

NASA JOHNSON SPACE CENTER ORAL HISTORY PROJECT

ORAL HISTORY TRANSCRIPT

NEIL A. ARMSTRONG
INTERVIEWED BY DR. STEPHEN E. AMBROSE AND DR. DOUGLAS BRINKLEY
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[This oral history with Neil Armstrong was conducted on September 19, 2001, for the Johnson Space Center Oral History Project in Houston, Texas. Interviewers were Dr. Stephen E. Ambrose and Dr. Douglas Brinkley. Assisting with the session were team members of the Johnson Space Center Oral History Project.]

BRINKLEY: I wanted to start a little bit about growing up in Ohio. Ohio is an aviation state. I read somewhere that when you were very young, your father took you to the National Air Races in Cleveland. You were so young, do you have any recollection?

ARMSTRONG: I was two the first time I went to the Air Races. Of course I have no recollection of that now.

BRINKLEY: Did your father have an interest in flight? Is that why he would take you there, or was it just in the air at that time, it was so exciting?

ARMSTRONG: I don't think he had a particular interest in flight, but just an opportunity to take children to new experiences, I guess.

BRINKLEY: You got to ride in your first plane when you were age six, in one of the Ford Tri-Motors. Do you have recollections of that?

ARMSTRONG: I do not.

BRINKLEY: You don't?

ARMSTRONG: No.

AMBROSE: When did you first hear of [Charles A.] Lindbergh?

ARMSTRONG: I can't remember when the first time was, but I'm sure it was when I was a schoolboy, in elementary school.

AMBROSE: Everybody in America knew.

ARMSTRONG: Yes. Schoolboys always talked about heroes of flight.

BRINKLEY: Did you later have an opportunity to meet Lindbergh? Was he somebody that had been in your mind when you were becoming a pilot, thinking about Lindbergh? Did he mean a great deal to you as an American icon?

ARMSTRONG: I did have the opportunity to meet him on several occasions. Had enormous admiration for him as a pilot. I'd read some of his books. I was aware of the controversial position he took on certain issues. But I was very pleased to have had the chance to meet him, and I think his wife [Anne Morrow Lindbergh] was a wonderful person and quite an [eloquent] writer.

AMBROSE: Yes.

BRINKLEY: Did you ever correspond with him at the time of the Apollo? Was there any kind of wishing you well before the Apollo 11 mission, wishing you luck sort of—

ARMSTRONG: I can't recall that. I think I have some letters from him in my file, though.

AMBROSE: When did you begin building things? Your interest and your concern with engineering, your wanting to build things, is that a part of your memory from when you were five or six years old? Did you have a special bent towards that?

ARMSTRONG: I began to focus on aviation probably at age eight or nine, and inspired by what I'd read and seen about aviation and building model aircraft, why, I determined at an early age—and I don't know exactly what age, while I was still in elementary school—that that was the field I wanted to go into, although my intention was to be—or hope was to be an aircraft designer. I later went into piloting because I thought a good designer ought to know the operational aspects of an airplane.

AMBROSE: Were you good in mathematics?

ARMSTRONG: Everything's relative. I was good in my small classes. However, I've since met many people who have far better mastery of mathematics than I will ever have.

AMBROSE: Did you have physics in high school?

ARMSTRONG: Yes, I did.

AMBROSE: Do you remember your teacher?

ARMSTRONG: Yes, it was John Crites. I remember him very well, because he was sort of an unconventional teacher. He allowed a few students in each of his classes to do special projects, and so we didn't go to class very much. We were always off working on our projects.

AMBROSE: What was your project?

ARMSTRONG: In physics we had two. One was building a Tesla coil. I think it was probably about a 50,000 volt Tesla coil, good enough to light up fluorescent bulbs in the next room. Then a wind tunnel. That project was by myself. The Tesla coil I did with another student.

AMBROSE: Tell us about the wind tunnel.

ARMSTRONG: Well, my knowledge of aerodynamics was not good enough to match the quality of the Wright Brothers' tunnel, and at that point I suppose I was equally educated to them. But it was a fun project. Blew out a lot of fuses in my home. [Chuckles] Because I tried to build a rheostat which would allow the electric motor to change speed and then get various air flows through the tunnel, not altogether successfully.

BRINKLEY: During this period you were traveling around Ohio to a lot of different cities. Is there one beyond Wapakoneta, other cities that you really identified with? Did you go to different schools in all those different towns?

ARMSTRONG: Yes. I went to ... half a dozen schools.

BRINKLEY: Were you able to develop friendships when you were going to that many different schools, or was it the family life become—?

ARMSTRONG: I'm certain I had friendships in every one of the schools I was in, but I don't remember those friends prior to probably the junior high school age. I still have friends that I see and remember from that time period and subsequent.

AMBROSE: Beyond your physics class and the projects, were you an avid reader? Were you reading engineering and aerodynamics or history or what?

ARMSTRONG: I was an avid reader, yes, and I read all kinds of things. I spent a lot of time in the library and took a lot of books out of the library, both fiction and nonfiction. However, when I was building things, like models and so on, they were predominantly focused on aviation-related “stuff.”

AMBROSE: Do you remember any specific book you read about aviation that—“Wow!” kind of response?

ARMSTRONG: I recall that I read a lot of the aviation magazines of the time, *Flight* and *Air Trails* and *Model Airplane News*, and anything I could get my hands on.

BRINKLEY: What about like Robert [H.] Goddard in science fiction, things about space? Did you ever read any of the science fiction writers of that time?

ARMSTRONG: As a young boy I don't recall reading much science fiction. I did come to enjoy it when I was perhaps late high school and college age.

AMBROSE: When you were very small, did you have any interest in [General William] Billy Mitchell's trial?

ARMSTRONG: I don't recall. I knew the name Billy Mitchell and I knew about his demonstration of the effectiveness of air power, but I don't recall things about his trial. I may have known, but I don't remember.

AMBROSE: You were what, a sophomore in high school when World War II ended?

ARMSTRONG: That's approximately—let's see. Yes, I was between my sophomore and junior year.

AMBROSE: The assumption among young men at that time was, "As soon as I graduate or as soon as I get to be eighteen, I'm going into the service." But then the war ended when you were fifteen. So you completed the high school without any "I'm going to enlist" kind of feeling.

ARMSTRONG: That's correct. We had a few people in my school who had either lied about their age or were a little older than the class, who had gone into the service, and came back and finished high school after the war was over. We had several of those fellows in our school, but the youngest of those would probably be two years older than I was.

AMBROSE: You got a Navy scholarship to Purdue [University, West Lafayette, Indiana] immediately after graduating high school, I gather.

ARMSTRONG: I believe that the test for what was called the Hollaway Plan, the Naval Aviation College [Naval Reserve Officer Training Corps, NROTC] Program, were administered nationwide while I was still in high school, probably shortly before graduation, although I cannot remember the

precise date. It was early enough so that we could pick a school. If we were accepted into this program, we could pick any accredited school in the nation to attend.

AMBROSE: Was the test on one of those IBM [International Business Machines] sheets where you, you know, one, two, three, four, five, and you have a lead pencil and you—

ARMSTRONG: I don't think so. I believe it was predominantly—I shouldn't really say, because I confuse that. But my recollection is that it was a pencil-and-paper exam with a variety of different kinds of questions and sections.

AMBROSE: Mainly mathematics or mathematics and physics?

ARMSTRONG: I'm sure they had a focus on things that would be appropriate to aviation, because it was an aviation-directed program, but I can't remember the details of the test, except that I recall it was quite long. [Laughter]

AMBROSE: What do you mean by long? All day?

ARMSTRONG: Yes, it was an all-day test.

AMBROSE: That's the way they used to do it, I know. [Laughter] I've been through that myself.

So you came out well, obviously, and the Navy offered you, and the "Holly" Plan—it was like Naval ROTC, that you would get tuition and a stipend of twenty-five bucks a month or something like that, I suppose.

ARMSTRONG: Fortunately, it was a little more than that. They would pay tuition fees and books, plus a stipend for board and room.

AMBROSE: So when you were accepted in this program, you were signing up, in effect, accepting a call from the navy.

ARMSTRONG: A seven-year program, yes. Two years of [university study], then go to the navy, go through flight training, get a commission, and then serve in the regular navy for a total then of three years of active duty, after which the plan would be to return to university and finish the last two years. The intent of this program, named after Admiral [James L.] Holloway [Jr.], who, if memory serves, was [astronaut Walter M.] Wally Schirra's father-in-law, and the intent was to build up the naval air reserve strength, which they felt was going downhill because people after the war really didn't want to do that stuff anymore. That was my understanding at the time.

AMBROSE: So you were called up for flight training after what, one year at Purdue or two years?

ARMSTRONG: A year and a half. It was supposed to be two years, but I suppose they saw [the] Korea[n War] coming or something, and they needed to ratchet the volume up a little bit, so they called us in early.

AMBROSE: So now you're in uniform, but not yet commissioned, being trained as a pilot, is that correct?

ARMSTRONG: Yes, I was in naval flight school.

AMBROSE: Tell me about training. How did the navy go about training you?

ARMSTRONG: Well, they found that the way I had learned to fly before wasn't nearly what they expected. [Laughter]

BRINKLEY: Just to backtrack for one second, you got your pilot's license at age sixteen in Ohio. Could you have gotten it any earlier? Is that almost like getting an auto license back when you're fourteen, fifteen?

ARMSTRONG: I believe you could get it in a glider at age fourteen, but in a powered aircraft you had to wait till you reached your sixteenth birthday, and then the license you got was called a student pilot's license, which allowed you to fly solo, but not take passengers with you.

BRINKLEY: Do you remember your first solo flight over the land in Ohio when you actually could be up in the air on your own? Do you have any recollections of that?

ARMSTRONG: Yes, I have vague recollections. A very exciting time when you go on your first solo.

BRINKLEY: Where was the location?

ARMSTRONG: It was in Wapakoneta, at a grass field there.

AMBROSE: Who was your first instructor?

ARMSTRONG: Oh, let's see. I had three. The first one's name escapes me at the minute [Frank Lucie]. The second one was named Aubrey Knudegard. The third was Chuck Finkenbine .

BRINKLEY: They lived in that area, in Wapakoneta area?

ARMSTRONG: I don't know where they lived, but I'm sure they didn't live far away.

BRINKLEY: Was this unusual for a young man your age? Were a lot of contemporaries of yours wanting to get pilot's license?

ARMSTRONG: I was in a class of maybe about seventy students, about half boys. We had three in my class that learned to fly at the same time I did. So I don't know how unusual that is, three out of thirty five, 10 percent. Not very unusual.

BRINKLEY: Before we get back to the navy, can I ask one Ohio question? I'm curious because of living in Ohio. Do you remember the towns that you lived in? Research says you lived in a lot of different towns, but they never say the names of them.

ARMSTRONG: I moved a lot before I entered school, and when I entered school, the rate of change of towns slowed down somewhat, but still about every couple of years it seemed like we were moving.

BRINKLEY: What were the names of some of the other towns besides—

ARMSTRONG: First school was in Warren, Ohio; and then Jefferson, Ohio; Moulton, Ohio; then St. Mary's, Ohio; [Upper Sandusky Ohio]; then Wapakoneta, Ohio.

BRINKLEY: I never knew those other towns. Thank you.

AMBROSE: Okay. When you began with the navy is training you to be a pilot, you had been up in a single-engine plane for some soloing, but now you're with the United States Navy. How did they train you?

ARMSTRONG: Training was divided into three parts. The first was a [four]-month nonflying ground school and physical training regimen. The second part was called basic training, which was all flight students went through the exact same protocol, did the exact same kinds of things, learning to fly, getting some experience soloing, learning to do cross-country flight, navigation, that sort of thing, learning to fly instruments, learning to fly acrobatics, learning to fly formation, learning to drop bombs, learning to fire guns, and learning to land on an aircraft carrier.

After that, went to advanced training, where—

AMBROSE: On an actual carrier?

ARMSTRONG: On a real carrier. [In] advanced training, you [were selected to become the pilot of single engine aircraft (fighters and attack aircraft) or multiengine patrol aircraft]. In my case, I asked for fighters and got fighters.

Then we went to Corpus Christi, Texas, and went through training there in single-occupant aircraft, in my case F8F *Bearcat*. We went through ... the same kinds of things, learning to fly on instruments and learning to do advanced navigation, over-water navigation.

AMBROSE: Navigation by the stars or navigation by radio or navigation by compass or what?

ARMSTRONG: We had learned in the earlier part, ... the ground school part, how to navigate and use celestial navigation. ... Celestial navigation was used by multi-engine pilots predominantly, while

single-engine fighters and attack aircraft required the full attention of the sole occupant on the flying, and so he couldn't be taking sextant shots and things like that. So the navigation was somewhat more rudimentary, but it required dead reckoning and use of radio aids and whatever might be available at sea....

AMBROSE: How do you dead-reckon at sea?

ARMSTRONG: By computing your true speed over the ground, by using your air speed, altitude, and outside temperature, and noting the direction of the wind however you could by wave action or cloud shadow movements.

AMBROSE: Guessing, in other words.

ARMSTRONG: Guessing. At least you'd hopefully be in the right direction, probably weren't always. And then the pilots had to be able to return to their carrier, so there were certain kinds of electronic aids that were peculiar to a carrier you wouldn't find anywhere else, wouldn't find in land-based navigation. So it was a matter of learning those and, of course, learning to use the aircraft as a weapon defensively and offensively, and learn tactics, and then finally qualify again on a carrier in advanced aircraft.... Other students went into multi-engine flight in either patrol bombers or transports or some variety of other craft. Everyone went their separate ways.

AMBROSE: In the army air force in 1942, '43, '44, only the very best got to be fighter pilots. If you weren't quite up to that standard, then they put you in a two-engine or a four-engine. Was that also true in the navy?

