-up display in it because it was already built, and they didn't want to go back and modify it right away. I don't even know when they started adding it to the newer Space Shuttles. The *Challenger* of course was the second one, and I don't think it flew until maybe the sixth flight.

The first five or six flights were flown with the *Columbia*, then later on when the *Columbia* went back for modifications of other sorts. I think that's when they put the head-up display in the *Columbia*. They all had them, and everybody seemed to like them. They managed to land quite well with them, although we didn't have them for the first few flights.

So that was an add-on. About the time that I got to the point where we sold the idea to management, I was assigned to the third flight of the Space Shuttle. Fred Haise was the commander, and I was the pilot. The reason I think I was assigned was because our job was to go and rescue the Skylab, or effect the next step for the Skylab, because it was coming down more quickly than anybody thought.

We thought it was going to be up there for a long long time, but we didn't really know as much about what's in space than we do now. Fred and I were assigned to that third flight, and then somebody else took over the continuation of the head-up display until it really got implemented. I think it was Dave [S. David] Griggs as a matter of fact. He took up where I left off and decided what the displays ought to look like.

Anyhow, Fred and I were assigned to the third flight of the *Columbia*. The purpose was to rendezvous with the Skylab and station-keep on it maybe 1,000 feet away. Then we had this booster package in the cargo bay about the size of a truck that I was going to fly over remotely from inside, like a radio-controlled airplane. It had a docking system on it so it'd dock where the Command Module had been when we lived aboard Skylab. It had a television system on it so I could see to dock it properly. It had reaction control thrusters to maneuver it, but it also had a booster engine, or debooster engine. We didn't know whether we were going to boost the Skylab higher or whether we were going to use that engine to deboost it in a place where it'd go in the water and not endanger anyone.

That mission had never been planned to begin with, so the Shuttle didn't have rendezvous radar or anything like that on it. Fred got busy and started getting that implemented and also developing rendezvous procedures. I worked with Martin Marietta and Marshall Space Flight Center [Huntsville, Alabama]. I had the lead on the development of the booster package. We worked on that for about a year. The Skylab was coming down more quickly than anybody thought. The reason it was coming down faster was because it was found that there were a few more particles out there than we had thought, but we really increased the number of particles when there was a flare in the Sun. So when there was an eruption on the Sun and all those particles came toward the Earth, it would cause our atmosphere to swell, get a little bigger. At the Skylab's altitude it was more dense.

The scientists and engineers noticed that every time there was an event on the Sun, the Skylab came down more quickly than it did before. We learned that there was a lot more out there than we had thought. Fred and I would come into work every morning, and they'd have a picture of the Sun and have a picture of where the Skylab was on the wall. We had a whole history of them. Sure enough, solar activity was making the Skylab's altitude to decline.

The Shuttle wasn't getting ready on schedule, and Skylab was coming down. It was coming down from originally 275 miles. It was getting to the point where it was clear it was going to enter the atmosphere sooner than anybody thought. I don't know if you remember now, maybe you're too young, but they had an early warning system that they were selling on the street. It was a beanie. You wear a beanie. If something hit the beanie, then the Skylab was coming down. There was a lot of human interest in this.

Anyway, the Skylab was coming down quicker than they thought so they moved Fred and I up to the second mission. We thought, well, we can't get there with the third, be too late, maybe won't be too late with the second. That put Fred and me in a different training scenario because the first two flights would use all the simulator time. The third and next would have to wait till the first and others got out of the way. The Skylab reentered after we had been in the simulator now for about a year of training, and we were moved back to the third mission. All of a sudden we're flying a desk again. That wasn't all that exciting.

ROSS-NAZZAL: So you're doing this in '78? Is that when you started work on this effort?

LOUSMA: It must have been around then sometime. Yes, I guess it was, maybe even '77. I'm not sure; the first Shuttle flew in '81. So yes it was probably '78, something like that. It must have been, because I was also—when the 1978 selection of [35] astronauts was announced (15 of them were pilots)—I was put in charge of [them]. [Alan L.] Bean was in charge of the whole scenario of what was going to be done with the new people, but he assigned me to the pilots. So I took on the job of getting the pilots oriented and getting them acquainted around town, around the Space Center. Had them over for dinner, the new pilot astronauts and their wives. Showed them around town so they could find a place to live.

I don't know if that was while I was doing the—maybe that was after the Skylab was already canceled. I don't know. I have to go back and look to see when the Skylab was canceled. I probably wouldn't have had a lot of time for new astronauts if I were really working on the Skylab rescue mission.

When we got put back to the third flight, then they gave up on the Skylab rescue. The [Mission] Control Center then did something they'd never planned to do. Up till that time they had forgotten about the Skylab or just left it up there, kind of being derelict, but tracking it, noticing it was coming down. They got busy to see if they could contact it and make it do anything, and so they did. They were able to talk to it and find out that some things worked and some things didn't.

Then there was a question on the management as to "Should we fix the Skylab and boost it up higher, add some modules to it, or not, or should we just bring it down in the water?" Nobody ever figured that out. Nobody ever decided. It was coming down and the Control Center did a great job guiding it as best they could. If they pointed it sort of into the wind it wouldn't come down as fast as if they pointed it perpendicular to the wind so it would come down more quickly.

They tried to maneuver it starting quite a long time before it really came in to understand its characteristics, but they had to predict ahead by three orbits or something like that, which was hard to do. Their intention was to put it in the Indian Ocean. They would maneuver it such that it would hopefully come down exactly at the right time to go in the Indian Ocean. Well, they got pretty darn close. Most of it did. A few of the pieces went into northwestern Australia. Didn't hurt anybody, but the farmers picked them up and sold them for space artifacts. That was the end of the Skylab mission and end of the Skylab, but it was an interesting piece of history because we learned a lot about what happens to the upper atmosphere when the Sun is active. We learned also that whatever else we put up there ought to have a little debooster engine on it, maybe.

Fred and I were sent back to the third mission, where we started. Fred decided he was going to go off and do something else. He had been injured in an airplane crash—you probably know about that—when I was in Skylab. He was burnt very badly and was off flight status for a long time, got an MBA [Master's in Business Administration] at the Harvard Business School [Cambridge, Massachusetts], came back, and he was I think the Assistant Shuttle Program Manager. He was really good at that sort of thing. After that, he was assigned to the Skylab reboost mission.

By the time that fell through, I was unclear as to what was going to happen next. He decided to take a job with Grumman as vice president of space operations. We had a backup crew at that time, and one of the guys on the backup crew was [C.] Gordon Fullerton. So they moved him up to be the pilot. It was his first flight. They moved me over to be the commander, which was my second flight. Gordo and I trained for that mission for two and a half years. We flew in '82. So in terms of timing, it was probably 1979 that we started working on that mission.

When the first STS [Space Transportation System] flight was back, then we had quite a bit of priority in the simulators. We trained for the mission. It turned out to be a very successful mission. This is where we wanted to start. I've been very long-winded in getting here.

ROSS-NAZZAL: No, actually it's great, because some of these questions I wanted to ask you. I want to go back and ask you some additional questions, but we can keep going.

LOUSMA: Well, I was thinking there probably wouldn't be too many folks that would talk about that. So Gordon and I were training for the third mission. Our job was to test the Space Shuttle. It was a third orbital test flight of the *Columbia*.

If all those four test flights were to be successful, then the Shuttle would be flown more frequently, and with larger crews, but of course there were only two crew [men] on the first four flights. We were also landing on lake beds for the most part at that time. The Space Shuttle had ejection seats for those first four flights for the commander and pilot, primarily to be used during approach and landing. If we weren't going to get to the right place at the right time, then we would be able to eject. As far as I was able to ascertain, there was no good time to use them during the launch.

Our testing of the Space Shuttle mostly had to do with the thermal characteristics of the Shuttle. We were testing the OMS [Orbital Maneuvering System] engines and doing other things like that as well, but one of our primary objectives was to see what happened to the Shuttle and its heating and cooling systems if you pointed it at the Sun for long periods of time.

I think we pointed the nose at the Sun for maybe at least three days, maybe four. It was always pointed at the Sun, to see if the heating system would keep the cold end [warm, and] if the cooling system would keep the hot end cool. We did that with the nose for about three days, I think. We did that with the tail to the Sun for about two days and then another day or two with the cargo bay pointed at the Sun.

Apparently all the systems worked quite well. We did notice though that when we tried to close the cargo bay doors, after pointing the cargo bay to the Sun, that the cargo bay doors wouldn't close. The shell had warped a little bit somehow due to the intense heat in the cargo bay. Then they had us barbecue it so to speak, roll it to stabilize the temperatures, and then we were able to close the cargo bay doors.

We did those kinds of tests. We also were testing the arm the Canadians made to take things out of the cargo bay and put them in space, and vice versa. The second flight had tested the arm, but we were going to be the first to test it with something on it. We had a small cylindrical payload. Of course now it's been used to put things out that weigh 40,000 pounds or so, like the size of a school bus or Hubble Space Telescope, but this was the first time to test the arm with something on the end of it.

We tested the arm for half a day for four different days. That was another part of the testing. We could fly the arm either automatically or manually. We had a preset routine that we were going to do every day and put it through its paces. The arm worked very well. The package that we had on the end of it was probably about five feet in diameter and about two or three feet deep. Just a round thing, but it wasn't just a round massive thing. It had some sensors in it to measure the environment around the Space Shuttle to see what kind of environment it would be for scientific investigation in the future. So while we were moving the arm, we were just taking all this data as well.

A few of the things we were testing, one of them was we were trying to determine what the constituents and the density of this cloud of particles was that we were dragging along with us, because in the vacuum of space the materials on the Space Shuttle, especially in the cargo bay, were outgassing in the vacuum. Would that impair the scientific investigations in the future?

We were testing the capacitance on the vehicle, the electromagnetic interference when you use the radios, the electrical charge on the vehicle, probably a couple other things as well. Whenever we were moving the arm, we could move the package out over the nose or around over to the wings and the tail. Not underneath because you couldn't get the arm to do that, but after all is said and done, it was found that the Shuttle was a good platform for scientific investigations. There was no real interference for that. So that was important.

We also had 15 scientific experiments we were doing. Some of them were in the cockpit, and some were out in the cargo bay. I can't remember all what they were. There was a couple of them that were studies of the Sun. There was another one, a study of electrophoresis, how to make new compounds, medical compounds and others, by using the feature of weightlessness. Ions of these various compounds were put in some kind of flow with a perpendicular electrical field. That would make these ions go into different buckets depending on what they were made of, because they're all different weights. They made a production unit later on. I think Charlie [Charles D.] Walker did that with McDonnell Douglas on some of his flights.