ARMSTRONG: The fighter pilots always said that was true. [Laughter]

AMBROSE: I'm not asking you to brag on yourself.

ARMSTRONG: But I don't know what the naval officers, the commanding officer of the training command would say about that. I was not privy to what process they used in deciding. My own guess is that a large part of it had to do with what needs they had at the time you graduated, because in my particular class, most of my classmates happened to get what they asked for, while I can recall people from a different generation saying nobody got what they asked for. So I can't really know.

AMBROSE: I've read that you told your mother you didn't want to be responsible for others; that's why you wanted a single-engine fighter. Is that story accurate?

ARMSTRONG: I don't know that I ever told her that. You know, I might have said something like that, but I don't remember saying that.

AMBROSE: When did you get your wings and commission? What was the date?

ARMSTRONG: I got my wings in August of 1950, but that was about seventeen or eighteen months after I'd begun my active duty service, so I still had another six months to go. So I was one of those rare birds, a midshipman with wings. So I went to the fleet squadron, was in a standby unit for a while, then assigned to a jet fighter squadron, still was a midshipman making seventy-five bucks a month plus flight pay, 50 percent of seventy-five bucks.

BRINKLEY: Landing on carriers at night, that was extraordinarily difficult to learn. Was there one aspect of this period that was a hard thing for you to conquer something like that?

ARMSTRONG: I happened to be a day fighter pilot. We had night fighter pilots on the ship I was on, and I thought they were crazy. [Laughter]

BRINKLEY: Did you ever have to do a night landing?

ARMSTRONG: I did it only in practice. I never did it on a carrier. All my landings on a carrier were in day. I was always happy about that.

AMBROSE: So, August of '50, the Korean War is now a couple of months old.

ARMSTRONG: Yes, just started.

AMBROSE: And you're completing your basic. Did they send you right off?

ARMSTRONG: I asked for the Pacific Fleet and was given the Pacific Fleet. But as I say, I was first sent out to a squadron called FASRON, Fleet Air Service Squadron, which is a utility squadron, handled all kinds of miscellaneous jobs that needed to be done around a large naval air station. That sort of was a holding position. They would typically take new entrants that come to that base and stick them there for a time period until there was a squadron opening for assignment, so I was in that squadron for probably three or four months, until there was an opening for me in Fighter Squadron 51 [VF-51].

AMBROSE: That would have been at the end of 1950.

ARMSTRONG: That was the end of '50. November or December, as I remember.

AMBROSE: And then off to the fleet?

ARMSTRONG: Yes. We immediately prepared to be assigned to the Korean action, and so a matter of the squadron training everyone in an operational sense to do the job that they would be expected to do, so that period. Again, you sort of do the same sorts of things as you did in training. Now you're in a new aircraft, but you have a much more specific objective because you sort of know what kind of an environment you're going into.

We didn't know to what extent we would be offensive, in the sense that we would be dropping bombs or shooting guns, or to what extent we might be defending the fleet against Chinese or Russian incoming aircraft, to what extent it might be air-to-air or air-to-ground. So we had to prepare for sort of all of those, plus become carrier-qualified in jet aircraft and doing a lot of practice with weapons delivery, instrument flying, and so on, the things that we would be facing when we got in operation. I was very young, very green.

AMBROSE: You were very young. Which coast of Korea were you on when you flew your first mission?

ARMSTRONG: All the time we flew off the eastern coast of North Korea, off Wonsan Bay, about 100 miles out, something like that. Had two kinds of flights. One would be called combat air patrol, which was defense of the fleet, basically. And the other was predominantly interdiction flights, flying against bridges and railroads and trying to find an occasional tank—

AMBROSE: Bombs and bullets?

ARMSTRONG: Bombs, bullets, and rockets sometimes, depending on what target it was. We had a combination of two jet fighter squadrons, F4U *Corsair* squadron, of course, air squadron, and an AD [*Skyraider*] squadron. [They] could carry the 2,000-pounders and really do some damage.

BRINKLEY: Seven in a squadron?

ARMSTRONG: I can't speak specifically to the numbers in each squadron. In our squadron we had twenty-four pilots and sixteen aircraft.

AMBROSE: Sixteen. But only twenty-four pilots.

ARMSTRONG: Yes. Started with twenty-four.

AMBROSE: Started with, yeah. The army liked to have two pilots for every airplane.

Tell us about your first mission.

ARMSTRONG: I can't recall it.

AMBROSE: I know you did a lot of them. Did you ever, in flying combat air patrol, did they ever come in and try to attack the fleet at night?

ARMSTRONG: No, and I'm glad they didn't.

AMBROSE: By air?

ARMSTRONG: No. I would not have enjoyed trying to go—well, I probably would have enjoyed it, but I don't know that I would have won against a MiG in an old *Panther*. It was a pretty primitive airplane. Of course, the MiG was pretty primitive too, but had a little better performance.

BRINKLEY: How did the F9F *Panther* perform?

ARMSTRONG: It was a very solid airplane. We thought it was wonderful. In retrospect, it was an airplane of the time and it didn't fly [particularly] well.... But we didn't know that at the time....

BRINKLEY: What were the weak points?

ARMSTRONG: It didn't have particularly good handling qualities. Pretty good lateral directional controls, but very stiff in pitch. Its performance both in absolute altitude, max speed, and climb rate were inferior to the MiG by substantial amount.

BRINKLEY: There's a story about September 3rd, 1951, when you had to eject yourself from a *Panther* after receiving antiaircraft fire. Was that one of the moments of the Korean War where you really feel your life is being put on the line?

ARMSTRONG: I do remember that one. It wasn't antiaircraft fire, although antiaircraft fire was ubiquitous at the time. I don't know to what extent that antiaircraft fire played a part in it, but I actually ran through a cable, an antiaircraft cable, and knocked off about six or eight feet of my right wing. If you're going fast, a cable will make a very good knife.

BRINKLEY: And what happened at that point?

ARMSTRONG: I didn't think that I could risk slowing the airplane down to landing speed, because once—

AMBROSE: You must have been almost right on the deck.

ARMSTRONG: Well, these are strung between mountains, so I was up maybe 500 feet or something, not an unusual altitude for the kind of things we were doing. I don't remember exactly what the altitude was, but they didn't put those big balls on the cables so that you could see they were there in those days.

BRINKLEY: What happened after that moment?

ARMSTRONG: I was flying on the wing of John Carpenter. He was an air force major, on an exchange program with us. We talked it over and decided not to try to land it, because if I got a little bit too slow and started to snap, I would have no [ability] to control it after that, so consequently decided it would be better to jump out. So, took it down south into friendly territory and jumped out in the vicinity of Pohang Airport, K-3, which was operated by U.S. marines.

AMBROSE: Could you eject or did you jump?

ARMSTRONG: I ejected. The old-style shotgun-shell-powered ejection seat, 22 G seat.

AMBROSE: Were you always wearing the parachute or did you have to put it on?

ARMSTRONG: We always had it on.

AMBROSE: Strapped into the small of your back?

ARMSTRONG: Exactly.

AMBROSE: Had you had any parachute training?

ARMSTRONG: No, we had not, but one of the gentlemen in the squadron, one of my classmates, actually, was assigned a collateral duty of being the equipment and escape officer, so he went over to parachute school, as I remember, in El Centro, California, and came back and told us how to do it, if the need ever arose.

BRINKLEY: Did you get rescued quickly once you landed, with no problem?

ARMSTRONG: Yes. A jeep drove up just as I was landing, from K-3. The driver was a roommate of mine in flight school.

BRINKLEY: A roommate from where?

ARMSTRONG: In flight school. He was now a marine lieutenant operating out of that field.

BRINKLEY: What was his name?

ARMSTRONG: His name was Goodell Warren.

BRINKLEY: Did you ever during the war receive other heavy damage flying, from ground fire?

ARMSTRONG: Yes, we had a lot of bullet holes in our airplanes when we brought them back. We'd patch them up.

AMBROSE: Put a little duct tape over that hole.

ARMSTRONG: Yes. Made them look pretty good, painted it over.

BRINKLEY: After your first month on the [USS] *Essex* [CV-9], then you had liberty in Japan when you'd get to spend time there?

ARMSTRONG: Usually we'd spend four or five weeks at sea and then they would take the entire ship back to Yokosuka for a week of refurbishing and reprovisioning and things like that. About one day a week we did some reprovisioning at sea (fuel) ..., but on a monthly basis, five weeks or something like that, we'd go back in for five days or six days, something like that.

AMBROSE: You could get aviation gasoline [av gas] while you were at sea? Or when you say fuel, you mean fuel for the carrier?

ARMSTRONG: You know, I don't really know what all kinds of fuel, but they had a pipe, a hose that they could put over from the provisioning ship to the carrier. I assume they had both diesel and jet fuel, and maybe av gas, too.

AMBROSE: Tell me about weather. North Korea, the whole of Korea is notorious for bad weather, and you're doing interdiction runs, so the weather is critical. Did you ever go off on a mission and you just couldn't find the target? Could you land carrying bombs?

ARMSTRONG: No, we'd—

AMBROSE: Or you'd jettison them in the sea?

ARMSTRONG: We would usually jettison armaments prior to returning, and we tried to jettison on targets of opportunity at the end of the flight when we had either found or not found our primary target, due to, in some cases, weather. Normally we'd have alternates, so if there was weather, we would divert to another target. We had some weather information, because we had Allied forces in the south of Korea and we had other sources of information, so they were able to give us not a bad weather briefing of what we could expect in the target area. It wasn't always right, just like it isn't always right here.

BRINKLEY: The teamwork and camaraderie experience on the *Essex*, is there any way to compare that at all to being in the astronaut corps or with engineers and contractors in the space program? The concept of teamwork now, this something that became a big part of your life from this point on. What was the teamwork aboard the *Essex*?

ARMSTRONG: Yes, it was [a] teamwork operation, certainly. We had very few occasions when we would do anything on a solo basis. Almost everything we did as teams, and in our case we usually liked flights of four at least, to help each other out. Eight eyes are better than two in looking for trouble and looking for targets.

AMBROSE: A diamond formation with the four?

ARMSTRONG: We used a formation, usually an echelon two airplanes each, separated by probably a quarter to a half mile. That would allow us to see a broad panorama both to the rear of the other—

we would be looking after their tail and they would be looking after ours. That was a different approach than had been earlier introduced, or at least attributed to [Commander] Jimmy Thatch, the so-called Thatch Weave.... We did not use that technique.

BRINKLEY: Can you characterize your air group commander, Marsh Beebe and your squadron leader, E. M. Beauchamp? Did they have a big impact on you, teaching you, or did you get to learn from them new ways of flight that you hadn't previously on your on-the-job training on the *Essex*?

ARMSTRONG: I flew with Commander Beebe some, and thought he was quite a good air group commander, the first I'd known and certainly the first in any operational circumstances or any combat circumstances. So I wasn't in a position to be critical anyway. I was, one, inexperienced; two, a junior officer. I was delighted when I had the chance to fly with him.

Ernie Beauchamp, a wonderful skipper, [I] had enormous respect for him. I thought he was—and is; he is alive today—a superior leader. I think if there was anything I learned from our skipper was that it's not how you look; it's how you perform.

BRINKLEY: Do you stay in touch with any of the men from your unit, or do they stay in touch with you?

ARMSTRONG: We have periodic reunions, yes.

BRINKLEY: Do you ever attend any of those?

ARMSTRONG: I was at one two months ago.

BRINKLEY: Were you really. They must be very proud, following your work with Apollo. But I guess to them you're just another one of the group.

ARMSTRONG: They've forgiven me for my errors. [Laughter]

AMBROSE: So, you came home from Korea and you'd completed your obligatory time in the navy, and you went right back to Purdue to finish school. Is that right?

ARMSTRONG: Actually, my time expired when I was flying off the *Essex*, and so my options were to either extend or swim home. [Laughter] So I extended.

BRINKLEY: This is a question that I sense you may not like, but the Air Group 5's operation became the basis for that [James S.] Michener's book, *The Bridges at Toko-Ri*. Have you read the book?

ARMSTRONG: Oh yes.

BRINKLEY: Did you like it?

ARMSTRONG: I thought it was an excellent representation of the kinds of flying that we were doing there. It was identical, same kind of aircraft and the same class carrier. They put girls in the movie, which I didn't remember from my experience. [Laughter] Actually, Michener was on our ship. I think he went on three tours, two or three tours, you know, at four or five weeks at a crack, and would just sit around the wardroom in the evening or in the ready room in the daytime and listen to guys tell the actual stories. He didn't ask questions much or anything; he just kind of absorbed it all. So most of the things that happened in the book, which was quite a different book from any other book he's written in many ways, were actual events. Maybe he strung them together with different

characters so they didn't happen precisely the way it would have been described in his novel, but, nevertheless, they were basically all adaptations of true stories that he used.

BRINKLEY: Can you recognize yourself in any of those?

ARMSTRONG: No, but one of my colleagues, named Leonard Cheshire, "Chet," we called him, he didn't return. But I believe there [were] a lot of Chet Cheshire's stories in *Bridges at Toko-Ri*.

BRINKLEY: In the time you did spend in Japan, do you have any memories of your time in Japan? Here's the boy from Ohio going to a foreign country and experiencing Japanese life.

ARMSTRONG: We usually went to these R&R [rest and recreation] facilities that the navy had organized and set up for our use, going to the Fujiya Hotel a number of times in the shadow of Mount Fuji.

BRINKLEY: Did you feel your time in the Korean War, which it's talked about as the forgotten war? You weren't questioning the politics involved in any way, with the cold war on?

ARMSTRONG: The naval aviators that I knew, first: were determined to do a first-class job. Second, most of them really enjoyed the combat experience in many ways. They'd rather be flying than not be flying. Lastly, they questioned everything. They'd talk about the Korean action and the reason for things and why certain targets might be available and others not be available, the same things that I suppose military people, it's the kind of questions they've asked themselves and talked among themselves throughout history. You're very much involved in the experience and questioning it is part of the natural things to do.

BRINKLEY: Were you excited to return to civilian life after the war and get on with getting back to going to Purdue and back to finishing your college degree? You must have been older now, right, going back to college. You were one of the youngest pilots.

ARMSTRONG: I was twenty-two. I was really getting old. [Laughter] When I went back to university, kids looked so young. [Laughter]

AMBROSE: Did you have a decision to make or did you always say, "I'm going back to Purdue and I'm going to finish this degree"?

ARMSTRONG: Well, there were tempting options, but I decided—

AMBROSE: To stay in the navy, for one.

ARMSTRONG: To stay in the navy or otherwise use the skills that the navy had taught me. Those opportunities showed up periodically, but I thought it was important to go back and finish my education, so I put that in first position.

BRINKLEY: Then you joined the National Advisory Committee for Aeronautics [NACA] at that point. Did you then move to Cleveland [Ohio]?

ARMSTRONG: I did. That was my first job out of college.

BRINKLEY: And that was at the Lewis Flight Propulsion Laboratory.

ARMSTRONG: Right.

BRINKLEY: You just rented an apartment on your own or how did you—

ARMSTRONG: I rented a room at first, in a private home, and later met one of the other young bachelor engineers there, and then we rented a small place for the two of us.

BRINKLEY: Was this close to the laboratory or in downtown Cleveland?

ARMSTRONG: Well, it was not far from the—I don't think we were more than ten minutes from work.

BRINKLEY: Did you acquire an automobile?

ARMSTRONG: Yes.

BRINKLEY: So you could go back home, too, to Cleveland or to Wapakoneta, to visit family.

ARMSTRONG: I could, yes.

BRINKLEY: And return back. What were your general duties and responsibilities there at the laboratory in Cleveland?

ARMSTRONG: A dual job as a research pilot and a research engineer. Actually, I think at that point they called them research scientists. The flying involved doing work with new anti-icing systems for aircraft, which we had a C-47 (or R-4D or DC-3) with various kinds of anti-icing equipment that

we would fly out in the worst weather we could find out [over] Lake Erie and try to pick up a lot of ice and find out which were the most efficient ways of shedding it.

We also did some work in high Reynolds number, high Mach number heat transfer, and this project involved flying an F-82, which was a *Twin Mustang*, and flying out to the Atlantic Ocean and going to high altitude and launching a multi-stage rocket downward into the atmosphere to get very high mach numbers at very low altitudes, and therefore very high heat transfer rates. The nose cone was instrumented to measure those kinds of things.

I did a lot of work in that area, also on my scientist or engineer job, in analyzing that data and also designing components for advanced versions of the rockets that we were using to fire in those days. But I wasn't there long, and I'd originally applied to Edwards [Air Force Base, California] for my first job. They didn't have a spot.

Unbeknownst to me, they had transferred my application to the other NACA laboratories, and it was as a result of that, that the Lewis Laboratory talked to me about coming up there and filling an opening that they had. It was the lowest-paying job that I was offered coming out of college, but I think, in retrospect, it was the right one.

BRINKLEY: Were there any memorable incidents or things that occurred in your time in Cleveland in flying? Were there any things in your mind where you said, "I want an opportunity to test this?" Were you anxious, with all the technology changes in aviation, were you wanting always to be headed for the newest research that was being done?

ARMSTRONG: The only product of the NACA was research reports and papers. So when you prepared something for publication, either as a principal or associate author of some sort, you had to face the "Inquisition," which was the review of said paper by experts who were predominantly lady English teachers or librarians who were absolutely unbearably critical of the tiniest punctuation or grammatical error, and that is what NASA needs today. [Laughter] Because it really made a good

product. The rigor of the language, which I never mastered, but I appreciated after being exposed to those charming ladies who were so tough.

AMBROSE: I know exactly what you mean. That's my wife that you're talking about. [Armstrong laughs.] And I get asked, "What's the secret to being a successful writer?" I say, "Marry an English major."

BRINKLEY: When you left Cleveland, did you drive from Cleveland to California with your car?

ARMSTRONG: I did.

BRINKLEY: And you're married at this time, so you're driving together?

ARMSTRONG: I was not married, no.

BRINKLEY: Was this your first cross-country trek, seeing the Rockies?

ARMSTRONG: No, no, because I'd driven—I first got my car when I was in the navy, so I had driven from the West Coast across the country before, to and from.

BRINKLEY: Where did you go immediately when you went to California? What was your destination city? You were going to Edwards?

ARMSTRONG: Edwards, yes.

BRINKLEY: But you're also eventually going to the University of Southern California [Los Angeles, California]?

ARMSTRONG: That was later. That was later. I went directly to my job at Edwards.

AMBROSE: So you started flying X-15s when you got there?

ARMSTRONG: Well, at the time, I went there in '55, summer of '55, and the X-15 was just put under contract in November of '55. It wouldn't be completed [till] four years later.

BRINKLEY: What were your first projects there when you got to Edwards?

ARMSTRONG: I'd have to look in my log to be sure. First they wanted me to learn a little bit of the NACA techniques for data collection and so on, and they had a P-51 [*Mustang*] that they had very rudimentary instruments and data-collection techniques for. They made me go out there and do a lot of flights and practice a lot of maneuvers for test purposes, and turn in the results so they could see whether I was starting to get the hang of it. Took me a while, but it was a good experience—

AMBROSE: Did I hear you say P-51?

ARMSTRONG: Yes, yes.

AMBROSE: Tell me about that plane.

ARMSTRONG: It's no F8F, but it's not a bad airplane.

AMBROSE: I was interviewing one of the Tuskegee Airmen who flew P-51s in Italy, and he said, "That was such a honey of an airplane, if it had been a girl, I'd have married it."

ARMSTRONG: [Laughter] It is a nice airplane, and wonderful sound, particularly when you retarded the throttle and you got those stacks putt-putt-putting. It was quite elegant. I enjoyed flying the airplane. Just didn't have the performance of an F8F, but it was built [to fly at] high altitude. Well, it first was built to be an attack airplane, not a fighter, but a fighter version of it became predominantly a high-altitude escort long-range aircraft.

AMBROSE: So, continue with—

ARMSTRONG: Other airplanes? They flew some other jets. They had a YRF-84F [*Thunderflash*]. When I got there, I was the fifth pilot. One was going to leave. [A.] Scott Crossfield had announced that he was going to go be the pilot on the X-15 program, whoever won it. He was going to go there and had agreements with all the different bidders, that if they won the contract, he would get the job. So told them he was going to leave, and that's what gave me the opportunity to transfer there.

They had five pilots, and, if memory serves, seventeen aircraft, pretty much all different. A lot of X-airplanes [experimental] and fighters, the B-47 [*Stratojet*] and R4D and a couple of B-29s [*Superfortress*], all kinds of exotic aircraft. So they let me fly a few of these at first, and as they became more confident in my abilities and as I became more experienced, why, they gave me more and more jobs.

I did a lot of different test programs in those days. That was the first time I ever flew supersonically, when I got an F-100 [*Super Sabre*], and I flew that aircraft a lot, a very nice early F-100.

AMBROSE: And you flew a B-29?

ARMSTRONG: Yes.

AMBROSE: That's a big plane.

ARMSTRONG: We had two that we used for dropping rocket aircraft, the X-1s and the [Douglas D-558-2] *Skyrockets*. So I, either as the right-seat or the left-seat guy in the B-29, launched over 100 rocket airplanes in the fifties.

BRINKLEY: A couple of your X-15 flights became pretty well known, one in which you lost your stability and had to recover, and then there's also the mission which you ended with the longest X-15 flight on record, when you had to fly back to Edwards from the south. Do you mind just commenting on particularly those two flights?

ARMSTRONG: I can remember several different system problems in the flights. You almost always had something. I can't recall the details of the SAS [Stability Augmentation System]—OUT problems. I would have it in my notes someplace, but I don't have it in memory.

The [other] flight was an altitude flight. I had done a lot of the development work on a new type of flight control system that was installed in the number three aircraft and different from the ones they numbered number one and number two. That system was developed by Minneapolis Honeywell in Minneapolis [Minnesota], and I would go up there and fly an F-101 [*Voodoo*] they had outfitted with a prototype version of this system.

Because the X-15 covered such a wide speed range and altitude range, it was impossible to set the gains in the flight control system to a single value that was optimum for all flight conditions. The one and two airplanes you had to continually be changing the gains because at one minute

you're at Mach 1, the next minute you're at Mach 5, and the airplane responds quite differently under those two conditions. So you were continually having to do this. So we were [trying] to ... develop a system that would avoid that requirement of continually changing gain. So Minneapolis Honeywell system was designed and built for the number three X-15.

In addition to automatically changing the gains by very unique and complex, even surprising method, which I won't burden you with, in addition to that, it would blend the aerodynamic and the reaction controls when you're outside the atmosphere. So in [number] one and two airplanes, when you're in the atmosphere you flew with the regular center stick, and when you're outside the atmosphere you flew with the reaction controls with a separate stick on the left side. With this system we hoped to be able to fly the same way all the time, with one stick.

This particular flight you mentioned, we went to somewhat above 200,000 feet, well outside the atmosphere, so that we were completely flying on reaction controls up there aerodynamic controls were completely ineffective, like flying in a vacuum.

Then we had a system limit built into the flight control system that would automatically prevent you from exceeding 5Gs. If you hit 5Gs, it would automatically put controls in to hold it below 5Gs, and one of the things I wanted to do was demonstrate that that part of the system worked. It had never been yet demonstrated in flight. That was my responsibility to do that. We tried this many times in the simulator without any difficulty, but when we really did it in flight, I couldn't [quite achieve 5 g's], so I [kept] pulling to try to get the G limiter to work.

In the process, I got the nose up above the horizon. We'd done this in the simulator, never had any problem with it. But I found when I did it in real flight, I was actually skipping outside the atmosphere again. I had no aerodynamic controls. That was not a particular problem, because I still have reaction controls to use, but what I couldn't do is get back down in the atmosphere. ... I [rolled] over ... and tried to [drop back into] the atmosphere, but [the aircraft] wasn't going down because there was no air to bite into. So I just had to wait until I [fell low enough] to have

aerodynamic control and some lift on the wings, [then] immediately started making a turn back. But by that time I'd gone well south of Edwards.

It wasn't clear at the time I made the turn whether I would be able to get back to Edwards. That wasn't a great concern to me because there were other dry lakes available there. I wouldn't want to go into another one, but I certainly would if I needed to. [Eventually], I could see that we were going to make it back to Edwards, so I landed without incident on the south part of the lake.

BRINKLEY: Did you have to glide in at that point?

ARMSTRONG: You always do. There's no power on the aircraft, so you're always a glider after the rocket burns out. The rocket only [burned for] a minute and a half.

BRINKLEY: Did any of these difficulties you had at Edwards, later with Dave [David R.] Scott and Gemini [VIII], did any of these experiences teach you kind of grace under pressure? When you had later problems with Mr. Scott and Gemini, how did these things—

ARMSTRONG: Well, I always felt that the risks that we had in the space side of the program were probably less than we [had] back in flying at Edwards or the general flight-test community. The reason is that when we were out exploring the frontiers, we were out at the edges of the flight envelope all the time, testing limits. Our knowledge base was probably not as good as it was in the space program. We had less technical insurance, less minds looking, less backup programs, less other analysis going on. That isn't to say that we didn't expect risks in the space program; we certainly expected they would be there, were guaranteed that they would be there. But we felt pretty comfortable because we had so much technical backup and we didn't go nearly close to the limits as much as we did back in the old flight-test days.

BRINKLEY: Have you ever read, would you like commenting on Tom Wolfe's *The Right Stuff*? Do you feel it captured the climate around Edwards in any way, shape, or form, or is it exaggerated?

ARMSTRONG: I haven't read the book critically. I'm not sure I've read it all. I've read a bit. I did see the movie. I thought it was very good filmmaking, but terrible history; the wrong people working on the wrong projects at the wrong times. It bears no resemblance whatever to what was actually going on.

BRINKLEY: And to live out around Edwards at that time, you were right near the base?

ARMSTRONG: I lived about an hour drive away, south. Nobody lived close. A half hour is about as close as you could live. Big base.

BRINKLEY: At this point in your life when you're telling all these stories to us, do you miss the opportunity of flying in that kind of way, on a regular basis, like you were doing back then? Sometimes you almost get nostalgic for those days at all?

ARMSTRONG: That was a very exciting job and very excellent flying, very challenging goals. I think it was certainly one of the memorable parts of my life.

BRINKLEY: When you flew in today, do you ever sit on the airplane and think, "God, I wish I could pilot this. I've got the itch. I wish I could just sit in the—"?

ARMSTRONG: I'm still a legal pilot and I still enjoy it as much as I always did...

BRINKLEY: We were out at Edwards. I was just wondering if you could comment on the air force's Dyna-Soar [Dynamic Soaring] program and how did you decide upon the Douglas F5D-1 *Skylancer* as the suitable demonstrator for parts of the Dyna-Soar flight profile. And did you develop any procedures based on flying this aircraft?

ARMSTRONG: Yes, I did. The Dyna-Soar program, of course, was first intended to be a high hypersonic but nonorbital vehicle, and predominantly a research vehicle. It was originally scheduled to be launched on the Titan I. It later became obvious the Titan II might be available and be a better choice, and that gave increased performance, but still not orbital.

Then when the Titan III was introduced, or looked like it was going to be introduced, with additional [solid] rocket engines strapped on the side of the liquid, ... why, it might be an orbital vehicle, and if it would be orbital, why, it could be an operational craft.