We were doing those scientific experiments. We were going to be up there seven days so we were really busy folks. This was the busiest flight plan that had thus far been put together for the Shuttle. We took some criticism for trying to pack too many things in there, but we just took them as they came and decided whether we could do them or not. We in fact got them all done.

We were also landing on lake beds in those days. Our intent was to land on the lake bed out at Edwards [Air Force Base, California]. We would be the third landing out there. About a week before the mission, Gordo and I were in quarantine at JSC in trailers inside of that big house down there. That's where we stayed for Skylab too, over by the gym. Chris [Christopher C.] Kraft came in and he says, "Hey, fellows, it's raining in California. The lake bed is wet. Next week when you want to land there it's going to be muddy. What do you want to do?"

We talked with him about it for a while, and we decided that there was only a couple other places we could go. There was a lake bed at White Sands [Northrup Strip], New Mexico. If we couldn't land there we could be the first guys to try the runway at the Cape [Canaveral, Florida], which was 15,000 feet long and 300 feet wide. I wish they'd made it half as wide and twice as long, but so far it's worked real well. We know a lot more about what the Shuttle does when it comes down than we did at that time, so we were playing it safe. Of course out on the lake bed you can make a runway that's six or seven miles long and crisscross them so if they don't get the right one, they can try another one.

We liked that, because we weren't totally sure that the guidance system was going to get us back exactly where we wanted to be. I said, "Let's try the lake bed at White Sands, because we've done a lot of training out there, and we know the terrain. We might not have all the navigational support out there, and there's only one runway instead of several. If the weather is not too bad, we can see from a long way out."

Chris said, "Well, I can't guarantee the weather, but if you're willing to give it a shot with using the Cape as a backup, we're willing to go with that."

I said, "Let's do it." We were going to land there in two weeks. This was only a week or so before we left. They moved 40 train carloads of stuff from the lake bed at Edwards over to White Sands to get ready for us. They started doing that before we left, and they were still doing it as we were in flight. They got it done by the time we had to come home.

One other thing probably before we get into the mechanics of the flight—which aren't all that big a deal—we were supposed to be there for seven days and come back. By the end of seven days, we'd got all of our mission objectives accomplished. It was a very successful mission in those terms. We had a few failures, of course, of the Shuttle like you always do early in a program, maybe 15 or something like that, 15 or 18. I'm not sure how many it was, but they were mostly all more minor failures, for which we had redundancy, and for which we had backup ways to work around, or we didn't need to use whatever was broken anyway in some cases. So they let us stay up there. Mission Control, in their ways of performing all kinds of magic, they're the best technical detectives in the world, they of course helped us with all these things.

We had a little bit of difference then too in terms of communications, talking about mission control. We didn't have relay satellites in those days. We could do like we did in Apollo, just transmit and listen when we were over a station—like at Madrid [Spain], Guam, or Australia. There's Bermuda and others. Of course there are three of them across the United States that are end to end. There are some times when you miss them all during an orbit, and sometimes when you seem to get all of them. That's the way it was in those days. There was probably a lot less radio chatter. You hoped things would hold together until you got to talk to Mission Control again.

We were going to come down on the seventh day. We got everything buttoned up. We got the cargo bay doors shut. Everything turned off. We got our launch/escape suits on and got in the seats and got ready to do the retrofire to come back. They said, "Stop. Wait. Wait. You can't come back. Don't come back today. We've got a bad windstorm at White Sands and the pilots who are flying practice approaches to the runway are unable to see the runway because there's just too much dust in the air."

The White Sands [runway] is made out of—not the kind of soil we have around here—it's made out of gypsum. It's very light and powdery sometimes. We had this bad windstorm at White Sands, and we couldn't come back and land that day. That was great, because it was an extra day in our world's favorite vacation spot, and we didn't have any eighth day in the flight plan. We finally had a chance to look out the window and enjoy being there. Otherwise we might as well have been in the simulator.

So we had an extra day, but they said, "You're coming home tomorrow. You're either going to come in to White Sands or if the weather is bad you're going to land at the Cape. Be the first guys to try that runway." It turned out that it was a good day at White Sands the next day. That's where we landed, but it turned out to be an eight-day flight because of that.

All that being said, it seemed every day looked like every other day, because it was a routine, "Do what the flight plan says," or however the ground has modified it. We didn't have much trouble getting all our objectives done. We were pretty much according to the flight plan except for odds and ends that would come up.

One of the things that came up, come to think of it, we got out to the launch pad about two and a half hours before liftoff. We had only a one-hour delay. In fact we knew about the delay the night before. We were supposed to go at 9:00 in the morning, and they had some sort of a delay on the launch pad that was going to delay us an hour. So we got off at 10:00—I think it was 10:00—anyway got off pretty much on time. Did on the Skylab too. There was no delay. It was good for everybody who came to watch. A lot of people came to see this launch. In fact, it reminded me. There were so many people there. It must have been spring break or something like that. It was at the end of March. I think we went around the world about three times before they all got out of the parking lot. It was a good day for the launch. We had a few clouds, and then we lifted off.

It was an almost uneventful launch except for all the great things you enjoy during one of those rides. It's the kind of thing you'd like to do every day. When we got towards the end of the boost, we lost one of our APUs, our auxiliary power units. Gordon tried to get it back, but it was failed. That then caused us to do some malfunction procedure aimed at making sure that the engines shut off on time.

I can't exactly remember what the effect of an APU failure was, but it seems like to me it had to do with whether or not the engine it was controlling would throttle and whether or not it would shut down on time. We backed that up, but we made it to the orbit we wanted to get to. The engine worked just fine. We got where we needed to go. I don't remember the altitude either. I'd have to go back and look that up. I'd like to say it was about 200 miles but it might have been a little bit less. I'm not sure.

After that, the flight was quite uneventful in terms of being different than the flight plan. One of the things that didn't work very well was the john. The commode plugged up. Right away it stopped. They had a slinger inside there. It stopped working on the first use so that made eight days of colorful flushing you might say, I guess. We had to improvise. They made some modifications to it when we got back, at least on how it was used, to try to avoid some of that. I haven't heard of any more failures of it, although I don't hear too much about what's going on anyway. There's probably some more history behind that, but that was probably one of the more inconvenient failures that we had. The rest were more technically oriented I guess you might say. This one was living-oriented.

We didn't have all the comforts of home. We didn't care. We would have gone in a trashcan if they would have sent us. We just wanted to go and do this. We didn't have any hot water. We didn't have any bunks. Well, I guess we had one sleeping bag but neither one of us used it. We didn't have a special wardroom or anything like that. We didn't have the food system they have now. We had leftover Apollo food, I think, freeze-dried food. We had some of that. We had military rations. They would come in a sealed foil container. We had the standard beverages with the collapsible or the pressurized accordion-shaped bottles.

We just floated around and had a picnic every time we ate. They have bunks now as I understand it. We didn't have a bunk.

ROSS-NAZZAL: Do you think things went backwards, compared to Skylab?

LOUSMA: Yes, we had one sleeping bag, and Gordo tried it, and he decided he'd rather just not have it, but it wasn't like the Skylab sleeping bag. It wasn't quite as plush I guess you might say, but we weren't going to stay a month either. It was just a week. This is like a camping trip. You can swat mosquitoes for a week if you know you're going to be coming home after seven or eight days. We were just bare-bones. We had a lot of development flight instrumentation (DFI) in the middeck where the bunks and all that go now. There wasn't a lot of room. We had extra water tanks down there. There wasn't really a lot of room for all the comforts of home.

We just didn't care. We'd have a cold water sponge bath if we wanted one, and we could brush our teeth and shave or we could just fumble along like you do on a camping trip. We ate our meals. It wasn't a real controlled diet like it was on Skylab. Eat what was there, nothing more, nothing less.

We'd just "raid the refrigerator," take whatever we wanted to, and just eat what was ever there. That's what we did. Now of course it's equipped for more people with bunks and a wardroom with hot and cold running water. It's more organized, but it didn't have to be then. We didn't care. It was just bare-bones.

Actually I think it was the development flight instrumentation that continued to some extent to be used every time the *Columbia* flew. I think that's how they were able to determine why the *Columbia* crashed. Well, as I understand it, the pieces were scattered all over Louisiana and Texas. They found some pieces that had been in the *Columbia* somewhere near where that recorder was. They looked in that area, and sure enough, they found it.

After having hit the ground, everything worked. They were able to get a lot of information from that, which doesn't come down on a normal telemetry loop. That enabled them to determine what the problem really was. That was very fortunate, but that was the part of the instrumentation that we had when we flew. It, the middeck down below, was pretty much filled, half of it anyway. We didn't have all the other things it's been replaced by.

Gordon was the arm operator. He was expert at that. I was operating the collection of data on the payload on the end of the arm for the scientific investigation. When we slept, Gordon found a corner to sleep in, and he wouldn't move. I just took a little lanyard with a hook on each end, and hooked it to my belt loop and to one of the little switch guards on the wall.

That just kept me from floating around. I slept very well. I guess maybe a couple nights I slept in one of the seats loosely held.

We just loved being up there. We just worked hard and did our job, took time out to eat, and fixed the john, and that was about the standard day. Golly, what more can I tell you?

ROSS-NAZZAL: You lost some tiles on that flight.

LOUSMA: Oh yes, I was going to say, when we launched we did lose some tiles. I heard it was about 40 of them but I don't know for sure. I looked out over the nose early in the morning of the second day. It looked like we had lost some tiles up front. I didn't know how many we'd lost anywhere else. I also knew there wasn't anything I could do about that. So I reported it to mission control, and I knew they'd work 24/7 [24 hours a day, 7 days a week] until they figured out what happened.

We also the used the camera that was on the elbow of the arm to look in some of those places that we couldn't see from the cockpit, like around the sides. Sure enough, we'd lost some up front, on the nose and the side. Seemed like we lost a couple on the OMS pods that we could see back there. We made that little survey, and then they went to work to decide if we'd lost any on the bottom. The ones I could see were on the top where it doesn't get too hot, so you can afford to lose them and get away with it.

But you don't want to lose them on the bottom where it gets up to 2,500 to 3,000 degrees, and they're about five inches thick. So after about five days or so—I'm not sure exactly how long it was—Mission Control came back and said, "You didn't lose any tiles on the bottom."