The air force savored the idea of having an operational spacecraft and having their own manned space program separate from NASA. So the project grew and grew. Eventually it was not continued; it was canceled perhaps because it grew too much.

The launch, unlike the Mercury and Gemini and so on, was a winged vehicle on top, and there was a question what kind of abort technique would be practical to try to use in case there was a problem with the launch vehicle, fire, say, in the launch vehicle, in the Titan. It was determined rather than a puller rocket, [a] pusher rocket, to push the spacecraft up to flying speed from which it could make a landing, but it wasn't known at that time what might be practical and how much thrust would be needed and how much performance would be needed.

We had the F5D aircraft, which I determined could be configured to have a similar glide angle or lift/drag ratio to the Dyna-Soar for similar flight conditions, and devise a way of flying the aircraft to the point at which the pusher escape rocket would burn out, so you would start with the identical flight conditions that the Dyna-Soar would find itself [with] after a rocket abort from the

launch pad. So then establishing that initial condition, you only had to work out a way to find your way to the runway and make a successful landing.

I worked on that project for a time and found a technique that would allow us to launch from the pad at Cape Canaveral [Florida] and make a landing on the skid strip, not the Shuttle landing strip, but the old skid strip. We practiced that, and I believe that Bill [William H.] Dana and Milt [Milton O.] Thompson both continued [that program] after I transferred from Edwards to Houston There was a NASA report written about the technique. It was a practical method. I wouldn't like to have to really do it in a real Dyna-Soar.

BRINKLEY: What other responsibilities did you have at the High Speed Flight Center other than being a test pilot?

ARMSTRONG: Our principal responsibility was engineering work. We did not do a lot of flying. It was program development, devising simulations, looking at the problems of flight, and trying to figure out ways we could test those things and devise solutions to those problems. It was a wonderful time period and it was very satisfying work, particularly when you found a solution that would work.

BRINKLEY: Did you know about the first call for astronauts that went out to military test pilots? I was wondering what your thoughts may have been when you learned about the astronaut program, when you first started realizing it.

ARMSTRONG: We were certainly aware of it, both through NASA, because NACA had become NASA by this time, and also from our colleagues in the military, good friends and people we flew with daily, some of whom had been invited to consider applying for that.

BRINKLEY: When you were at Edwards, did you develop a close friendship with other astronauts with people that later, or did you stay more to yourself and your own life, or do you guys all socialize?

ARMSTRONG: I knew a number of the air force people at Edwards who later transferred to Houston like I did. But I wouldn't say that I knew them very well, not nearly as well as I knew the other NASA pilots and NASA engineers, for that matter. They were on a different part of the base. We occasionally had meetings where we would be discussing the same subjects and we would see them probably more frequently in the air when they were out on our wing tip with an F-104 [*Starfighter*] or something.

BRINKLEY: In this period, the notion of space in the '50s is starting to be talked about. NASA is officially now NASA. [President Dwight D.] Eisenhower administration. Do you have any thoughts on some of the early events of the space race, such as the launch of Sputnik? Do you remember your feeling, on hearing about Sputnik and Explorer 1? Were you conscious of the politics of the cold war going on with the race into space at that time when you were at Edwards?

ARMSTRONG: Well, before it was Dryden, before it was Flight Research Center, it was called NACA High Speed Flight Station, and they were working on the problems of high-speed, high-altitude flight. They were looking ahead to days when we would fly hypersonically and high hypersonically and eventually even further, [hoping] to solve ... the problems along the way that would allow that to happen. It wasn't something we talked a lot about, because in those days space flight was not generally regarded as a realistic objective, and it was a bit pie in the sky. So although we were working toward that end, it was not something we acknowledged much publicly. Not necessarily for fear of ridicule, but probably somewhat.

BRINKLEY: With Sputnik, do you recall where you were when you heard about that?

ARMSTRONG: Yes. The Society of Experimental Test Pilots was holding a symposium in the Beverly Hilton Hotel [California] in October of '57, and I was working on—I think I may have been program chairman—I'm not sure about that now—for the symposium. But in any case, I was very much involved in the symposium, and we were trying to find ways to get the Los Angeles press interested in the kinds of technical presentations that were being produced there, and get a little coverage of what our industry was doing and what was happening in the test-flight world. But it was a very hard sell, and it became completely impossible once Sputnik came across the sky, and all of a sudden we couldn't get any people to come listen to problems about airplanes flying.

AMBROSE: And your own reaction to Sputnik? Curiosity or more than that? Or "God almighty" or what?

ARMSTRONG: I don't remember exactly what my reactions were at the time, too much colored by intervening events. But I guess it was disappointing that a country who was the "evil empire" in our minds at that time would be beating us in technology, where we thought we were preeminent. At the same time, it was encouraging, because it demonstrated the kinds of things that we were interested in really might be achievable and perhaps it would encourage people to look at our world with somewhat more curiosity and perhaps approval than they had before.

It did change our world. It absolutely changed our country's view of what was happening, the potential of space. I'm not sure how many people realized at that point just where this would lead. President Eisenhower, I think, was saying something like, "What's the worry? It's just one small ball." But I'm sure that was a facade behind which he had substantial concerns, because if they could put something into orbit, they could put a nuclear weapon on a target in the United States, because the navigation requirements were quite similar.

AMBROSE: Something you said a minute or two ago reminded me of all of the—how did the Russians get the bomb? They must have stolen our secrets. They couldn't possibly have done this on their own, and they must have stolen our secrets. And they did in some part. But the real secret of the atomic bomb was revealed in August 1945. That is, it works. It seems to me that's almost what you're saying about Sputnik. It can be done.

ARMSTRONG: It can be done. That was an eye-opener, I think, to a lot of people [and to Killian]. Maybe there was substantial interest in, "Well, maybe we can get people up into space." That was instantaneous, that possibility.

BRINKLEY: Here you are a test pilot and you're flying the most advanced aircraft in the world. What makes you at that point in time want to join the astronaut corps? What is it that made you decide, "This is what I want to do"?

ARMSTRONG: It wasn't an easy decision. I was flying the X-15 and I had the understanding or belief that if I continued, I would be the chief pilot of that project. I was also working on the Dyna-Soar, and that was still a paper airplane, but was a possibility. Then there was this other project down at Houston, [the] Apollo program. Gemini hadn't been really much identified yet at that point. It wasn't clear to me which of those paths [would be best]. Recognize that people who are in this world see projects come and go. A project's established, begun, it may run for several years, finally get canceled, and I had been assigned to aircraft test projects and never, never flew the airplane, because the need changed or something else became more important. I never got to that goal.

We sort of saw every project of this type as something that, it may go or it may not. Although you learn a lot when you're on a program that eventually gets canceled, there's a lot more

satisfaction in being in a program that really reaches its fruition. I can't tell you now just why in the end I made the decision I did, but I consider it as fortuitous that I happened to pick one that was a winning horse. But there would be no way to predict that at the time when it got to that fork in the road. In my case, a three-way fork.

BRINKLEY: Some of the other test pilots that didn't go into the Apollo program, that stayed at Edwards, that believed, "We're flying our own planes," and had that attitude, did you ever catch like "Space, that's for like the dog that went up or the monkeys."

ARMSTRONG: Monkeys.

BRINKLEY: Is that kind of an attitude that prevailed?

ARMSTRONG: On the part of some, yes. At the time the Mercury program was started, it might well have gone that way. In a sense it did, in that they had a lot of monkey flights and so on, chimp flights. But I believe that the reason it did not keep that characterization was that the Mercury crewmen insisted on making it an airplane-like device, have the same conventions as normal airplanes, so that your natural instincts were proper, and insist that the crewmen be able to perceive enough and see enough and have sufficient information available, ... that he could make reasonable choices about proper alternatives in how to control the craft in a manner that would maximize the ability to get toward the objective.

So I think that was a great contribution on the part of the Mercury guys, who were probably abrasive to some of the engineering managers in that time in their demands that the craft be built in this way. So that certainly was important.

BRINKLEY: Did you have any encounters with Chuck [Charles E.] Yeager during this period at all?

ARMSTRONG: Oh, I've known Chuck for, you know, forty-something years.

BRINKLEY: I'm just curious, is he somebody that other pilots look up to as this extraordinary pilot, or is he just another one of the guys?

ARMSTRONG: I think people recognize that he was a good pilot, a stick and rudder man.

BRINKLEY: He's become almost a mythological pilot. The legend of Chuck Yeager has become—do you think that's just through books and media, things like that?

ARMSTRONG: I'll pass.

BRINKLEY: What was the astronaut selection process like, and what kinds of physical and psychological tests were you subjected to once you made that decision on your part?

ARMSTRONG: Well, I don't think the community of flight medicine and flight physiology knew very much what they needed to do at that point. There were widespread predictions that humans could not survive in space, for a variety of reasons, both physical, physiological and mental and psychological, all kinds of reasons. So they didn't really know exactly what to test for, I think, so they did everything. They didn't miss anything, as far as I know. They did every test known to man. [Laughter] Not necessarily fun. Survivable.

BRINKLEY: You obviously passed all those with flying colors.

ARMSTRONG: I don't know what the results were.

BRINKLEY: What was your first experience? Suddenly you're now in the astronaut ranks. What became your impressions of the Space Task Group, and how did that differ from being out in California?

ARMSTRONG: Well, a lot of the people in Space Task Group I'd known for some years. They mostly came from Langley [Research Center, Hampton, Virginia], although some actually came from Edwards. Some came from Ames [Research Center, Mountain View, California], but predominantly Langley. I had known them in my work at Edwards, because they were very much involved in the analytical and the wind tunnel work that supported the kind of work that we were doing.

Bob [Robert R.] Gilruth was a wonderful man, who was a superb handling-qualities expert, [among] the best in the world. I knew Chris [Christopher C.] Kraft [Jr.] and Max [Maxime A.] Faget. I remember the discussions earlier that we'd had at conferences on these subjects of blunt shapes and flying bodies and winged vehicles and so on, which were the best configurations and what were the pluses and minuses of different routes to go into space. So I came in with a high confidence level that these were people who I could respect, and knew had the background and the inclination and the determination to do what would lie ahead.

BRINKLEY: How did your job now as an astronaut differ from being a test pilot what were the first things that you realized were going to be different for you?

ARMSTRONG: Well, it was very different. There were some similarities in the sense that we were planning and we were trying to solve problems and devise approaches, but since we were trying to do an operational job, we were extremely focused. A research project tends to be more broad, generic, cover a range so that you have indications as to which might be the best path.

The Apollo and Gemini programs—Mercury I really wasn't involved in the early parts of that, but in the germination of Gemini and Apollo, we were looking for not a range of stuff, but the best method that we could find that would give us ability to go at the earliest possible time, maximum speed, and with the highest level of confidence. Quite a different responsibility, yet the skills, the engineering approaches and the equipment available to us was really quite similar.

BRINKLEY: I'm trying to picture training and simulation, which are all part of getting ready for a successful space flight. How did you help determine what should be simulated and how? In retrospect, how realistic were these training sessions and simulations from what you ended up encountering?

ARMSTRONG: I think training was about one-third of our time and effort. A third had to do with planning, figuring out techniques and methods that would allow us to achieve the trajectories and the sequence of events and the ways of picking from the available strategies the one that might work the best. The last part was testing, and that's probably equal to thousands of hours in the labs and in the spacecraft and running systems tests, all kinds of stuff, seeing whether it would work and getting to know the systems very well.

So the one-third that was training is training in a different sense than most people think of training, because, after all, there wasn't anybody that had done this and could tell us how to do it, because nobody had the experience. But they could tell us what they did know, and some became systems experts and would know the details of how the inertial guidance system or the computer or certain kind of engine valves and so on would operate and how we might handle malfunctions. So we spent enormous amounts of time gleaning everything we could from the people who were experts in these particular smaller components of the spacecraft or the launch vehicle.

We also spent a lot of time in simulations. Simulators have gotten better over the years at a prodigious rate. In my days at Edwards, we did a lot of simulations of flight characteristics and

aircraft trajectories and things of that sort. We did them all with analog computers, because digital computers were just far too slow to use for simulations.

About the time of the early '60s, digital computers were getting faster and they were much more precise, slow but very precise. So then we started marrying analog and digital computers. We used the digital to do the precise calculations, and used the analog part to do the actual aircraft response things, which had to be a lot faster.

Then by the middle of the sixties, ... computers were getting to be fast enough that you could actually do simulations of aircraft flight motions with them. So because I worked a lot on the simulations as collateral duty while I was here at Houston, I spent a lot of time evaluating the authenticity and appropriateness of the simulation models that they were using. You'd usually find that the simulator didn't behave properly like it should in some regions of life, so it was incumbent on us to uncover the problems that simulation had and try to make it as accurate as we could.

There was some danger in that, because you might not be right about your conclusions about the appropriateness of the simulation, but it was an important part of our function, and certainly the astronauts' crews weren't the only people doing that. Test pilots at Grumman [Aircraft Engineering Corp.] and at North American [Aviation, Inc.] and McDonnell [Aircraft Corp.] also were doing similar kinds of things that contribute to that.

The result was that in the late '60s our computer simulations were really quite excellent. They were quite adequate to do most all the things that we were doing. There's an old perception that simulators are always more difficult to fly than the craft themselves. In general, that is true, and it's certainly turned out to be true in Apollo, particularly the lunar module [LM], which was to our benefit that it was easier to fly than the simulator, because we were expecting something that was somewhat more cantankerous and contrary than it actually turned out to be.

BRINKLEY: Did you stay in involved with operations and training even after you became a backup commander on Gemini V?

ARMSTRONG: To a lesser extent, because once you get on a flight crew, a very large percentage of your time is committed. So at that point in time, and before we had many new guys come in, we had a bit of a gap, in my perspective. Too many people were—they were gladly assigned to flight crews, but it left some openings behind us and some things weren't covered to the degree we would have liked them to have been.

BRINKLEY: How did you feel when President [John F.] Kennedy made his great challenge to put a man on the Moon in that speech, not just yourself, but the whole team you were with? Was that a moment where you really—can you recall Kennedy's speech and can you recall that kind of commitment that came out of President Kennedy?

ARMSTRONG: Well, yes, I certainly remember it, but it's a big hazy because I've heard recordings of it so many times since, that you're not certain whether you're remembering or you're remembering what you're remembering. So I'm not certain what it was. And, of course, it's been colored by the fact that I read so many stories of how that process actually occurred and what led to his conclusion to do that. I guess I've been persuaded by historians that it wouldn't have been his first choice, but he didn't find any other good options to go against the Soviets with. The world was caught up in what the Soviets were doing. And he'd campaigned against Lyndon [Baines Johnson] on the basis that we were behind in rocketry. And [Richard M.] Nixon.

AMBROSE: Against Nixon, too, of course. Against Eisenhower, really.

ARMSTRONG: Yes.

BRINKLEY: I guess I'm thinking of the youngness of all of you, and here's this young president saying that. Did you feel like he was part of the team, like he was a leader now? With President Kennedy we really had a leader that wanted to put the space program on the forefront of the American agenda?

ARMSTRONG: Our concern always was, "What will the Congress do?" Because the president can proclaim, but it's the Congress that makes things happen. So that's really where the question was. As it turned out, they were motivated to support the president in this area, which I'm not sure I necessarily would have guessed at that point, based on my recollection of priorities—

AMBROSE: Let me go back for a second to the event that got the president to say, "We're going to get to the Moon." You were a combat pilot in the Korean War. That was only a decade earlier. You were at the very cutting edge of test pilot and working on all the things that you were working on at the time of the Cuban Missile Crisis. Did you guys pay much attention to that? Was there a feeling of, "God almighty! We want to be in on this!"?

ARMSTRONG: Yes, there was, because (you remember at the time) it was a time of such incredibly high tension nationally and internationally, and I think everyone felt we were right on the brink of potential World War III. I don't think anybody, even the people in the back woods of Montana, were unaware of this tension, this heightened sense of tension. I was very aware of it. I thought that we could shove aside all the work we're doing in favor of other things that the country decided were more important from a strategic point of view.

AMBROSE: What about you and the people you were working with? Did you feel like, "What are we doing this for? Because we need to be a part—if there's going to be World War III, we want to

be a part of it, and what we're aiming at right now, what we're trying to do is like yesterday's newspaper."?

ARMSTRONG: Exactly. That was a concern, but at the time I think the reality was, you've got your job to do and you just go ahead and do it, and keep doing it and hope for the best.

AMBROSE: As in the events of last Tuesday [September 11, 2001].

ARMSTRONG: Yes. Just carry on.

BRINKLEY: Where were you when Alan [B.] Shepard [Jr.] made his famous flight?

ARMSTRONG: I was at Edwards at the time, but I can't remember where specifically I was.

BRINKLEY: The same question with John [H.] Glenn [Jr.]. Do you remember?

ARMSTRONG: Yes, I was at home at the time, I remember.

BRINKLEY: Watching it on the television news, reading about it?

ARMSTRONG: Right. It was very early in the morning. I was in California, as I remember. I think it was dark.

BRINKLEY: Do you recall when it was you were assigned to the Gemini V mission? And what were your thoughts at that time? How was training for that mission different than your general training? How did your life change when you suddenly were assigned to the mission?

ARMSTRONG: Well, I was really pleased to be assigned to a flight, and quite satisfied to be in that position of backing up [L.] Gordon Cooper. It was quite a change from the time before, when we were working lots of general projects and trying to build pieces here and there, to all of a sudden having a pretty much complete focus on achieving the objectives of that flight, which was originally intended to be a one-week-long flight, [the first] long-duration flight. There were a lot of other [parts] besides just long-duration, but that was the principal objective.

Elliot [M.] See was my associate on the backup crew. [Charles] Pete Conrad [Jr.] was flying the right seat in that flight. We were a very close team. We spent almost all our time together for months on end, getting ready for that flight, both going back and forth between Houston—spent a lot of time at the [McDonnell] plant in St. Louis [Missouri], working with the spacecraft as it was nearing completion, and participating in the testing of that spacecraft. So we all knew it very well by the time it was shipped to the Cape.

AMBROSE: When you say "spent almost all our time," your meals, too?

ARMSTRONG: Yes. We ate together. Not when we were in St. Louis. We certainly were at home. We'd get home sometimes. But the reality of the world in those days is that a lot of the testing took place at two o'clock in the morning or four-thirty in the morning, and we were spelling each other off. We would spend enormous amounts of time together, working out the details.

AMBROSE: And this was single-minded. You weren't bullshitting about the latest play that you saw or the latest novel you'd read.

ARMSTRONG: No, no. I would not say that we never cracked a joke or talked about something off the project, but we were 98 percent focused on the job we had to do. I was and my perception of my colleagues was the same.

AMBROSE: It is part of the popular perception, I guess, and it appears in some of the literature that the other astronauts have put out, that there was a lot of jockeying for position.

ARMSTRONG: Yes.

AMBROSE: And a lot of tension about who's going to get on this mission or that mission, who's going to be backup, etc. Your reputation is the exact opposite of that. I would like to hear you speak about that.

ARMSTRONG: Well, I was so pleased to be associated with the program, because it was going, it was happening, it was exciting. The goals, I thought, were important to not just the United States, but to society in general. I would have been happy doing anything they told me to do. It's probably true that I was less inclined to be concerned about just what job I had than some were. I think they're all different people, they all had different kinds of views on that subject.

It wasn't as obvious to me as some of the stories I've read have portrayed it. I looked forward to an actual flight assignment as much as anyone, as opposed to being in the backup role, but the backup role, I thought, was an important job, and just might turn out that we had to be ready, and we were going to be ready. As you know, in some flights it did turn out that the backup crews, or members of them, had to step in.

BRINKLEY: During the mission, how closely were you involved with evaluating various problems, like fuel cell problems or the thruster excess water production? What were your duties in assisting

evaluation for, say, fuel cell problems? Did you have a specialty that you really knew more than the others?

ARMSTRONG: I was not a fuel cell expert. We were at the Cape. Elliot See and [I] came back immediately after launch and actually talked to the spacecraft when it went overhead at the end of the first orbit, from our T-38, on VHF [very high frequency], and came back and landed immediately, went to mission control and made ourselves available to help with the flight. So we were both involved throughout that entire flight. Certainly all the various problems that they bumped into on that flight, we were very much involved, but I can't recall any specific aspects of it.

BRINKLEY: What were, then, the different requirements for the commander as opposed to a pilot on these missions? What made the commander—what different responsibilities did the commander have?

ARMSTRONG: Well, we tried to divide the responsibilities such that each crew person was about equally loaded. We tried for each person to be able to know how to do everything if they had to, but we divided the responsibilities such that each would go into their area in [substantially] more depth. That worked pretty well. I don't think it was practical or maybe even possible for both crew men to know everything in the same degree of depth on every subject. So it was a shared responsibility situation.

The commander, I guess, principally differs because he has the responsibility for the decisions, just as the commander of a ship or commander of an airliner or anything.

AMBROSE: If necessary, the commander can override.

ARMSTRONG: Yes. He's always responsible for his craft. There was probably more concern as to when there were differences of opinion, would be the differences of opinion between those in flight and those in mission control, but I think we worked that out pretty well. We had great respect [for] the guys down there, the guys and gals in mission control.

BRINKLEY: I was going to ask about the relations between mission controllers and the astronaut corps. You just characterized it during this period—I guess you did—as pretty good. You felt there was respect for each other's job. But did tensions flare? "Hey, you don't realize what we're dealing with, guys?"

ARMSTRONG: Sometimes it did. We were fortunate that on the flights I was involved in, I don't think we had any problems of any significant magnitude in that category. Generally the people in flight and the people in mission control were on the same frequency most of the time.

AMBROSE: There was not a "we" and "them"?

ARMSTRONG: No. It's "we" and "we."

BRINKLEY: Can you describe a little bit your training for the Gemini VIII mission? How was that different from your other training?

ARMSTRONG: Well, I'd already been through one cycle with Gemini V. I knew generally the content of the preparation. The differences were those things that would be different between the flights. We were going to have a rendezvous, which Gemini V did not have. We were going to have an extravehicular backpack in the back. We had experiments that were different than the

experiments on Gemini V. So we probably concentrated somewhat more on the things that were different.

We still did practice the rendezvous and practiced the launches and practiced the entry steering and all those kinds of thing. You had to sort of fill the squares and make sure you had done enough of those that you felt confident in your ability and people that were watching you on the ground, and...grading how you did. You also felt confident that you were in control of your destiny.

BRINKLEY: How well did you know Dave Scott at the time?

ARMSTRONG: I had not known Dave well at all at Edwards, so I only got to know him when he came to Houston, but I liked working with Dave. He was very good at what he did. He was diligent and he was hard working. I felt confident in his ability to handle his part of the responsibilities.

BRINKLEY: Then the backup crew, Conrad and [Richard F.] Gordon. I was just wondering how—I've never quite understood this. How did NASA decide who was going to be in which position and which mission? It wasn't for that particular mission they felt one of you had a better skill? It was just to rotate you all and give you equal experience?

ARMSTRONG: Well, Deke [Donald K.] Slayton was responsible for assigning the crews, and I don't know what technique he used to do that. He gave me the assignment of determining how many crews were needed throughout the entire Gemini program, how many people were needed, with assignments for primary and backup or alternate flight crews. Some people off, some people on vacations, some people sick. And so I built a schedule for him of my perspective on what was required. And it's my belief that he used that kind of a schematic to determine when additional

crews needed to be brought into the program and used that kind of thing . . . , in assigning individuals to crews, because you couldn't just take one person and decide where he's going to be without knowing what he would be doing next or before and how that interfered with or interconnected with other crew assignments. It was quite a complex job.

We actually had so few people, that almost everybody was assigned all the time. In that period I would come off one crew assignment, and within a few weeks I'd be assigned to something else, and that endured throughout the entire Gemini program.

BRINKLEY: With the Gemini VIII mission, how concerned were you with the success of the docking maneuvers, considering it this was really NASA's first attempt?

ARMSTRONG: We had a docking simulator which was quite, quite [realistic]. We felt it was a good representation of what we could expect, and indeed it turned out to be quite similar to what we encountered in flight.

I really believed that we wouldn't have any trouble with the docking, based on the simulations we did. Indeed, that turned out to be the truth.

BRINKLEY: What was going to your mind, however, when your [space]craft started to spin at that moment? You'd had a lot of close calls from Korea to Edwards. How do you maintain your cool under such harrowing conditions?

ARMSTRONG: We first suspected that the Agena was the culprit. We had shut our own control system off, and we were on the dark side of the Earth, so we really didn't have any outside reference, or very good reference. I didn't actually notice when it started to deviate from the planned attitude. Dave first noticed it.

Neither of us thought that Gemini might be the culprit, because you could easily hear the Gemini thrusters whenever they fired. They were out right in the nose, in the back. Every time one fired, it was just like a popgun, "crack, crack, crack, crack." And we weren't hearing anything, so we didn't think it was our spacecraft.

Dave ... had the control panel for the Agena. [Through the] docking adapter [was] an electrical connection ... that allowed Dave to send [signals] to the Agena control system. He was trying everything he knew, without success.

When the rates became quite violent, I concluded that we couldn't continue, that we had to [separate from the Agena]. I was afraid we might lose consciousness, because our spin rate had gotten pretty high, and I wanted to make sure that we got away before that happened. Of course, once we [separated] and found out we couldn't ... regain control in a normal manner, we recognized that it was a failure in our craft, not [in] the Agena. The reason we didn't hear it is, you only hear [the thruster] when it fires; you don't hear it when it's running steadily. I didn't ... know that at the time, but I figured it out.

BRINKLEY: So was there concern about colliding with the Agena?

ARMSTRONG: Sure we were, because we didn't know exactly what our relative trajectories would be, because at the time we disengaged, we weren't in steady flight. If you're in steady flight, you can disengage and ... predict what the relative paths will be, but when you're tumbling, [it's] not predictable, so it was a bit dicey. It was a great disappointment to us, to have to cut that flight short. We had so many things we wanted to do, and I know Dave wanted to do an EVA [extravehicular activity] and try out the backpack and do all that kind of stuff. It was very disappointing to have to call it quits and come home.

AMBROSE: But you made a decision and you got back to Earth. I spend a lot of my life talking to men who have made big decisions, and in this case your life and others' were at stake. Sometimes it could be a whole battalion and sometimes a squad or sometimes a crew of a ship or whatever. What I get more often than anything else is, "What were you thinking? How did you come to this conclusion?" Or, "God, that was really gutsy of you to have done that," or so on, I'll say. Almost always they'll say, "That's where the training comes in, and you just follow your training. And this situation demanded that I do that, and I had learned that in training, so I did it." Now, I'm not putting any words in your mouth and I'm not putting those into your mouth, but in your case, it's certainly something you thought about since. What do you attribute that decision and the action that you took to?

ARMSTRONG: Well, I can't make too much of it. I think generally you try to keep going as long as you safely can and try to save the flight, the objectives, and try to put everything back together. At some point you just have to make the decision that, "I can't take the risk of pursuing my goal further, because I have to go back to the foundation instincts", which is save your craft, save the folks, get back home, and be disappointed that you had to leave some of your goals behind.

BRINKLEY: What was the reaction in mission control when you reentered communications with them? Were they quickly able to adapt to the situation?