ROSS-NAZZAL: Do you think the DoD [Department of Defense] did some looking for you?

LOUSMA: I guess they could have if they had wanted to. A number of the tiles were picked up on the beach, most of which came off around the upper nose of the *Columbia* early in the boost. They found more of them down in the flame trench that came off the right upper body flap surface when the main engines were ignited. These tiles are mostly air, they're 80 percent air, and as we went on up across the beach, and over the water the tiles that came off would float onto the beach.

They said that since each one had a serial number, they had a whole stack of paper, which was the pedigree for every tile, all 35,000 of them or something like that. You probably remember early in the program they were flying the Shuttle from the west coast to the east, and a bunch of them came off while it was on the 747 [Shuttle Carrier Aircraft], scattered across the country. Then that delayed everything because they had to take them off and put them back on. They were stuck okay, but the tiles would shear at the bottom. They had to immerse them in some solution in order to add more structure to the bottom of the tile.

I might be wrong on that too. They apparently hadn't gotten to all of them before we launched. They did all the ones in the critical places, especially on the bottom and other places they could get to them, but they knew the serial number of the ones that came off, and then being able to track their history, they not all been redensified yet. They knew that the others that didn't come off had been redensified, and that all the ones that were in critical areas had already been processed. So that made a difference between the tiles that were critical and didn't come off compared to those that did, but maybe there were others that had that had not been processed that remained intact. I don't know. At least I was told that they were able to tell from those serial numbers and the pedigree that went with each one that these were tiles that had not been totally processed.

I don't know if I can believe that or not because I would think that they wouldn't send anybody until all the tiles had been processed. It might be hearsay, but there were probably some other ways they could confirm that no tiles were missing on the bottom.

ROSS-NAZZAL: I understand there was a ceremony for the first couple of flights. There was a ceremonial key that was given to the next crew that was to fly. Do you have any recollections of that event?

LOUSMA: I've heard of it, but never had anything to do with it on our flight. I think maybe some of the new folks came along and incorporated a few new ideas. That's good. Some of us are pretty old stuffy people.

ROSS-NAZZAL: Tell us about your crew relationship with Gordo. How was the team relationship for this flight?

LOUSMA: We had a great team. Gordo and I have never had a cross word. He's having problems, real medical problems right now, you know. I keep up with him when I'm home on a daily basis, how he's doing. He's making progress, but it's unbelievable what's happened to him. Gordon is an Air Force test pilot. He flew three of the ALT missions with Fred Haise. Gordon is a test pilot's test pilot. He's a really sharp pilot. He proved that, I think, on the flight that he commanded, but he is really into details. He knew everything about the right side of the Shuttle and probably most of the left. So I thought we were a good combination.

Like on the Skylab flight, Alan [Bean], Owen [K. Garriott] and I never had a cross word either. Al is more of a detail guy, and I'm more of a generalist. Big picture person. Gordon is a detail guy too, and I'm still more of a big picture person so we worked together real well. He really got into the details. So did I when I needed to, but he was even more ambitious in that regard. Gordo is a real pro and also a top-notch character individual. We worked together real well.

On the other hand sometimes you have to let the detail go because the big picture says we've got to do something right now or it's going to be too late. I think there's a need for both kinds of people on a crew. Both the crews I was on, we had the detail guy that took care of that side of it. I was doing the big picture stuff.

I got into detail when it was really life-critical, obviously. We did our things together well. I was just thinking. One of the other things that we were doing that didn't work out to my satisfaction was the approach and landing. One of the things that was different about our approach was that we had high westerly winds, at unusually low altitudes. If we did a normal circling approach we would not be able to get back to the runway if the winds were very high. Of course most of the flights do the circling approach: come high over the field, circle, and alter their speed and altitude to manage their energy as they go around the Heading Alignment Circle [HAC] so they end up in at the right place at the end of the runway.

We didn't have that option because we were coming in from the west, and we were returning in the wintertime when the winds are very high at those circling altitudes. The jet stream moves south during the winter. We discovered that they'd been having some real high winds out at White Sands at about 25,000 feet or so, which is fairly low.

I was concerned about not being able to make the circling approach. You couldn't pull a lot of Gs [gravity force] with the Space Shuttle; sort of like an airliner. You can't pull more than two Gs to turn the Shuttle "around a corner" and get on the glideslope. If you come over the field and start to make the circle back, you might not be able to glide back into the wind coming around the circle. We discovered after we had been redirected to White Sands, which was really late in the program, about a week before launch, that if the winds at about 25,000 feet were more than 80 knots or some number like that, I'm not sure what it was, we'd have a hard time getting back to the runway if we crossed over the runway and flew the HAC back to land to the south.

We made a rule that if the winds were more than about 80 knots at 25,000 feet we would instead just make a right-hand turn and land on the south runway, which didn't give you as much latitude in terms of adjusting your altitude, speed, and your energy to be at the right place at the right time over the end of the runway. Before we came down on that particular day, it was determined the winds were too high. We were going to have to just make this right-hand turn to the runway.

The reentry had to be set up such that we would lose a lot of the energy before we got there. Otherwise you have too much energy, you'd be going too fast. The guidance system worked quite well in bringing us over a ground track that would enable us to lose some of that energy that we otherwise would manage in the HAC; get rid of it before we made the right-hand turn to the runway, but there was less room for adjustments in managing the energy.

That was something that was different on STS-3. I don't know if anybody's ever had to do that since, but that was something we did. It worked, so that's a good thing to have ready, but you would prefer to do the circling approach because you have a better chance of trading off your airspeed versus your altitude, or if you're a little low on energy, just make the circle a little tighter. If you're high on energy, just let it drift out a little bit.

There's actually a display in the cockpit of the Shuttle that tells you whether or not you're on the right energy profile. That's good. We didn't have that. We were going by the seat of our pants. We also didn't have all of the indicators on the runway, like the ball/bar that they have now to make sure you're on the right inner glide slope. We didn't have a drag chute to deploy after touchdown. We didn't have the head-up display either that really enables you to fly a perfect approach.

The thing I am getting at is that we were also asked to make a test of the automatic approach system. The way we flew this during the reentry was that it was nighttime when we entered the atmosphere. It was quite colorful. We had the little pinkish glow when we first entered the upper atmosphere as we were lightly settling in our seats and then it got more orange and then white-hot. I've seen pictures through the overhead windows of the lightning flashes going off, which is like a fireball in the Command Module, which was really very evident. We were looking forward so we couldn't see those fireworks, but we could see the bright glow around the windows.

Then we popped out into daylight and couldn't see it anymore, but we knew it was still there. It was very colorful. During the entry we had some detailed test objectives, some DTOs, where I was to take over manually during the entry and put some small control inputs like forward stick to neutral to back stick to neutral (on one second intervals), and then return to auto to see how the control system would respond. I did that probably about ten times during reentry on cue according to the timeline. We repeated this sequence in the roll axis, as well with the body flap at several settings during the descent. That is, I would take over manually, put the test input in and then put it back in auto and see how the auto system would recover. I guess there are some things you can analyze, study, change, test, and simulate, but sometimes there are things you can't learn unless you just go out and do it. That's what we were doing, so as to improve the control system for the next flight.

Prior to the mission, we had flown the nominal reentry ground-track in the T-38, beginning at a coastal crossing point near Santa Barbara and ending at White Sands so as to familiarize ourselves with visual ground-based checkpoints as a confirmation of the guidance-derived ground track. Actually, however, we delayed the entry by one day so our ground track on Day 8 crossed the western coast of Mexico which was covered by clouds. We were visual the rest of the way, passing just north of Phoenix [Arizona] enroute to White Sands.

A final DTO for this mission was to engage the automatic system to fly the approach down the Outer Glide Slope [OGS at 19 degrees], through the preflare [1,750 feet], and until stabilized on the Inner Glide Slope [IGS at approximately 1.5 degrees]. At that point, I was to take over manually to control the landing and rollout. The final flare, touchdown, and rollout software had not yet been developed.

With the exception of the entry DTOs described above, the entry was flown automatically until slowing below the speed of sound, Mach 1.0. At Mach 0.95, I took over manually and flew the Shuttle to the OGS and centerline of the south runway at White Sands. I used the speedbrakes to slow down and maintain 285 knots. The *Columbia* was easy to fly and was very responsive to pitch, roll, and speedbrake inputs. Compared to a large aircraft, it flew more like a fighter than a bomber.

As I had done for switchovers between auto and manual control during the entry, I used the auto and manual pushbuttons on the left edge of the glare shield to engage the automatic approach system at about 15,000 feet with two red and two white PAPI [Precision Approach Path Indicator] lights on the 19 degree OGS, on centerline, and on airspeed at precisely 285 knots. That was the last I saw of a stabilized airspeed, although the automatic system controlled OGS well, including the transition from OGS to IGS.

The auto system made a slight right roll correction to nullify the effect of the right crosswind at that altitude, but I felt the speedbrakes close immediately, and we accelerated above 285 knots. Just as I was about to take over control of the speedbrakes manually, I felt them opening again and expected them to get us stabilized back to 285 knots.

The automatic speedbrakes, however, over-corrected so as to slow us below 285 knots, which was also below a software set-switch that would automatically fully close the speedbrakes at 4,000 feet if the speed at that altitude were below a certain number whose magnitude I don't recall.

On a nominal manual approach, we would have closed the speedbrakes at 2,500 feet so they would not cross-couple with the preflare pullup at 1,750 feet. In our case, however, automatic closure of the speedbrakes 1,500 feet early caused an acceleration before preflare, as well as a speed coming out of preflare, that were both well beyond what we would have seen on the typical manual approach. The automatic control of wide swings in speedbrake position did not mimic typical manual pilot inputs of small corrections to maintain constant airspeed.

When stabilized on the IGS at 150-200 feet above the ground, I took over manually by depressing the manual pushbutton on the left edge of the glares shield and made the landing.

The Shuttle "felt" differently in the slower landing configuration than it did when flying it to the OGS.

From the ground, it appeared we had lowered the landing gear low and late. In fact, however, we lowered the gear earlier than planned at 275 knots versus 270 knots. On the ground, the gear-lowering appeared late and low because the high-speed entry onto the IGS placed us lower to the ground than it would have been at the nominal gear-lowering speed.

The high speed also targeted us to land much farther down the runway than desired, so I flew the Shuttle to a shorter landing position. This resulted in a faster than nominal landing, but the landing parameters were within the Shuttle's landing limitations.