ARMSTRONG: Well, we didn't have much communication with mission control. You see, Murphy's Law says bad things always happen at worst possible times. In this case, we were in [orbits that] didn't go over any stations. We were sort of out of radio contact most of the time, and when we were [in contact], it was over the *Rose Knot Victor* or the *Coastal Sentry Quebec*, the ships that were at sea. They had limited ability to communicate back with mission control and transmit data to them. So our communication was just with the people on those ships, and they were trying as

best they could to be helpful and identify things, but it was a real challenge for them, because there wasn't much to be gained. They could see that we had a problem, but as far as deciphering that problem, I think they were, in general, as much mystified as we were.

BRINKLEY: When you started heading back towards Earth, did you start worrying about now you're going to have to land in some remote location, have to have a splashdown, or "Are we going to be found?" I would think I'd almost be more terrified with splashing down into the ocean and being unfound in a capsule there that might have a leak or something. Or you just keep trying to go over?

ARMSTRONG: Being an old navy guy, I much preferred coming down in the water to coming down in Red China at the time.

BRINKLEY: And they found you okay. Was there a lot of lag time between your rescue and pickup?

ARMSTRONG: We heard the sound of the propeller airplane—I think it was a C-54—as we were coming down in the chute. We assumed it was friendly.

BRINKLEY: I guess what I'm getting at is, I'm just trying to put in these moments, an X-15 when you're not sure you're going to be able to land. I guess the skills of astronauts is that ability to respond without panic in the most unbelievable situations imaginable, the thought that at any minute you might be unconscious in space. That's happening, and at the same time you're seeing the most spectacular scenery. I can't even imagine seeing Earth for the first time. It seems to—what a rush of adrenaline and emotion, and yet with all that happening, it seems the astronauts, by and large, kept things in check. Is that a testimony to the training or the intelligence of NASA to find the right men who had, to use the cliché, "the right stuff"?

ARMSTRONG: I think it predominantly is experience over training. Training certainly helps, but having been in flying machines for many years and faced a lot of difficulty, [pilots] become accustomed to being required to solve problems as they arise . . . , and particularly test pilots who get a higher percentage of things going wrong than normal pilots. And I'm not saying that we did it perfectly in every case; I'm sure we didn't. But the experience that we'd had in flying a variety of different kind of machines in difficult circumstances certainly enhances your ability to look at a situation, . . . analyze it and determine what your probable best course is and how much latitude you have to deviate from that best course. It's not an easy subject to describe adequately, but it seems to have worked.

AMBROSE: It's a quite wonderful answer, and it's got me to think, the men of World War II whom I've interviewed, almost none of them, not even the regular army officers, nobody had ever been in anything like World War II before it came about, and they had to rely on their training, but you had experience and you did as you just said. So if you're leading a squad forward into an attack on a terrain that is different from any other, there's no experience you can draw on, on that. It's got to be training. But in your case—that's just quite a wonderful answer.

And it also got me thinking of you're afraid you're going to pass out and you're reeling around in space and all the rest, made me think about that guy last Tuesday on that plane that crashed, that he sent down in Pennsylvania, and he just made this news, "Screw this. I'm going to die anyway."

ARMSTRONG: I think that's what happened.

AMBROSE: "I'm going to act on that basis."

ARMSTRONG: Yes. There are a lot of scenarios you can conjure about that, but one of them is right, because they did decide to try to regain control of the aircraft, and there was some kind of a battle between the people on board and it didn't end up the way they wanted. Could have ended up worse, too.

AMBROSE: Those are real heroes.

ARMSTRONG: Absolutely.

BRINKLEY: All this training, as exciting as it is to hear your career, there's a lot of sacrifice you're making constantly. You're living in far flung, in the desert, in California, in Houston as it's just starting to really grow, and difficulty—

AMBROSE: Some people would think it's a sacrifice to live in Houston.

BRINKLEY: And raising children, and different hours.

ARMSTRONG: Just in August, though.

BRINKLEY: Well, I would think anything's worth it just to see Earth, just to see Earth from that perspective for a pilot. That must have been something that's so awesome.

ARMSTRONG: You can see these pictures [points to book *The Infinite Journey: Eyewitness Accounts of NASA and the Age of Space* by William E. Burrows] and kind of get an idea, but you can take a picture of the Grand Canyon, too, and it's not the same as standing on the rim and looking down there. I think it's the same here. A picture does a great job, but it's not nearly like being there.

BRINKLEY: I can't imagine. [Laughter] At that moment, did a kind of calm come over you when you see Earth like that? Is it almost a religious experience?

ARMSTRONG: I don't know how to answer that. It probably affects different people in different ways. It is spectacular, and I think everyone is touched by it when they have the experience, but I don't know what goes on in other people's minds.

BRINKLEY: Let's move into the early Apollo program. The Apollo program started off with a tragedy. Can you share with us how the AS-204, Apollo 1 fire affected you personally, if you have any memories of that?

ARMSTRONG: Oh yes, I remember it very well. I'd known Gus [Virgil I. Grissom] for a long time. Ed [Edward H.] White [II] and I bought some property together and split it. I built my house on one-half of it, and he built his house on the other. We were good friends, neighbors. Some very traumatic times. You know, I suppose you're much more likely to accept loss of a friend in flight, but it really hurt to lose them in a ground test. That was an indictment of ourselves. I mean, [it happened] because we didn't do the right thing somehow. That's doubly, doubly traumatic.

BRINKLEY: Were you involved in the investigation of what occurred?

ARMSTRONG: No, I was not. If I remember correctly, Frank Borman was involved in the leadership of that investigation.

BRINKLEY: There are some people that say that that tragedy in many ways started helping get a better sense of focus and discipline with NASA in exactly what it would take to make a lunar

landing. Did you find a change around NASA in general, a more seriousness of intent, more triple-checking of everything before, taking nothing for granted?

ARMSTRONG: Partly that. Secondly, and perhaps even more importantly, we were given the gift of time. We didn't want that gift, but we were given months and months to not only fix the spacecraft, but rethink all our previous decisions, plans, and strategies, and change a lot of things, hopefully for the better.

Same thing happened after the *Challenger* [51-L] explosion. They got time and they fixed a lot of things that needed to be fixed and they never had time to do it before. So we get an added benefit, but we regret the price we had to pay.

AMBROSE: Let me interrupt for this second. Test pilots are losing friends often. And you must have lost some friends.

ARMSTRONG: Many, many.

AMBROSE: You hit me hard with that, "This was on the ground." Whew.

ARMSTRONG: That's not the way you want it to happen. Not that it's any less noble.

AMBROSE: Of course not.

ARMSTRONG: It just hurts.

BRINKLEY: I'm just wondering how the Apollo missions were different from the previous ones, the training for the Apollo program, especially since the possibility was that you're training for the Moon. How did the training change?

ARMSTRONG: It was the same, in that it was very goal-oriented. We tried to define it as narrowly as we [could], rather than as broadly as you would in research, because with the time constraints that we were facing then, the desire to get there as fast as we can, we were in a race and that was very evident to us all the time. You wanted to not be diverting your attention in any way to things that you really did not need to worry about. You wanted to focus on all the things that you knew you had to do and had to master. That was the principal difference as we went into the Apollo flights.

BRINKLEY: First, on the Apollo 1, on the tragedy, do you remember where you were when you—

ARMSTRONG: I was in Washington [D.C.]. The President was signing the [Outer Space] Treaty with other nations that kept the Moon as the property of all people. It was a non-staking-a-claim treaty.

BRINKLEY: So you were there at the White House?

ARMSTRONG: I was at the White House. I think it was at the White House. I believe it was.

BRINKLEY: At a ceremony, and then suddenly the news came through to everybody there, or on your way out?

ARMSTRONG: I think it was after the ceremony, but I don't remember exactly.

BRINKLEY: You were with a group of people representing NASA that had come up to be part of the ceremony, then you got the news, then you came back to Houston after you got the news?

ARMSTRONG: Probably the next day. That's a bit hazy.

BRINKLEY: No, no, that's helpful to just put you in a place. How did you react when you first learned of NASA's decision to send Apollo 8 to the Moon? Do you recall the feelings of which one of these was going to go to the Moon? They were talking about sending Apollo 8 to the Moon.

ARMSTRONG: We were very excited about it. We thought it was very bold, because we still had the Pogo problem on the Saturn and we'd had a couple of problems with [both] Saturn V launches, so to take the next one, and without those problems being demonstrated as solved, and put men, a crew on it, not just take it into orbit, to take it to the Moon, it seemed incredibly aggressive. But we were for it. We thought that was a wonderful opportunity. If we could make it work, why, it would make us a giant jump ahead. You remember it was kind of complex because we had to switch crews around and switch some spacecraft and change the order completely. It was kind of a complex process, but it showed a lot of courage on the part of NASA management to make that step.

BRINKLEY: What was the impetus for that decision to speed it up to that degree?

ARMSTRONG: The lunar module was falling behind, wasn't ready to fly, and they were saying, "What can we do?" We'd been in Earth orbit. What can we do without a lunar module? I don't know which minds first came up with the idea of, "Well, why don't we think about a circumlunar flight with it and leave the lunar module behind."

BRINKLEY: What immediate new concerns would somebody like yourself have, let's just say that you're a pilot, a top-flight pilot would have about leaving Earth's immediate gravitational influence? What would frighten a pilot about that?

ARMSTRONG: Well, I suppose that everyone would have concerns, but I don't know that they'd all be the same. People would worry about different things. I remember that one of the things that I was concerned with at the time was whether our navigation was sufficiently accurate, that we could, in fact, devise a trajectory that would get us around the Moon at the right distance without, say, hitting the Moon on the back side or something like that, and if we lost communication with Earth, for whatever reason, could we navigate by ourselves using celestial navigation. We thought we could, but these were undemonstrated skills.

BRINKLEY: That's something to think about. [Laughter]

AMBROSE: You've got me thinking about—you didn't have a very big window to look out of to do celestial navigation.

ARMSTRONG: NASA's probably the only organization in history that's been sold a one-power telescope. And that's what we used for doing the sextant shots and doing the star shots.

BRINKLEY: What were your thoughts when you were finally—and where were you—I'm sorry sometimes I try to put things in locations personally. But what were your thoughts and where were you when you were chosen for the lunar landing mission for Apollo 11 when you first got the word?

ARMSTRONG: It was during the flight of Apollo 8.

AMBROSE: While it was up there?

ARMSTRONG: Yes, and during the flight of Apollo 8 I had three or four meetings with Deke Slayton about, first, would I take the third one down and then we had a lot of talks about who might be available and be right to be on that crew, that sort of thing.

AMBROSE: So you participated in a discussion of who.

ARMSTRONG: Yes.

AMBROSE: It was his decision, but he wanted your input.

ARMSTRONG: It was his decision, absolutely.

BRINKLEY: And [Michael] Collins and [Edwin E. "Buzz"] Aldrin [Jr.] were two people you thought would be—

ARMSTRONG: We didn't have very many choices, but we had several other people that we could make available, so we spent a lot of time talking about that.

BRINKLEY: How well—

AMBROSE: Wait. What characteristics mattered? Level-headedness, quick-wittedness, eye-hand coordination?

ARMSTRONG: Experience.

BRINKLEY: General knowledge? Experience.

ARMSTRONG: Experience and what these people were particularly skilled at, had some knowledge or flight experience related to those jobs and so on. There were other considerations, like if we switch things around too much, you're going to get other people's nose out of joint because they stole somebody from somebody else's crew. I mean, there were a lot of typical kinds of things that you would concern yourself with.

BRINKLEY: Personality?

ARMSTRONG: Sure, we talked about those things. Talked about everything that you might expect.

BRINKLEY: You must have been quite touched that Slayton asked you. It must have made you—"My goodness, this is happening now." The excitement, the reality that this could be the big moment.

ARMSTRONG: Well, it was going to be a big moment, no matter what the flight objective was, but there wasn't any way you could know what it was going to be at that point in time, because the lunar module had not flown, hadn't even been in Earth orbit. We didn't know if we could communicate with two vehicles simultaneously at lunar distance. We didn't know whether the radar ranging would work. A lot of things we just didn't know at that point, and I think at that point in time I did not really expect that we'd get the chance to try a lunar landing on that flight. Too many things could go wrong on [Apollo] 8 or 9 or 10, whatever.

BRINKLEY: What was your relationship? Did you know Collins and Aldrin fairly well before this assignment?

ARMSTRONG: I'd never worked on a crew with them [during Gemini], but part of the time I had in the early days of Apollo 8, Michael was first on [the prime crew of] that flight. And I had ... worked with Buzz [on the Apollo 8 back-up crew]. But I'd known them pretty well [before that] because ... we were still a pretty small group. We knew some of the people a lot better than others, because we worked with them a lot, spent a lot more hours in the middle of the night testing spacecraft. You get to know each other very well in those periods.

BRINKLEY: Who ended up picking the names *Eagle* and *Columbia* for your spacecraft? What is the symbolism, do you feel?

ARMSTRONG: The crew. We, as a crew, did that. We all participated. I think Mike probably was as convincing as anyone, as we deliberated.

BRINKLEY: Was it one of your fun recreational things, making a list of what we should call them?

ARMSTRONG: We had lots of those little things which we considered to be non-operational decisions. They were kind of a pain to have to deal with all those, but we had to do it.

BRINKLEY: Did you have a name that you preferred to the *Eagle* and the *Columbia*?

ARMSTRONG: No, I thought we came out with the right ones.

AMBROSE: While we're on these naming, these are famous names, of course, it was [British Prime Minister] Winston Churchill who picked *Overlord*.¹

ARMSTRONG: Was it?

AMBROSE: And then how did they get *Sword*, *Juno*, *Gold*, *Utah*, and *Omaha* Beach? They drew them out of a hat.