Moreover, the automatic system lined us up slightly right of centerline coming out of preflare. Due to close proximity to touchdown at takeover, I decided to accept the slightly right lineup, as it was, without correction.

Nominally, the Shuttle's nose gear is held up in the landing position by the attitude-hold control function for aerodynamic braking until slowing to 165 knots, at which point it is manually lowered to the runway. In the STS-3 case, the nose began to lower to the runway immediately after touchdown. To hold it up, I executed a quick pitch-up input with the rotational hand controller [RHC] but with no apparent effect. I repeated the same input, and the nose began an unexpected and rapid pitch-up, whereupon I quickly lowered it to the runway. The remainder of the rollout to the end of the runway was uneventful with the exception of a nose wheel steering DTO at slow speed just prior to wheel-stop. Later, it was reported that a divergence or instability in the longitudinal control software for the Shuttle landing configuration caused the unexpected pitch-up behavior.

While the speedbrake control of airspeed was unacceptable for follow-on missions and resulted in a landing of lower quality than I would have made without the encumbrances of the DTO, at no time did I feel it was dangerous or that a safe landing was jeopardized. After all, STS-3 was an official test flight, and it was highly desirable to perform each DTO within safe and reasonable limits as perceived by the flight crew. As a result of this test of an automatic approach system, however, at least two recommendations were implemented as “lessons learned”, as follows:

1. For future Shuttle flights, the landing gear would be lowered based on height above ground, 400 feet, versus airspeed.
2. Development of an automatic approach and landing system was terminated indefinitely due to the inability to implement an FAA [Federal Aviation Administration]-like powered aircraft certification program for an unpowered glider like the Space Shuttle. That is, an automatic system cannot be reasonably certified for an aircraft without a go-around capability in the event of an autoland system failure, because the only recourse in the Shuttle is to land rather than to execute a wave-off maneuver as in a powered aircraft. The practice of having to salvage a good landing out of a poor approach is not professionally accepted airmanship.
3. Further, the STS-3 experience was classified as a “late-takeover” action in which a failure of the autoland system in even closer proximity to touchdown could result in an upset too late in the landing phase to be reasonably recoverable. "Monitoring" the approach versus actually "controlling" it induces a time lapse in the mental-to-physical control conversion process which increases in criticality for manual takeover as the aircraft approaches touchdown. An automatic failure on the IGS, with no

recourse for a wave-off, would be unsafe compared to a totally manual- controlled approach.

Further observations point to deficiencies in integrating autoland flight software into training simulators and to validating it prior to implementing it into the Space Shuttle systems. For example:

1. The STS-3 auto approach software was apparently not implemented into the Shuttle Mission Simulators [SMS], which was in total violation of long-standing requirements to incorporate flight software timely in the SMS. Auto approach training in both the fixed-base and motion-base simulators never exhibited the unacceptable speedbrake control experienced in the STS-3 mission. The software in both of those simulators modulated the speedbrakes in small increments, as a pilot would do, to control speed very precisely on the OGS. That is, we were led to believe there were no deficiencies in flight software related to OGS speed control, so the actual flight behavior in this regime was a complete surprise to which we were required to react in real time; exactly what pre-flight training is conducted to avoid! Ironically, the SMS-software programmers apparently "got it right" whereas the actual flight-software programmers did not.
2. This deficiency was not uncovered in sessions in the Shuttle Avionics Integration Laboratory [SAIL], either for reasons unknown or due to SAIL implementation and evaluation obscurities. We did not notice the speedbrake behavior described above in SAIL runs from either Entry Interface [EI] or Deorbit Burn to Final Approach. This could have occurred due to differences in Shuttle displays and the less obvious way the SAIL displays the same information. It could also be related to time we had

> available to spend with SAIL evaluations because it had few reset points, making it necessary to spend 30-60 minutes per run from EI to Deorbit in order to enable observation of the last minute of speedbrake operation. By contrast, the SMS had many convenient reset points, including some close to interception with the OGS. Thus, the SMS was far more time efficient in training for automatic approaches, and thus more frequently used, than the SAIL for this purpose.

ROSS-NAZZAL: Tell us about preparing for the flight, training, and working in the simulators, perhaps in the STA [Shuttle Training Aircraft], some of the Building 5 simulators, and the WETF [Weightless Environment Training Facility]. I know you were training for contingency EVA [Extravehicular Activity].

LOUSMA: We were training for contingency EVAs, and we had suits on board to handle that if necessary. The contingency EVAs would be primarily if the cargo bay doors were stuck, wouldn't shut, or wouldn't latch, and we were able to close them using a block and tackle system. We could also put latches on the interior by doing an EVA on the inside of the cargo bay and latching them down either at the centerline or the ones at the ends of the cargo bay.

We could also disconnect the arm. If we couldn't get the arm in with the block and tackle, we could jettison it. We had the same thing with the S-band antenna on the right side. As I recall we were able to figure out a way to get rid of that too if it wouldn't fold inside the envelope of the cargo bay door. Those are the contingency EVAs we trained for.

We didn't have the big neutral buoyancy water tank like we have now. We just had the round one over in the old centrifuge building. Gordon and I developed the procedures for doing most of the contingency EVAs. I guess the first two crews must have had some too. We hoped never to have to use that training, but if we had to we were prepared.

This was the first time we had a motion base simulator. We didn't have it in Apollo. This was pretty slick to have this motion base simulator. We had a fair amount of time in that for launches and for reentries, landings, then we had a fixed base simulator that we spent lots and lots of hours in developing the flight plan and doing integrated sims [simulations] with Mission Control.

There's nothing unusual to report about that. The WETF we talked about. The mockups in Building 9, of course we used those to do stowage and getting some of the in-cockpit experiments working and so forth, but that wasn't a simulator. It was more of a fit and function type of trainer. Helped us decide where to put the cameras and where they were and how to do the mechanical parts of spacecraft and do repairs as well—replacing a computer or some other element. We could learn to do that in mockups there in Building 9.

ROSS-NAZZAL: What about flying the STA? Did you find that to be particularly helpful?

LOUSMA: Oh yes. I think the STA was extremely helpful. Of course since we were flying a lot of our STA [runs] out of White Sands it helped us to be familiar out there. We would also occasionally go to the Cape and fly them too, even though we weren't going to land there. You never knew but we might. We also did at Edwards as well even though we had finally decided to land at White Sands. We had been practicing at Edwards periodically, but most of it was at White Sands.

The STA was invaluable I think in terms of the landing trainer. It wasn't perfect, because you couldn't land, but you could come close to it and you could determine how good the landing would have been if you'd been able to touch down. Moreover, you could put various conditions in that were not perfect. In fact, we seldom flew when it was perfect. It was always left to the instructor pilot to fly either too far away or too close in to the nominal flight path and having to adjust our airspeeds and our flying technique in order to get it on the runway. That was really very helpful to understand the limits that you had within which you could get the Shuttle on the runway and be able to do it safely. That was good.

We did a lot of T-38 flying at all three landing sites as well. I think I must have had about 800 approaches in the Shuttle training airplane. Besides that a lot of them with the T-38 just to get the sight picture over and over and over again. That was helpful. It's better to be flying than sitting at your desk.

ROSS-NAZZAL: Did training change at all after STS-1 and STS-2? Were there any changes that the crews suggested to trainers?

LOUSMA: Let's see. There probably were but I don't recall. Every crew that went was asked how it was compared to the simulator. We would determine what needed to be changed and what not. Of course, there were more changes after the first and a few more changes after the second, and a few more changes after the third. Finally got to the place where it's been tweaked up pretty good by now I'm sure, but for the most part there weren't many surprises.

You use the motion base simulator just for launches and entries primarily. You can put turbulence in, and you can put weather in. You can put the conditions that you would expect when you had staging and engine cutoff. Plus the emergencies that you might have with losing APUs, losing an engine, flying the RTLS [Return to Launch Site] approaches, or doing the transatlantic aborts to some airfield either over in Spain or in Africa. All of that was essential because you had to be prepared for that on any launch. Fortunately we never had to do it, but at least we were able to go through the procedures and have the confidence that if the simulator and the machine flew the same you could get where you wanted to go. The simulators—I don't know how you'd do it without them really.

ROSS-NAZZAL: Did Joe [H.] Engle or Dick [Richard H.] Truly pass along any advice to you based on their flight?

LOUSMA: One was the automatic approach. Joe had flown the outer glideslope leg of the automatic approach. That was part of his mission, down to before you would make the preflare pull-up. Apparently it went okay so they extended our flight to go through the preflare and into the inner glide slope but not the landing. He passed along the word that it seemed to fly okay. Maybe his software was different than ours because ours didn't fly okay, or maybe he took it over manually. I'm not sure which, but I decided it's a test flight. Test everything you can. As long as it was not unsafe, then I was willing to let it go. It wasn't unsafe, it was just a little fast.

I'm sure that there were a number of things that were passed through the training system that they input that I didn't know about. They showed up because they put them in, and we were there, but every flight learned from the one before. Guessing even nowadays you still learn something new, but in those days just about everything was new. We tried to inform the crews that came after us what to expect. The first crew especially had a lot to report.

ROSS-NAZZAL: What did you share with the crew of STS-4 that you had learned from your mission?

LOUSMA: Actually, when they landed at Edwards they didn't land on a lake bed. They landed on the hard runway. It was the first landing on a 15,000-foot runway. I guess we passed along to them that we knew enough about what the Shuttle does when it gets near the ground. You can probably get it stopped in 15,000 feet. You pretty well know where it's going to land. We got better and better on that as we went through the first, second and third flights. So other than that I don't recall. There were probably some things that we discussed but good grief, it's been 35 years or more.

ROSS-NAZZAL: Been a while. I did have a question about the launch. I was reading that you flew a different launch pattern than the other first two flights. Do you have any recollection of that?

LOUSMA: No, I don't know how that was different.

ROSS-NAZZAL: I think that we hit all the highlights of the mission but I did have some other questions for you about some of the earlier material you had talked about. Would you mind if we went back and talked about some of that?

LOUSMA: No.

ROSS-NAZZAL: One of the other assignments that I saw that you had worked on were software issues besides those crew displays that you had talked about. Were you working with SAIL or FSL [Flight System Laboratory]?

LOUSMA: I had little interaction with the SAIL except for an unsuccessful attempt to understand how the STS-3 software for an automatic approach system was implemented. I had a little bit to do with software development when it concerned some of the video displays, the CRT [cathode-ray tube] displays, especially that had to do with the experiments that we were flying. The ones in the back of the bus were primarily put on by Goddard [Space Flight Center, Greenbelt, Maryland]. We had to interface with them. Before the mission, when I realized what they were going to be and that there hadn't been much work done on the displays for operating those experiments I got the principal investigators together up at Goddard. We went up and took a look at their stuff. This is where their experimental equipment, the flight hardware, was being tested before it'd be sent to the Cape.

We went through the flight plan and found out what it was they wanted to do and made sure the displays were compatible. They effectively had not done much with displays at all. That's what cued us when we started looking at their displays down here in Houston. They were unsatisfactory for doing the real mission. We went up there and ironed all that out with several of the experiments that were in the cargo bay. OSS [Office of Space Science]-1 was one of them; Goddard was responsible for the test, evaluation, and preparation of most of the cargo bay experiments.

ROSS-NAZZAL: This included Getaway Specials [GAS]?

LOUSMA: I don't recall who managed the Getaway Specials.

ROSS-NAZZAL: You had mentioned that there were different types of HUDs that you were evaluating. Can you tell us about some of those different types?

LOUSMA: Well, the HUDs that were in the fighter airplanes were all a little different depending on what their mission was. Some were fighters, and some were attack airplanes. That part of their displays really wasn't applicable to what we were doing, but it showed me the capabilities that could be used for what we were doing.

The airlines were looking at a head-up display that was already built but that was portable that they could install up near the windscreen. I don't remember who made that, but it was more like a laptop-size display; it would project on the windscreen or you could look through it. Most of them had a projector up front on the glareshield that would project the numbers up on the windscreen. The primary difference was a military HUD was dependent on the mission of the airplane, but none of them really had what I'd call a landing display, because they're more interested in the fire control, air-to-ground weapons delivery, coastline terrain, and mapping. We didn't have really need for that.

What we had a need for was the approach phase that turns the Shuttle around the circular approach and gets it on the runway, particularly the last part where we use it for the outer glide slope and the inner glide slope. That's where it had the most application, but we added to it such that we could look through the head-up display and we could see the terrain all around when we were actually coming around the heading alignment circle as they call it. That was different than all of the other applications, except for the ones the airliners wanted to use. Theirs was mostly for doing the straight in approach in bad weather. It would paint a picture of the runway on the windscreen. It would have all the sensors in it such that it would know where the runway was. When you were in clouds it'd see a simulated runway there and you'd see your ground track to it. It would give your airspeed, roll and pitch angles, speed brake position, and other landing parameters.

Actually the Shuttle one does that too. It paints a runway where it thinks it is, and you hope it's right. So when you break out of the clouds and it coincides, why, that makes you happy. The airliner plans for head-up displays were more allied with what we wanted to do, but the airliners weren't using them yet. I called the Air Line Pilots Association, ALPA I guess it is. I talked with the president of that. I said, "Are you guys using head-up displays."

They said, "Well, no. We know of them, but the airlines don't want to spend the money for them." They would have to equip every airplane with a head-up display. That's a major expense so they had not implemented them yet. The landing head-up display that the airline would use was more applicable to what we were doing, but we effectively invented our own.

ROSS-NAZZAL: You mentioned that it was fairly costly. Do you recall how much it was at the time?

LOUSMA: It was always a lot more than I thought. I don't have the numbers for that. I don't know if there's anybody who does.

ROSS-NAZZAL: Well, tell us about convincing management of the need for this HUD. Would you share with us how the process went from, "Let's go investigate it" to "This is something that we actually need on the Space Shuttle?"

LOUSMA: Yes. I wasn't going to go into that.

ROSS-NAZZAL: It's your call.

LOUSMA: They were not too keen on putting it in. In fact there was a time when I thought they might not, but this was also during ALT flights. The last ALT flight had a little dipsy-doodle in their landing. When Rockwell saw that they thought maybe a head-up display wouldn't be a bad idea.

ROSS-NAZZAL: So they agreed with you.

LOUSMA: They didn't want anybody breaking their airplane.

ROSS-NAZZAL: You mentioned that *Columbia* didn't have this HUD until later. Did the STA have a HUD? Or you didn't use a HUD until later?

LOUSMA: It didn't have one when I was doing it. No, the left side of the STA was configured just like the Shuttle we were flying.

ROSS-NAZZAL: Tell us about the '78 class coming in. You mentioned you were orienting the pilots, but tell us what it was like when you had women and minorities coming into the office, and a very large group of astronauts coming in.

LOUSMA: There were no women test pilots at that time so they weren't in the 15 pilots that I was getting oriented. The 1978 women were all mission specialists. I thought they really were doing a good job as mission specialists. Sally [K.] Ride worked on the remotely controlled arm on STS-3 and contributed greatly in that area. I thought they were very proficient in what they were doing. I've admired what they've done.

Shannon [W.] Lucid on the Mir—she was for a while the most well traveled astronaut. Shannon is a good friend. I appreciate her company. She's still around. I saw her in Mission Control the other day working on that. We had a Bible study that my wife and I started when those folks came. She of course is a missionary's daughter, with quite a colorful early history. She was a member of that Bible study as were some others.

Anna [L.] Fisher, I worked with her quite a bit as well, Judy [Judith A.] Resnik, Kathy [Kathryn D.] Sullivan too on the EVA. They contributed to the development of things we were doing. They came on, and that's the way they learned. Like the rest of us did before. We were in support crews. They took over that function for us.

ROSS-NAZZAL: Do you think they changed the office in any way?

LOUSMA: It made it more diverse obviously. No, I don't think so. I think they fit right in real well. We just accepted them as any astronauts we would have. They were all Mission

Specialists. I wasn't there when the [women] pilots came aboard, but I've gotten to know Eileen [M.] Collins since that time. She did a great job with the piloting and commanding three flights that she flew too.

ROSS-NAZZAL: Tell us about orienting those new Space Shuttle pilots. What sort of advice were you giving them as they came on board?

LOUSMA: I don't know as it was giving them advice so much as I was helping them find places to live, who to go see for certain kinds of things, [where] to get their car fixed, or have them over just to get acquainted with them. Their wives would come as well. It was just more of a get acquainted opportunity and giving them a chance to do the things they wanted to do. If they wanted to go to the Mission Control Center, I would say, "Here's who to see to get to do this," and helping them get over there. Sometimes we'll have to go to the Cape to work, and sometimes you'll have to go to Huntsville. Get them acquainted with who was there and how to get around.

Most of them were pretty self-reliant. You didn't have to paint much of a picture for them, the pilots anyway. Being a military person myself, I was able to communicate with them fairly readily and knew what they needed to know in most cases. They were a confident bunch. They were used to going to new places and getting reassigned regularly and figuring out how to get their family settled. I was just there to assist wherever I could.

ROSS-NAZZAL: You had mentioned, when you were working on the Skylab mission, something that I wanted to ask about. You were going to be working on that remote-controlled booster.

Can you share with us how you would simulate that and where you would work on those simulations?

LOUSMA: Yes. The simulations for the remotely controlled booster were done at Marshall. They had the lead contract for the development of the booster package. One of the things that was necessary was to define the power that was going to be in the control system. We also knew that the Skylab wasn't just sitting there motionless waiting to be docked with but it was actually augering through the sky with a motion that made the nose of it wobble in a circle. When we designed the booster package, it had to be capable of being flown so it could match that wobble of the docking port around a centerline; it was auguring around a centerline in a circular motion.

I had to fly that booster over there and match that circular motion and have enough power in the control system to make sure that could be done. We set up a simulation system over at Marshall. We simulated known wobble of the Skylab and made sure we could get to that, then we added to it and made a bigger wobble so we could size the control system. That was part of the development. The operational part had to be compatible with what was up there.

That was most all of the docking simulation that we had during that first year. We had not thought of making a more elaborate simulator here by the time that the program got canceled, but that seemed to do the job.

ROSS-NAZZAL: Was that primarily computer-based?

LOUSMA: Yes. As I recall just a CRT that showed what the Skylab was doing. I had a simulated docking module that would dock with it and see if I could make the docking. That's all it was.

We didn't have anything more elaborate than that. We didn't have the two big pieces physically to dock together; we might have had that later, but it didn't get that far. This was adequate; it was only going to be done one time anyway. We didn't have to have a simulator for lots of different astronauts. It was a one-shot deal.

The Marshall Space Flight Center was the head of that contract with Martin Marietta. I would go to work with the engineers at Martin Marietta, but we didn't have a simulator there. We just took the data that we got off the one at Marshall and made them aware of what needed to be done.

They did a good job. As long and as far as it went, we really were able to define what the requirements were and match them with the final design of the booster package.

ROSS-NAZZAL: You mentioned it was going to be as big as a truck?

LOUSMA: It was about the size of a dump truck, yes. Sits in the payload bay of the Space Shuttle. It was quite large. There are some pictures of it, or schematics of it, around. Perhaps you've seen them.

ROSS-NAZZAL: No I haven't actually. I'll have to.

LOUSMA: I have slides at home, but clearly they've got them over in the archives here somewhere.

ROSS-NAZZAL: We'll have to look and attach them to the transcript. That'd be great.

LOUSMA: It had a booster engine. It also had fuel tanks on it too, propellant tanks. It had to be fairly good size to do the job. Nobody ever decided which way it was going to be used, to go higher or to go lower.

ROSS-NAZZAL: Were you also working on prox ops [proximity operations] and rendezvous efforts?

LOUSMA: No I didn't work on that. Fred was working on that for this particular mission, the rendezvous and prox ops with the Shuttle and Skylab, but I was going to do the part in between. It was kind of Buck Rogersish, but it was doable. Also made it exciting.

ROSS-NAZZAL: Yes, it sounds really neat. Did you have any specific role in the maiden flight of *Columbia*? The first STS flight?

LOUSMA: No. Just went to see it go. That's about it. Got back here in two days. So no, I didn't have any role in the first two missions. Gordon and I were just training for ours. So two and a half years before the flight we started training; that included starting with classes. When the Space Shuttle itself was so brand-new, there was a lot that was unknown about it, but we worked with the flight controllers, went to classes, and learned about how the systems worked. We were ready to get in the simulator. There were some part-task trainers also that we could get some time in as well before we got in the Shuttle mission simulator.

So let's see. Two and a half years before that would have been end of '79 I guess, but that's how long we trained for the Skylab mission with Bean and Garriott too, two and a half years.