ARMSTRONG: Is that right?

AMBROSE: Yes.

ARMSTRONG: Interesting.

BRINKLEY: Okay. Once the decision had been made on Apollo 11 to be the first one to attempt a lunar landing, how much emphasis did the mission planners and manager place on public-relation issues? How much of your time was consumed with "How are we going to market this to the American public" for all the reasons that you'd have?

ARMSTRONG: I didn't think there was very much of that. There were some things that were done specifically for the benefit of giving the press the opportunity to either talk with us or take pictures of our activities in preparation, and there were other normal things that we were doing, where some access was granted. We probably resented that to some extent, but at the same time we recognized that it was not an unreasonable requirement, and we were certainly willing to accommodate those requirements.

¹ *Operation Overlord* was the code name for the World War II Allied invasion of Normandy, commonly known as D-Day, on 6 June 1944. The beaches the soldiers landed on were code named *Sword*, *Juno*, *Gold*, *Utah*, and *Omaha*.

BRINKLEY: Did you find the intense media focus disrupting, a disruptive force in any way or for your concentration or training?

ARMSTRONG: Well, it might have been a burden if we'd had time to notice it. [Laughter] But we were going full blast trying to be ready on time, and we just tried to shut anything out of our mind that wasn't focused on our principal objective.

BRINKLEY: Describe your training with the Lunar Landing Research Vehicle [LLRV] and the Lunar Landing Training Vehicle [LLTV]. What was it like to try to fly it, and how valuable was that experience during your mission?

ARMSTRONG: Start at the end and work back. It turned out to be very valuable. Originally, when they started first talking about lunar landing, it wasn't known what technique would be used to go there. I was at Edwards, and we started thinking about how you would simulate flying over the Moon. That was a natural thing for us because in-flight simulation was our thing out at Edwards. We did lots of in-flight simulations, tried to duplicate other vehicles or duplicate trajectories or duplicate this or duplicate that, make something fly like something else. It was just what we did.

Don [Donald] Bellman and Gene Matranga, two engineers, and myself, to some extent, started talking about how you might do this. Our first idea was, if we ever needed it for training, was to have the spacecraft—and we didn't know what the spacecraft would look like—but have the spacecraft carried on another vehicle and make that other vehicle be something that would create the conditions that would duplicate the lunar gravity and lunar vacuum and so on.

...Our thought was, when the vehicle gets built, we can put it on top of this carrier and they can actually fly it just like they would over the Moon, and they could do it at Edwards or wherever, and learn how it flies.

Then we decided that was going to be a pretty complicated project, and what we should do before we did that was build a little device, a little one-man device which would just investigate the qualities and requirements of flying in a lunar [environment]—to build the database from which we would build the bigger thing to carry the real spacecraft.

So we actually devised such a craft. It looked like a tin Campbell Soup can sitting on top of some legs, with a gimbaled engine underneath it. That became the basis for what went out as a requirement for bid to build the LLRV, lunar landing research vehicle. It was not known at this time that there would be a lunar module. It was direct descent, and Earth orbiting rendezvous and other strategies were still being considered. Matter of fact, the lunar module came after the lunar landing research vehicle.

Fortunately, the characteristics and the size [and] in the inertias and so on of this training device were very much like the lunar module. That was strictly fortuitous. So it turned out that the people—this is after I'd left there—Joe Walker, Don Mallick, and so on, went through the project to fly this thing, and finding out what the characteristics of a machine flying in a lunar environment would be.

... At that time it was decided to go the lunar orbital rendezvous method and build a lunar module, and it turned out that [the LLRV] was just about the right size. After that, they made the lunar landing training vehicle, which was designed to be even more LM-like, so it would give you a good representation. In fact, it did. All the pilots, I think, to my knowledge, ... thought it was an extremely important part of their preparation for the lunar landing attempt. As you know, as you may know, the lunar module was designed to be able to make an automatic landing, but, to my knowledge, no one ever did.

BRINKLEY: So the simulation—how close a simulation was this training to the actual landing? Were you in for any surprises when you actually had to land it differently than the simulation?

ARMSTRONG: It was harder to fly than the lunar module, more complicated, and subject to the problems that wind and gusts and turbulence and so on introduce, that you don't have on the Moon. The systems were somewhat choppier or less smooth than the actual lunar module, both propulsion and attitude control systems were so. The lunar module was a pleasant surprise.

BRINKLEY: Do you mind discussing the incident you had with the lunar landing research vehicle when it crashed? What was your involvement in the investigation and recovery process in that? Were you part of all that?

ARMSTRONG: Well, it's fairly well covered in a variety of documents. Just say that for an unknown reason, the pressurant gas—I was conducting a simulated lunar approach and lost the pressure and gas to the attitude control rockets, and when you lost attitude control...it diverges—not very slowly. And there was very little time to analyze alternatives at that point. It was just because I was so close to the ground, below 100 feet in altitude. So again, time when you make a quick decision. You departed.

I did not participate in the investigation of that, because I had otherwise assigned duties at the time, so others did that. We lost three of those vehicles, and it was a contrary machine and a risky machine, but a very useful one.

BRINKLEY: How did your training for Apollo 11 differ from your training, say, for Apollo 8? Briefly, if you could, what did your training consist of?

ARMSTRONG: Well, on the training part of our activities, the addition was the lunar module, which we had not had on Apollo 8. ... Michael Collins spent all of his time mastering the command module. Buzz Aldrin and myself focused a great deal of our time on mastering the lunar module, knowing it inside out, and then we had, of course, to learn the experiments and the lunar surface

science work and the installation of equipment on the Moon, and all that kind of stuff. It took a lot of time. I suppose we would have liked a little more time, but when the time came, we had to say, yes, we were ready to go.

BRINKLEY: Were there any specific incidents during the training of Apollo 11 that made a significant impact on you or your crew members or your mission, something that occurred during training that when you were in space and heading to the Moon, was of extraordinarily beneficial nature? I know there were many things that were. I just wondered if something—

ARMSTRONG: Yes, there were a lot of complexities. We were most concerned with mastering the times like when we separated the vehicles, making certain that the computer knew what the velocities and directions of each vehicle were before and after that separation. It's a very difficult, complex procedure to make sure the computer isn't fooled somehow, or loses information in that process.

Then the navigation system was dependent on the alignment of the inertial unit, and anytime, once you turn that loose, it drifts at a very slow rate, so we wanted to be sure that it didn't drift outside limits. [We developed] procedures that we could use to confirm that we would still have adequate quality navigation information to complete the lunar landing.

I'm afraid it's a complex subject that's not easily described. But from the time we last aligned the platform until landing was some substantial number of hours, so we wanted shortly before landing to confirm that that platform hadn't drifted off too far as our attitude reference, so we took a sun shot—had the computer point us at the sun, our telescope at the sun, and made sure that it cut the sun just exactly through the middle. If it didn't the error would be due to the alignment... (the drift) of our navigation system. A lot of little things like that which were extremely important and painfully tedious, but absolutely necessary.

BRINKLEY: How did you cope, as the flight day got closer and closer, with the just overwhelming interest that developed for the Apollo flight and the first man on the Moon, crowds of people everywhere, the whole world watching? Here you are, a young man from Ohio that's gone through all these programs. How did you numb out all those external forces that are happening all around you? Just experience?

ARMSTRONG: I don't know the answer to the question. We tried to provide some information that would allow that public exposure to the kinds of things we were doing, and beyond that, when those things were done, we just turned back inwards to our own problems, our own schedules, our own list of things that we had to get done and get a confidence level that we were ready to go. So we just sort of shut that out all the time that it was outside those spaces that we specifically allocated to the public exposure.

AMBROSE: To follow up on Doug's question, I don't know if it was the most anticipated event of the 20th Century, there have been a lot of events in the 20th Century, and many of them have changed the world and so on. But nobody knew that [Adolf] Hitler was going to invade Poland. Hitler and his general staff knew it; nobody else in the rest of the world knew it. Nobody knew about Pearl Harbor except [Admiral Isoroku] Yamamoto and a few pilots. Nobody knew about last Tuesday except this small handful of people. This [first lunar landing] had to have been just about the most anticipated event, maybe even ever.

A heavyweight boxing champion going into Muhammad Ali versus [Joe] Frazier, there's a lot of pressure on those guys and a lot of buildup and they've got to learn to do exactly as you've just said, you've just got to freeze it out and you've got to—and you look at their eyes, these heavyweight boxers, and their concentration is total.

But you went through the most anticipated—because it was so anticipated, the most, and yet what you've said reminded me of Muhammad Ali. This wasn't a sporting event or anything else,

but I don't know what the hell else you do except you just try to screen it all out and concentrate—and I'm trying to put words in your mouth, and I don't mean to do that. But—

ARMSTRONG: I think you're right. We tried to be as focused as we could, work on the things we could do something about, and not worry about the things that were beyond our ability to change.

BRINKLEY: If you can really capture yourself back, as the day clock's ticking for takeoff, would you every night, or most nights, just go out quietly and look at the Moon? I mean did it become something like “my goodness.”

ARMSTRONG: No, I never did that.

BRINKLEY: Really? [Laughter]

ARMSTRONG: You know, we'd look at the books or we'd talk about strategies or "What are we going to do if this happens?" Or, "Are you sure you know how to handle this?" That's where we spent our time.

AMBROSE: A lot of "what if" talk?

ARMSTRONG: Yes, yes, that's our business. You know, normally...a lot of unexpected things happen, and usually they're not the ones you practice, but the fact that you practiced a lot of different things puts you in the proper mindset to handle whatever it is that comes along, even if it isn't the one that you've experienced before. And I think that happened on a lot of the flights.

BRINKLEY: Did you develop a relationship of studying the Moon, the maps of the Moon as they were at the time, and learning everything you could about its makeup? Part of your reading, if you're not just looking at the Moon, you had to become an expert on the Moon? Or was it that important?

ARMSTRONG: You know, we'd been doing that part of it now for three or four years, working on just background information. In the last months before flight, we didn't do much of that except to look specifically at our landing areas and landmarks and things that we would actually be using or to which we would be referring during the progress of the flight. Those things we looked at, but the broader picture we didn't spend much time on...

BRINKLEY: I was curious if you had any geologic—I guess I was getting to this on the question about the Moon itself, but did NASA require geological training for the Apollo 11 mission so you could notice things that you might see? Or was—

ARMSTRONG: Yes, we spent a lot of time in geology training, predominantly before we had a flight assignment, not exclusively before, but predominantly before. Had very fine group of instructors, very knowledgeable about the subject of astrogeology or selenology or various things that might most be applicable to what we might encounter on the lunar surface.

Some had the opportunity and the interest to become very good geologists. I never put myself in that category. I enjoyed geology, and it was certainly appropriate to understanding what we were seeing on the surface of the Moon, but our time was quite limited there. We had a lot of things to do. Had I been a better geologist, I might have seen some things that were important, that I missed. If that's true, I regret it. But in the time we had available, I think everyone did a pretty credible job of being able to see things that were important and know which samples to pick up and be able to describe to people back on Earth what they were seeing.

Certainly the knowledge of the lunar surface has increased immensely as a consequence of those observations and those samples. Of course, as you know, that work continues yet today in labs around the world.

BRINKLEY: Was there a debate whether you would find water on the Moon? Was that something that was—

ARMSTRONG: There was not an expectation that we would, and I don't remember what our thinking might have been, looking for things that might disclose the possibility of either past or hidden water. I just don't remember that very well.

AMBROSE: Let me ask a layman's question on this. Now I understand there is some feeling in NASA that there may be water. The question is, how could there be water without clouds? If there's water, there's going to be clouds, it seems to me.

ARMSTRONG: The thinking is, if it's in perpetual darkness, that is, in a polar crater or low spot so that it never sees the sun, sublimation rates will be extremely low, and there well might be bodies of [ice] there. There's some spectral data that indicates that that may be true. But it's not yet proven, to my knowledge.

BRINKLEY: Was there anything about the takeoff Apollo 11 launch that was different from the feeling that—I'm talking about just the immediate seconds after launch, that was different than other missions you were on?

[This question may have been directed toward the Saturn launch from Earth.

Note: The answer below applies to the launch from the Moon.]

ARMSTRONG: Yes, it was one—well, a couple of things. One is, the acceleration is at a very low G level. Starts at—well, I don't know, I think less than half a G. I've forgotten exactly, but it appears to be quite rapid. But it would be substantially less than the acceleration of a rock that you'd drop, so it's kind of a slow ascent.

The thing that surprised me—and we knew this ahead of time—the attitude control in space, to pitch the craft you use a—say you wanted to pitch up, you would use a down-pointing rocket in the front and an up-pointing rocket in the back. That would pitch the craft up. But we didn't want any rockets firing up when we're accelerating away from the Moon, because that would be wasting fuel. So we would only use the down-pointing rockets because they would be adding to our velocity, would be fuel-efficient.

But the result of that is that there's a substantial rocking motion. As you pitch forward, the pitch-up thruster fires, lifts your nose up, then it stops, then the nose falls down again and the rocket fires as though you're in a rocking chair.

Now, we knew this, but the simulators never included this in their representation of the motions. So consequently, it's quite, I thought, an unusual motion, and perhaps I should have expected it, but we'd never seen it in our preparation.

BRINKLEY: How serious a concern was there over contamination on return to the Earth? Was that something not just NASA, but yourself—how serious was that concern?

ARMSTRONG: I don't know that I can say. As you know, the National Academy of Science was given the task of evaluating the potential danger from lunar contaminants on the Earth, and it was they who, I think, said the chances are extremely unlikely, and they gave a statistic which I won't attempt to quote, because I'm sure I'd have it wrong at this point.

Nevertheless, they decided to go ahead and have a decontamination facility and put us in quarantine for a period of time equal to the expected incubation time of any disease that could provide an epidemic, twenty-one days from the time we left the surface of the Moon until they let us out.