ROSS-NAZZAL: Had training changed at all since Skylab?

LOUSMA: Oh yes. We had a motion base simulator that we didn't have before. We had less experimental training to do for the Shuttle. Skylab had 60 experiments. We had to become solar physicists, Earth science experts, medical science experts, astronomers, and [experts in] materials processing. We got into the science of all those things in Skylab. We decided at the outset that we were all going to learn how to do everything. The scientists had to become pilots, and pilots had to become scientists. We were, all three of us, capable of doing anything on the mission that any other one had to do in case there was an incapacitated person or somebody was ill for a while, [and we] had to take over.

The things we trained for were quite a bit different in Shuttle than for Skylab. For STS-3, there was not as much scientific training because we didn't have as many experiments. Some of them were just turn on, turn off, things like the Getaway Special canisters. There wasn't a lot to know in some of those things.

I guess the experiments that took the most time in Shuttle were the ones that had to do with the environment: testing with the payload on the arm. A couple of the solar experiments required a fair amount of inside-the-cockpit maneuvering, but we had one in the cargo bay that was a very complex science experiment. It was based on an electronic discharge along the magnetic lines that was initiated by an electron generator. We couldn't call it a gun, but it was an electron generator, not an electron gun, an electron generator. We put electrons into the magnetic field. We had to orient the Shuttle such that the magnetic field would be perpendicular to the cargo bay to see if we could elicit some sort of electron glow that would coil around the Earth's magnetic lines.

Come to think of it, we did discover something there. In order to do that, we had some very sensitive film that would take good pictures in dark places. We had to have all the lights down. We had to cover the windows and have the camera pointing out with a shroud around it. We never ever detected that electron coil so to speak, but because the film was so sensitive, it found a glow around the Shuttle, around the OMS pods and around the tail. It was just a glowing layer conforming to the shape of the Shuttle. You'd think it'd just be dark at night, but it wasn't. That was a discovery that we weren't looking for.

We didn't find what we wanted to find out, but we found out something new. That amused the scientists for a while, and engineers, because that must have had to do with the fact that the Shuttle was moving through space and it was intercepting and ionizing some of the very thin atmosphere that was there, the molecules. That caused a glow. They thought there must be some oxidation on the surface of the Shuttle, maybe over time that could be destructive.

They pursued that. Frankly I don't know what they came up with in the end analysis, but I know that I've seen the pictures. I don't think that it was anything that was considered finally to be destructive to the Shuttle, but was some new gee-whiz item that they ought to keep in mind and see what happens as a result of that, for example, surface deterioration or coatings to prevent long-term damage.

It's one of those things that astronauts get into. We train real hard to understand the physics and the science of the experiments that we do, whether it's medical or whether it's just astronomy or solar physics. We try to understand the science so we can do a better job of gathering the data. If something goes wrong we can come up with a good alternative, if we know the basis of the science.

Same with the medical things about diagnosing illnesses in long-duration flights and taking care of those kinds of emergency medicine type things. You need to know how to do all that and what the causes are so you can do a better job of addressing the problem. So you go and you do that. You do your best to get the data. Some folks aren't into the science so much, but Skylab was and Gordon and I were too. We wanted to make sure that we got everything done that the scientists wanted to get done and that we did a good job of it. So we had to understand the underlying physical principles.

So we get the data. Then when we get home, we do our postflight report and a few public appearances, and we go on to the next thing. We seldom know what the results were of the things we did. That's the case with this particular observation. I don't know what the end result was of all that. I'd like to be more informed, but like I say, we go on to other things. Often the principal investigators, they go on to their things, take their data and do whatever they want to with it, but we don't end up being informed of the results. Some of that was different though on the Skylab missions. Some of the principal investigators were really good about informing us as to what they learned, especially in the medical area. I thought that was good, but some of the other areas not so much.

But this was another case of that. I'm sorry I can't tell you more about the scientific spin-off.

ROSS-NAZZAL: You mentioned something that just triggered another question. Tell us about your postflight tours that you did after STS-3.

LOUSMA: One of the things we did right away was to go and tell the Canadians what a great job they did building that arm. We were invited to go to Canada, and Gordon and I did. We went to the Maritime Provinces, one day for each of the four. It was New Brunswick, Nova Scotia, Prince Edward Island, and Newfoundland. We were obviously well received. We would report to the community at large or to a science group or to a university or just a civic Rotary lunch. Whatever they wanted to do, we would tell them how it worked, and tell them about the rest of the flight as well. That was just the four-day deal. We went up there in the Gulfstream. They dropped us off at different places. We'd get to tour around a little bit too to see how the people lived and what was there. We enjoyed the cultural interchange. We also went to China.

ROSS-NAZZAL: Did you really?

LOUSMA: Yes. That was in 1982. I think we flew in March, and we were there in November. It was colder than heck in November. Winter was starting there, but this was when they were still kind of having their coming out, still a totally Communist country. We spent about three weeks in China. The deal was that if we were to tell them about our space program, they would show us some of their space facilities. That was a good deal, a good interchange. We saw some of their space facilities.

Even in those days they were asking questions about life support, spacesuits, how you feel, those kinds of things. That was in 1982. They finally put some of that to use obviously.

They're doing better all the time. We were in Beijing about 10 days. We were hosted by the Chinese Astronautical Society, I think it was, something like that, like our AIAA [American Institute of Aeronautics and Astronautics] probably. It was aeronautics and space. It was mostly space. Of course when you get to China, everything is totally upside down with respect to time, because it's 12 hours different. If you want to go and see a play or something, it's around bedtime home, why, it's hard to stay awake.

We finally adapted. We had four Chinese, they were members of the society, [who] were our daily hosts. They were with us all the time, but when we first got there we went to the Beijing Duck Restaurant for our introduction to the chief of the Astronautical Society. They do things early there, and they go home early. We got there about 5:00 and had a little reception. They always have round tables, I think too. Just the right number of people. We had about three round tables, I guess. At the reception I was introduced to the head of the Chinese Astronautical Society. He was probably about as old as I am now, maybe even older, but he was very quiet. I tried to engage him. I was the leader of our delegation, obviously. We were there with our wives. We had a NASA rep [representative] with us as well.

We had this director of the Chinese Astronautical Society, and the four people who were going to host us for the next three weeks, and a few others. I tried to engage this guy during the reception. I don't speak any Chinese. I figured, well he doesn't speak any English so it's going to be a hard thing to do.

We were there, and we went to the dinner. Sat down at the dinner table, which was where the reception was. I sat on his right. To his left was the interpreter. I thought I should get acquainted with this guy. I asked him a question. I don't remember what the question was, but of course when I asked it I just was looking at the interpreter. The Chinese director answered the question in perfect English. I said, "Well, where did you learn to speak English so well?"

He said, "Well, I graduated from college in the United States" in 1937. I said, "Well, what school did you go to?"

He said, "I went to the University of Michigan in Ann Arbor.

I said, "That's my hometown. That's where I went to school." I found University of Michigan alumni clear over there in China on my left side. We had a great conversation about where we lived and went to school. It worked out good. So you never know where you're going to find somebody who speaks English.

We were around Beijing. We met with a number of the Chinese future space people. By this time they had fired off several rockets, Long March rockets. It was interesting. In this culture most of them wore Mao clothes, and they were riding a lot of bicycles. They'd line up for a stop sign. It'd just be 100 bicycles ready to go. There were some cars. The cars were mostly for getting officials around. The general public didn't have cars. They would drive us around in the cars though, wherever we had to go.

The first thing they did when starting the taxi was blow the horn. It seemed like the car wouldn't move until they blew the horn. They would blow the horn all the time we were going somewhere. They'd go for 20 seconds, blow the horn, boop boop. It was common to blow the horn. I remember that, but when you're downtown you can expect to see lots of bicycles.

We were staying right near Tiananmen Square. They took us all around the Old City and took us to all the sights, then we would have lectures for the scientists, engineers, and technicians who might be involved in space. Sometimes there were maybe 700 or 800 people. Gordon and I had a lot of slides and some videos. We would explain what they were, all about the Apollo Program, Gemini Program. All that was common knowledge.

I took along several space photos of China. We were able on the Shuttle missions to take pictures of China and Russia. We weren't on Skylab, but they finally changed that. I had taken a picture of a beautiful emerald-colored lake in China. It was just beautiful. All around it was desert, a tan sandy desert. It was an absolutely beautiful picture. I showed them this picture. I noticed out in the audience all of a sudden there was a rise in the noise level. Like they were all talking about something. It was a happy sound. They were shuffling their feet.

The interpreter said, "Next slide, please." We went on. I thought maybe I pronounced the name of the lake wrong or something; then we were showing another picture of Shanghai and the airport. Once again, noise. A happy sound, but conversation out there. It died down. Later on we had a social event that evening. When I could get the interpreter by himself I thought well, maybe I better not engage this guy too much, because he'll think he's transmitting information he shouldn't. Might be politically bad for him.

I said, "I showed these two pictures. I showed this picture of the lake, and there was a noise in the audience, then you said next slide. We didn't get to talk about it. Did I pronounce the name of the lake wrong or something like that?"

He said, "I think that's an atomic test site." Here these Chinese, they probably weren't supposed to know about that but did. They had to have some American come over to show it to them. It was a long time ago so I'm sure it doesn't make any difference now, but we had conversations with a lot of people who might be interested in human spaceflight. They had been talking with the Russians and also talked with the Russians about crew selection. They had some interesting ideas about crew selection and who they should select based on Chinese medicine. I didn't get into that. They have different ways, but they've done very well with what they have.

We also went to a place where they made satellites. There were a number of English-speaking Chinese scientists there. They'd been educated at UCLA [University of California, Los Angeles] and other places in the United States and were there in China making [up] part of their aerospace program, but I was thinking earlier that it was interesting to see this communist country without much of what we enjoy today, but they had these shining gleaming silver rockets that they could shoot off. They had not put anything above low-Earth orbit. They had put some weather satellites and some animals into low-Earth orbit, but they had never put anything into geosynchronous orbit like communications satellites, but of course they've done all that now. They've had the help of Chinese scientists and engineers who were trained here in the United States.

We met some people in the government too. Congressional people, equivalents of our Congress, that had been educated here and were now serving there. We dealt with the American embassy there as well. We would do a program for the American school while we were there. They were good about showing us around the Chinese cultural areas.

We also went to Shanghai for a few days. We went to Xi'an, where they have the terra-cotta archeological sites where the emperors' tombs [are located], and they had started digging up some of those tombs and exposing some of those terra-cotta armies and soldiers. It was fairly small at that time. I think it's expanded greatly now, but it was about the size of a hangar out at Ellington Air Force Base [Houston, Texas]. They had uncovered that much. They had planks. You could walk around and look at these things. It was very fascinating.

There were also groups there of students, like college students of scientific orientation, who wanted to know what we were doing so we told them about Apollo, Gemini, and some of the things we learned. We went to another place where they made their rockets. They did show us five different sites. They showed us another place where they tested their equipment with vibration and thermal chambers.

I don't think they showed us the newer things. We didn't go to their launch site for example, but I think it probably is much more open now, but it was a very interesting tour. Of course we went to the Great Wall of China. I don't know who started the rumor that you can see the Great Wall of China from the Moon, but you can hardly see it from low-Earth orbit. Hate to bust their little bubble, but that's the way it is. The Great Wall is not all that big a deal.

It was really a pleasant visit. We enjoyed it greatly and brought back some Chinese mementos, vases and so forth, that they make, but in those days they didn't have all of the shopping that they have now. They were just starting to get a store here, a store there. Of course wherever there were any electronics, you'd see the kids all congregate there. They had made a subdivision they took us to of fairly new homes, maybe five or six of them. They were very proud of the construction, because it was different than they had downtown in Beijing. They were starting to do that. They were starting also to allow people who worked on communes to keep some of their produce so they could sell it on the open market, a little bit of free enterprise, you know, entrepreneurs.

I think if you give a Chinese person a chance at a business, it's going to run. It's going to take off and run. They were doing that. Some of them were accused of selling more than they should and of making too much money at it. They were going to have to give a little more of it to the commune than they'd been doing. They slapped them on the wrist a little bit, but they said, "That's not capitalism, it's just good socialism." That's what they called it. That was a really good trip, but I think those are the only two that I can remember that we took.

ROSS-NAZZAL: Great trips though.

LOUSMA: Yes, they were. They asked me first to go to Argentina. It was near the timeframe of the Falklands War. It was when the Americans sided with the Brits [British] against the Argentines at the Falklands. I asked, "You're sending me down there? I'm going to get assassinated. I don't want to do that. Let's go somewhere else. Let us go somewhere we haven't been. We'd like to go to either China or Australia." So they sent us to China, which was really a great experience, in that time especially.

ROSS-NAZZAL: Do you want to talk about your [time as the] backup crew [for ASTP]?

LOUSMA: Yes, I could do that. The Apollo-Soyuz mission was just a rumor at the beginning of the era of detente that we had with the Soviets, in which we had traded back and forth people in music, education, farming, athletics, and all those various areas. One of the things we traded back and forth was a joint spaceflight. I had heard just a rumor that that was going to happen, possibly. At the same time the Skylab was right on the edge. There were times when they were talking about canceling the Skylab, saving the money, and doing something else with it. In that era the ASTP mission was rumored. I thought well, if I don't fly on Skylab I better try to get on this Russian flight.

While I was training for Skylab in the early days I took a course in Russian language. I just did it on my own. Military people do distance learning or correspondence courses with University of Maryland [College Park]. I found out they had a Russian language course, a one-semester course. It was written only. It was no conversation, but they taught you how to pronounce words. I took it and sent the lessons in. It was 15 or 20 lessons. I passed the test so I had a start on the Russian language. At least I could read it, I learned quite a few words, and I could write it.

I couldn't converse with anybody. When I took the test then I sent a copy of my graduation letter to Deke [Donald K. Slayton] and got it put in my jacket. I knew Tom [Thomas P.] Stafford very well because I'd worked with him on Apollo 10, and I had heard a rumor that he was going to be the commander. I said, "I'd be willing to be part of your crew." By the time I got around to that Skylab was back in. I knew that I couldn't get off Skylab and turn right around and be on another prime crew so I said, "I'd like to be on your backup crew."

He said, "Well, let me think about it." I guess that meant he had to go talk to Deke. Later on he came back, and they assigned me to the backup crew with Al Bean and Ron [Ronald E.] Evans. Of course Ron had just come back from Apollo 17, and Al and I just from Skylab too, so we were all well trained in terms of Command Module, Saturn launches, entries, and rendezvous. The thing we weren't very well trained in was the Russian language, but they hired, as you probably know, four Russian language teachers, three of who were real former Russians, and one of who was American who learned it.

My instructor was Vasily Kostun. He was an escaped Red Army soldier. He was a Czech. After World War II, the Ukraine needed farmers. They were invited to go there from Czechoslovakia. His parents went there as farmers, and either stayed or were forced to stay, I don't know which. He was drafted in the Red Army and somehow he got out through Czechoslovakia and came here.

The Russian language course was totally conversational Russian. We had the course that was taught at the Defense Language Institute [Monterey, California] for people who were going to live and work in Russia in the diplomatic corps for two or three years. This was not just for short tours. It was for people who were going to go for long engagements.

We'd have these just one-on-one conversational instructional lessons every day depending on how much time we had. Of course we had also to continue to train to do rendezvous and dockings and make sure we knew how the docking adapter or docking module worked. There was a lot to do besides Russian language, but it was a good chance to learn something I'd never done before. It was also very interesting at that time because we didn't know much about Russia or the Soviet Union. More information was coming out about the culture, history, how people lived, and politics, and that all was fascinating to me. We went over there three times to train with them, and they came over here three times. We got to know the cosmonauts real well.

By the time we left, we could converse with them and the families in Russian without an interpreter. Of course for the language of spaceflight we learned all of that, and they learned it in English. At first if we couldn't quite understand or didn't know the word, why, we could help with our English and they could help with their Russian to get through what we were doing. By the time the flight came our crews and theirs were well versed in the language.

It was good to have them come here and for us to go there. We enjoyed the home tour part of it. We enjoyed being over there in Moscow. While we were there when President [Richard M.] Nixon and Secretary of State [Henry A.] Kissinger made a state visit. All of us astronauts and cosmonauts were part of that. It was a huge thing in Saint George's Hall, I think, or one of those saints.

We got to meet with their president, [Leonid I.] Brezhnev and [Alexsey N.] Kosygin, and got to say hello to them. They asked a few questions, and we tried to give a few answers. To me that part of it was extremely interesting. It was one of the most interesting assignments I ever had, although I didn't fly the mission. It was one of the most interesting from the cultural point of view, especially at that time when it was still Iron Curtain days. Shortly thereafter the era of detente was terminated, and everybody went back to doing things the way they had done before until [Mikhail] Gorbachev and [Ronald] Reagan got together.

I guess it was interesting from the point of view that it was so unusual to have Americans over there and to Russians here. We had them over for dinner. We'd have them over two at a time. They enjoyed seeing how Americans lived. We enjoyed seeing how they lived.

The training was good. I think the training in Russia was interesting, too. I thought their workload and training regimen was considerably less than ours. We did a little more socializing during training hours in Russia than we do here. We kept them real busy when they were here, but that was a successful flight. I don't know what to tell you beyond that.

ROSS-NAZZAL: I think that's a good overview. I just had a couple general questions we always like to ask everybody. What do you think was your most significant accomplishment while you were working here at JSC?

LOUSMA: Most significant accomplishment. Well, probably getting on my first spaceflight. On the first spaceflight, [Skylab 3], you've probably been told we accomplished 150 percent of our objectives. We did, because nobody had ever lived in a big thing like that and didn't know how to train for it so we did the best we could. We allowed extra time in training to do everything, because we were moving big packages around and we were living in a big place for the first time. There was a lot of fixing to do, also.

Turns out when we got up there, the first time we went through everything, we learned where everything was. Every time after that, we did the task a lot quicker so we had extra time. We wanted to be productive so we asked for more work. They generated some more kinds of things for us to do.

One of them was Earth Observations to quantify more precisely what you could see of the Earth from space, and how you might use that vantage point to better advantage in the future than we had thought about doing in the past. So we developed that Earth Observation program. Up until the time I left it was a program that was applied to every flight, including our STS-3 flight. We had a book of things to look for, see if we could see them and report back. I think probably the Skylab flight made a significant contribution to further Earth Observation studies.

ROSS-NAZZAL: What do you think was your biggest challenge?

LOUSMA: The biggest challenge was probably learning the Space Shuttle, because it was a more complex machine. For Skylab and all of Apollo, of course, the computational capability was very small compared to the Shuttle. In Apollo, the operational parts of the systems were not computerized and the GNC [Guidance and Navigation Control], although new, was relatively straight-forward.

I could learn the spacecraft, the Command and Service Module as well as the Lunar Module. I knew them like the back of my hand. In fact I was more lunar-trained than anything else because in my support crew roles, the first two assignments were on the Lunar Module. The first Lunar Module came from Grumman in Bethpage [New York] and was actually tested for almost a whole year before it was ready to go out to the Vertical Assembly Building. Fred Haise was the lead guy for that, but Fred got assigned to the backup crew of Apollo 8 and I got his job. I took the rest of Lunar Module 3 that was for Apollo 9 through the test and checkout, out to the Vertical Assembly Building to test again and out to the launch pad to test again prior to launch,

I learned the Lunar Module. I did the same thing for the Apollo 10 Lunar Module when they orbited the Moon with Stafford and [Eugene A.] Cernan. While I was at the Cape, I would get in the simulator when the crew wasn't there, or if they needed someone to help them check out the simulator. If one of the crewmen had to go to a meeting or something, I'd fly with the other one. I had 700 hours in the Lunar Module simulator.

I was also flying helicopters in preparation for lunar missions. Alan Bean, when he was on the backup crew for Apollo 9, and for which I was on the support crew, asked me to develop the malfunction procedures for the crew to use on board. I worked with the flight controllers to get those made. All things considered, I expected I was headed for a Lunar Module assignment.

The last three Apollo flights, of course, were canceled. That terminated any aspirations I might have had for a lunar mission, but that's the direction I thought I was headed.

ROSS-NAZZAL: You were talking about your most challenging milestone was learning the Shuttle.

LOUSMA: Of course the Lunar Module and the Command Module in terms of computing power were about the same, and the spacecraft systems were operated like you operate your car or your house with the switches that you throw and handles that you move manually. Then the Shuttle comes along, and it's mostly controlled by software. All the spacecraft systems are now also controlled by software, and so is all the guidance, navigation and control, of course, but it's much more complex now. Learning the Space Shuttle to the depth that I wanted to, as I had in the Apollo, seemed to be a formidable job, and almost impossible in the time that we had to do it. I found that the most challenging was to learn as much as I could about how the Space Shuttle worked. Not just the mechanical stuff, but how the software worked, and how then I needed to use that information to stay alive and to fly a good mission. So that, I think, probably was the most challenging.

ROSS-NAZZAL: Rebecca, did you have any questions?

WRIGHT: I just have one, because you're one of the few people we can ask this question. That is you flew in your first mission on a Saturn [rocket], and you launched, of course, on the Shuttle. Can you share with us the differences that you felt in those launches and the differences in training and how they prepared you for each one?

LOUSMA: That's a good question, and it's often asked. I do lectures for a couple weeks every year down at the Cape at the Kennedy Space Center Visitor Center for the general public. That's one of the questions often asked. I've even made a program for that. Every day I do one of those. Well, the differences. There are six of us who have flown both the Shuttle and Saturn, or Apollo.

The Saturn and Apollo got us into orbit in ten minutes. The Shuttle is eight and a half minutes. The G-forces in the Saturn were about four Gs for launch, and they're about three Gs for the Shuttle. Of course you're lying down in both cases. The Shuttle could accelerate to more Gs, but it doesn't want to get more than three, because it could overstress the fitting between the tank and the Shuttle. When you get to three Gs the throttle comes back to maintain three Gs and get in orbit that way, but still you get there quicker. Eight and a half minutes. That's quicker than Saturn but with fewer Gs, so it's a spectacular ride!

Another difference, of course, is you have what I call a "real staging" with the Saturn, and then sort of a "semistaging" with the Shuttle, because with the Saturn you had to shut down the stage you'd burned out just before you got get rid of it. So you're accelerating forward and all of a sudden you shut down that engine. You get thrown forward in the straps and you say, "Hey, the engine shut down" and then you have to get rid of it too. There's a big explosion as the cord around the—can opener so to speak—explodes, and the debris goes in every direction, like a big disk. That separates that spent stage away. Meanwhile you're just coasting, and you're waiting for the next stage to light. That's what I call a real staging. For the Shuttle, we call it staging when we just get rid of the solid rocket boosters, but the main engines have been burning all along right from liftoff. That's what I call sort of a "semistaging."

Vibrations are different in the two rockets. Both of them have fairly heavy vibration right at liftoff, but on the Saturn the vibration would quickly damp out, and the ride was quite smooth. You'd feel the engine surge a little bit, but there wasn't any vibration. It was quite a smooth ride. It laid you back in the seat to four Gs, as I mentioned. The Shuttle though, after the heavy vibration, you clear the launch tower and make your roll maneuver, and there's still a steady chatter. It's not a heavy vibration, but it's like running over railroad ties real fast with a car, a steady vibration. That's caused by solid rockets, but as soon as you get rid of the solid rockets, then the ride is much smoother. Then, you feel this relentless, aggressive, powerful push just throwing you into orbit.

The other thing that's different of course on launch is you have a launch escape tower on the Apollo. You don't have anything like that on the Shuttle. If you lose an engine on the Shuttle you have to continue to fly east for four and a half minutes before you can turn around to start back. In the Saturn you have a launch escape tower if it's necessary.

That's different. When you get rid of the launch escape tower, of course, it's connected to the conical shroud that covers the Command Module and all its windows except one. You must get rid of that launch escape tower because you don't need anymore after you get above the atmosphere. You throw a switch, and that escape rocket ignites and pulls the shroud off. It goes screaming away like a scalded eagle. It's a lot of whooshing noise. It's real spectacular to see that rocket auguring away from you, carrying the shroud. You can see a lot more now because the other four windows are uncovered. I would say the ride in the Saturn for all those reasons is more dramatic than the Shuttle ride.

Coming back in Apollo, you're in a capsule, looking backwards, and lying down. You get up to about four Gs coming out of Earth orbit. Whereas, in the Shuttle you're sitting up and looking forward, and the most Gs you get is one and a half, sitting down. But if your backside hasn't been sitting on something for a week or two, why, when you start feeling one and a half Gs on your seat, and it feels like you're going to fall through the floor. But that's all you get is one and a half Gs. You can't pull more than two Gs with the Shuttle because that could overstress it. So the entry G-forces are less in the Shuttle than in Saturn.

You're also looking forward in the Shuttle. Obviously it's different when you land. Coming back in both cases you have to fall from orbital altitude through space for maybe 150 miles or so before you hit the top of the atmosphere. In both cases you have to hit the atmosphere at just the right angle. In a Shuttle night entry, you see this kind of a peachy glow, out the windows, then it's a pale orange glow and then brilliant orange and then brilliant white-hot. You're looking forward, and the light show goes away when you breakout into the daylight.

The temperature on the Shuttle heat shield gets up to 2,500 degrees, 3,000 or so on the leading edges, whereas the capsule heat shield gets up to 5,000 degrees. In the Apollo capsule, you're looking backwards. Fragments of the heat shield are burning away to take the heat away from your spacecraft and they envelop the Command Module in kind of a sheath. They form a fireball about 30 feet in the direction you're looking. You're looking backwards at a shimmering, mean, hot-looking fireball. It breaks up when you fire the thrusters on the spacecraft because you've got to roll the spacecraft to keep it on trajectory. Those thrusters are firing right by your head. It's like having your head in a barrel with somebody beating on it with a sledgehammer. Bang bang bang, and there is all this rolling, and the fireball out there.

Once again, the capsule is more dynamic. You get down to where you get through the major heat pulse and then you have to get the chutes out. To do that, you have to blow off the nose ring of the capsule. That goes tumbling off with a pyrotechnic bang and then you get these two small drogue chutes out at 25,000 feet. They're white. They're on lanyards that are about 30 feet long. They're dancing around up there trying to slow you down and stabilize the spacecraft.

Then at 10,000 feet you get rid of those drogue chutes. You cut them loose and quickly leave them behind. Now you really have a sinking feeling, and you get the main parachutes out. You're below 10,000 feet now. You're getting ready to hit the water. The chutes, as they come out, all scrunched up or gathered at the base in what is called a "reefed" configuration.

That's good, because you're going fast, and if they were to blossom out immediately, the panels would be blown out. You have to slow down for a while. After a few seconds, those reefing lines are cut, the parachutes blossom out and then to their full size, and you wait for the landing.

The capsule is suspended below the parachutes on an angle. The heat shield is not parallel to the ocean surface. You don't want to do a belly flopper. The capsule hangs on an angle so when it hits the water, it slides in. It's like a train wreck when you hit the water. If you hit on one side of the wave it's going to be more of a train wreck than if you hit on the other side. When you splash down, you go completely submerged, and you come up either right side up or upside down. We bobbed up upside down in the Skylab.

After two months in space and being weightless we were now hanging from the ceiling looking downward in the water. Then, we can pump air into three balloons around the tip of the capsule. This changes the buoyancy and flips you right side up. Then you go through the process of getting on to the ship and cruising a couple days to San Diego [California]. You finally get home after three days or so.

Recovery is much simpler with the Space Shuttle. You land, you have your picture taken, and you go to lunch. That's all there is.

WRIGHT: Right side up.

LOUSMA: The Shuttle landing is a whole lot different. The only thing you don't want to do is to go off into the water along the runway, because there are alligators in there. There are quite a few differences. All things considered, I think the Apollo ride is more dynamic.

WRIGHT: Sounds like a great career. Thank you so much.

LOUSMA: I've been a very fortunate person. We're going to talk about Apollo 13 in the Apollo Mission Control Center. NBC is doing a documentary of some sort. I guess they'll play it next month during the 40th Anniversary of Apollo 13 during April 11 to 17. I was one of the CapComs [Capsule Communicators]. Joe [Joseph P.] Kerwin and Vance Brand were the others. I was on duty with Flight Director Gene Kranz when the explosion occurred. I don't know who all is going to be over there, but they're putting a documentary together. So that's what brings me back to Houston today.

WRIGHT: You got a lot of memories today from one range to the other.

LOUSMA: Yes. I didn't get to the Moon, but I had a very fortunate career. I was in training for another [Shuttle] flight, but it was two years downstream. It was just to dump off a satellite. It wasn't a test flight. I got in the simulator and started training, thought to myself, "Hmm, been here, done this." A lot of people would give their right arm to do it.

I decided that since it wasn't as exciting, and I'd done this all before, it was probably time to be moving on. So I quit. I thought well, if I don't get a buzz out of it it's not worth the risk to my family, besides, two years might be six. You really don't know. At some point in time you have to think about getting a real job and going to work for a living!

WRIGHT: Put it off as long as you could, did you?

LOUSMA: Yes I did, yes, but I do enjoy being involved with it; lot of camaraderie with my friends who have enjoyed unique experiences. I go to the Cape often. The astronauts have a Scholarship Foundation, too, of course. I stay involved in that.

The Association of Space Explorers is another way to stay involved. Sometimes, I do their things. We rendezvous in various encounters around the country. Now it's 40th anniversary time; started with Apollo 10 in Tom Stafford's hometown, Weatherford, Oklahoma.

I did the Apollo 11 one up in Washington [DC]. Whatever [Apollo] 9 did, I didn't get to that. I don't even know if they had something, but we had another with [Apollo] 12 down at the Cape during an Astronaut Scholarship Foundation event down there. Neil [A.] Armstrong showed up for that, too. For Apollo 13, there are several celebrations. I plan to go to the 40th anniversary celebration at the Cosmosphere in Hutchinson, Kansas, way out in the middle of nowhere. It's going to be a good time, and they have one of the finest space museums in the US.

I think the Lovells are having something in Chicago [Illinois], too. Marilyn Lovell was talking with my wife the other day and said, "Hey, we're having an event at the Adler Planetarium downtown Chicago. Why don't you come? We're having a reception."

My wife, Gratia, said, "Well, I guess so. Just let us know."

WRIGHT: That'd be fun.

LOUSMA: Yes. It's fun to get together with everybody. Everybody's more mellow now than they used to be, because everybody's had a chance to do their thing. They were pretty competitive days, but now it's fun to get together because everybody's had a chance to fly and enjoy it. There's a certain camaraderie there that doesn't exist anywhere else.

WRIGHT: Nice to reflect on the fact that you all have that bond of doing something that very few people have done. And doing it well.

LOUSMA: Getting to be more and more astronauts now, but I think we had the best days.

WRIGHT: We thank you.

ROSS-NAZZAL: Thanks for coming in.

[End of interview]