As you know, they used samples of the soil and put it in [earth] soil that plants were growing in and exposed it to animals and various kinds of things to see if there were any reaction whatsoever. I don't know to what extent they found anything, but certainly if they found anything, it wasn't serious. After a couple of flights with that quarantine, they discontinued that protection system.

BRINKLEY: During the actual landing on the Moon, when the program alarms sounded, what was your reaction? How did you respond?

ARMSTRONG: You're always concerned when any kind of alarm comes on, but it wasn't a serious concern because there wasn't anything obviously wrong. The vehicle was flying well, it was going down the trajectory we expected, no abnormalities in anything that we saw, other than the computer said, "There's a problem, and it's not my fault."

The people here on the ground were right on top of that, and of course, the computer continued in a contrary manner periodically all the way to the surface. But my own feeling was, as long as everything was going well and looked right, the engine was operating right, I had control, and we weren't getting into any unusual attitudes or things that looked like they were out of place, I would be in favor of continuing, no matter what the computer was complaining about.

BRINKLEY: As much as you've talked about your experience and duty in propelling this mission forward, there's a real chance of death and failure here, and not just failure for you—and death for yourself and failure for the United States, the whole world watching this kind of mission.

ARMSTRONG: Yes.

BRINKLEY: Did you read lately that they released that Nixon had William Safire write a death letter about what would happen if you, the three astronauts died on this mission? Did you get a chance to see that document?

ARMSTRONG: I have heard that, but I have not seen it.

BRINKLEY: You just have to numb yourself from that kind of concern at the grandness of all this? Or is this with—I guess what I'm saying is, is Apollo 11 due to the, as Steve said, it was perhaps the most watched event in the history of, certainly the century, of the world. How does—you didn't treat it differently mentally at all, as you would something—one of your previous missions?

ARMSTRONG: I was certainly aware that this was a culmination of the work of 300,000 or 400,000 people over a decade and that the nation's hopes and outward appearance largely rested on how the results came out. With those pressures, it seemed the most important thing to do was focus on our job as best we were able to and try to allow nothing to distract us from doing the very best job we could. And, you know, I have no complaints about the way my colleagues were able to step up to that.

AMBROSE: Let me interject here that you share a quality with General Eisenhower. When reporters would come to him during the war and want to get a story, he would always say, "Go talk to [General Omar N.] Bradley. Go talk to [General George S.] Patton [Jr.]. Go talk to a sergeant. That's where the real story is. This is a team effort," and he would never allow it to concentrate on him. It was inevitable that it was going to happen, but that was his—and then, after VE [Victory in

Europe] Day, Churchill arranged a big event in London that Eisenhower went to be awarded, I think, the keys to the city, that said you're now a citizen of London, and all this concentration on Eisenhower. And in his speech he talked about the closeness between Abilene [Kansas] and London, which was a nice touch, the way we all believe in freedom and we're going to fight for it, and so on. But he also said, "If I'd had the wisdom of Solomon, if I'd had the character of [Abraham] Lincoln, I never could have done any of this by myself. This is a team effort."

And you just spoke about the hundreds of thousands of people that have been working for so long to make this happen, and I invite you to make a reflection on the team nature of the Apollo 11 mission.

ARMSTRONG: Each of the components of our hardware were designed to certain reliability specifications, and for the majority, to my recollection, had a reliability requirement of 0.99996, which means that you have four failures in 100,000 operations. I've been told that if every component met its reliability specifications precisely, that a typical Apollo flight would have about [1,000] separate identifiable failures. In fact, we had more like 150 failures per flight, [substantially] better than statistical methods would tell you that you might have.

I can only attribute that to the fact that every guy in the project, every guy at the bench building something, every assembler, every inspector, every guy that's setting up the tests, cranking the torque wrench, and so on, is saying, man or woman, "If anything goes wrong here, it's not going to be my fault, because my part is going to be better than I have to make it." And when you have hundreds of thousands of people all doing their job a little better than they have to, you get an improvement in performance. And that's the only reason we could have pulled this whole thing off.

AMBROSE: Let me invite you to also make an observation, if you wish. It is a part of the popular culture that anytime a government gets involved in a project, they're going to screw it up. Talking to Moira [Buckley Ambrose, his wife] this morning, I was thinking about some of the great events

of this century, or the Twentieth century or the Nineteenth century, the atomic bomb, the [Meriwether] Lewis and [William] Clark expedition, the Louisiana purchase, Dr. [Jonas] Salk. It's almost always the government that gets behind this, and you certainly, or Apollo 11, were at the very cutting edge of an enormous spear that was built by the government. I would just wonder what comments you might or might not have on that.

ARMSTRONG: When I was working here at the Johnson Space Center [JSC], then the Manned Spacecraft Center [MSC], you could stand across the street and you could not tell when quitting time was, because people didn't leave at quitting time in those days. People just worked, and they worked until whatever their job was done, and if they had to be there until five o'clock or seven o'clock or nine-thirty or whatever it was, they were just there. They did it, and then they went home. So four o'clock or four-thirty, whenever the bell rings, you didn't see anybody leaving. Everybody was still working.

The way that happens and the way that made it different from other sectors of the government to which some people are sometimes properly critical is that this was a project in which everybody involved was, one, interested, two, dedicated, and, three, fascinated by the job they were doing. And whenever you have those ingredients, whether it be government or private industry or a retail store, you're going to win.

BRINKLEY: Probably the question you must get tired of the most is the most famous words of the twentieth century, and that is "One small step for man, one giant leap for mankind," and whether you've answered this question so many times before, but do you find it curious that NASA didn't script a line for you to say, that they allowed you the kind of personal freedom to—you know, I almost—if I had put myself in NASA's position, I would almost want to say, "Neil, here's the line we'd like you to say," and yet they gave you that freedom.

ARMSTRONG: Well, in retrospect, they might have wished that. [Laughter] But the late Julian Scheer, who really led the NASA relations with the outside world in many ways, was absolutely adamant that Headquarters never put words in the mouths of their people, not just astronauts, but anybody, that they let people speak for themselves. They made it known sort of what the party line was and what the NASA position was, but beyond that, they never, to my knowledge, controlled the ... public statements of others. Certainly they insisted, in the case of the flight crews, that they not be told what to say, that their statements be their own elocution of what they saw and what they wanted to say. As far as I know, that prohibition was never violated.

BRINKLEY: And with you actually crafting that line, that was just something you were thinking about as the moment approached when you knew this was going to happen, did you think about in your head? Or did you think maybe, "I should just say 'Man is now on the Moon,'" or did you realize—I think that's a magnificent line. I think most people do. Everybody, I really think, does. How did that come about? Were you—had some time while you were getting prepared for the—you know, to leave the *Eagle* that you knew that that would be the proper line, the line you wanted to say?

ARMSTRONG: Yes, I thought about it after landing, and because we had a lot of other things to do, it was not something that I really concentrated on but just something that was kind of passing around subliminally or in the background. But it, you know, was a pretty simple statement, talking about stepping off something. Why, it wasn't a very complex thing. It was what it was.

AMBROSE: As Doug said, everybody in the world knows the line, and everybody in the world are so grateful that you didn't say, "That's one giant leap forward for the United States."

BRINKLEY: I guess now you must realize how often that news clip of you descending, the television image. When you see that now, this many years later, that image, does it still affect you in any way, like, "Wow, that's me back then?"

ARMSTRONG: No. No.

BRINKLEY: When you crafted the line when you were coming down, were you—I mean, how much of a concern is that? I mean, you had a lot of things running—also you're hoping just to get that footprint put on the Moon.

ARMSTRONG: I didn't think of it as being as important as others. I didn't want to be dumb, but it was contrived in a way, and I was guilty of that.

BRINKLEY: When you were on the Moon, there are not that many photographs of you on the Moon. There seem to be much more of Buzz Aldrin. That's because you were taking more of the photographs?

ARMSTRONG: He's a lot more photogenic than I am. [Laughter] I had the job of taking a lot of the pictures. That was part of my assigned responsibility. There was a short time in the middle where I transferred the camera to Buzz and he took some pictures, and we each had assigned objectives that we were supposed to catch. I think we probably caught a fair share of the things we were supposed to take pictures of, and not too many really bad shots. [Laughter]

AMBROSE: I'm struck by—coming down here, there had to be a lot of wonderment, a lot of excitement as you took that last step onto the lunar surface, then you guys went to work. Insofar as there are critics, they said, "Why did we send men to the Moon? We should have sent up machines

to gather up things." I'm struck by something you said earlier when you were talking about geology. There is no computer in the world that can match the human eye and the human brain. The things that you saw you hadn't expected to see, that's worth it. I mean, no machine in the world can do that.

ARMSTRONG: Machines are getting better and better, but fortunately, there's still a place for us *homo sapiens*, some reason for us to continue to exist. [Laughter]

BRINKLEY: I guess we should mention—we jumped the story a little—but when the landing occurred, you had to pilot to make sure it didn't go into a crater. How damaging would that have been if you couldn't and you landed in—would that have been the end of the mission?

ARMSTRONG: We could have tried to land there, and we might have gotten away with it. It was a fairly steep slope and it was covered with very big rocks, and it just wasn't a good place to go. You know, if I'd run out of fuel, why, I would have put down right there, but if I had any choice of a more promising spot, I was going to take it. There were some attractive areas far more level, far less occupied by boulders and things, a half mile ahead or so, so that's where I went.

I wanted to make it as easy for myself as I could on that first—there's a lot of concern about coming close to running out of fuel, and I was very cognizant of that. But I did know that if I could have my speed stabilized and attitude stabilized, I could fall from a fairly good height, perhaps maybe forty feet or more in the low lunar gravity, the gear would absorb that much fall. So I was perhaps probably less concerned about it than a lot of people watching down here on Earth. That's not to say I wasn't thinking about it, though, because I certainly was, but I thought it was important to try to get it down smoothly on the first try. We didn't know how that landing was actually going to go until that point. So I wanted to make it as gentle as I could.

BRINKLEY: Was there anything about your Moon walk and collecting of rocks and the like that surprised you at that time when you were on the Moon, like, "I did not expect to encounter this," or, "I did not expect it to look like this"? Or included in that, the view of the rest of space from the Moon must have been quite an awesome thing to experience.

ARMSTRONG: I was surprised by a number of things, and I'm not sure—I can't recall them all now. I was surprised by the apparent closeness of the horizon. I was surprised by the trajectory of dust that you kicked up with your boot, and I was surprised that even though logic would have told me that there shouldn't be any, there was no dust when you kicked. You never had a cloud of dust there. That's a product of having an atmosphere, and when you don't have an atmosphere, you don't have any clouds of dust.

I was absolutely dumbfounded when I shut the rocket engine off and the particles that were going out radially from the bottom of the engine fell all the way out over the horizon, and when I shut the engine off, they just raced out over the horizon and instantaneously disappeared, you know, just like it had been shut off for a week. That was remarkable. I'd never seen that. I'd never seen anything like that. And logic says, yes, that's the way it ought to be there, but I hadn't thought about it and I was surprised.

BRINKLEY: And the collection of rocks that you gathered and things were pretty much what you expected? There was no—nothing that—

ARMSTRONG: We didn't do a very good job, and I particularly didn't do as good a job as I would have liked to have done in collecting rock samples. It was at the end of our [time] period on the surface, ... we were running low on time, and the geologists, properly, would have liked us to authenticate each sample with photographs from different directions before selecting it so they can identify it. I thought, since we didn't have time to do it, the better part of valor was to just pick up

all the different kinds of samples I could as quickly as I could, stick them in the bag and get them back in the craft, and button up shop.

BRINKLEY: When the American flag was planted on the Moon and the famous photograph of Buzz Aldrin was taken and other places, but just reflect on how important did you feel at that point and any—I know it's so hard to put you back in that moment, really, but this was now the mission was accomplished, the United States had gone to the Moon, that all this work had counted, in other words, a sense of patriotism, the flag there of the United States. On the other hand, you're looking at Earth as one unity, and there's sort of a pride of American nationalism but also that sense of, "Jeez, we're all on that little planet in the sky together."

ARMSTRONG: There were a lot of proposals for what to do on the lunar surface by different people. Some people thought a U.N. [United Nations] flag should be there, and some people thought there should be flags of a lot of nations. In the end, it was decided—and I think the Congress had something to do with it—that this was a United States project and we're not going to stake a claim here, but we ought to let people know that we were here and put a U.S. flag.

My job was to get the flag there. I was less concerned about whether that was the right artifact to place. I let other, wiser minds than mine make those kind of decisions, and I had no problem with it.

BRINKLEY: When you finally—I guess what was the most harrowing part of Apollo 11 was getting the lunar module off of the Moon to reconnect with Michael Collins. Is that the part of the mission that you were most concerned about?

ARMSTRONG: Well, I'll take that in two steps. Fortunately, there were no really harrowing parts of the flight. The most difficult part from my perspective, and the one that gave me the most pause,

was the final descent to landing. That was far and away the most complex part of the flight. The systems were very heavily loaded at that time. The unknowns were rampant. The systems in this mode had only been tested on Earth and never in the real environment. There were just a thousand things to worry about in the final descent. It was hardest for the system and it was hardest for the crews to complete that part of the flight successfully.

But having said that, it wasn't too hard, because six crews were successfully able to do that. So perhaps my concern at that point was more than it should have been. But it was the thing that I worried about, just because it was so difficult. Walking around on the surface, you know, on a ten scale, was one, and I thought that the lunar descent on a ten scale was probably a thirteen. [Laughter]

BRINKLEY: Steve, do you have anything on the Moon?

AMBROSE: I wanted to ask, I have heard or read somewhere that there are only two man-made objects on Earth that can be seen from the Moon, and that one of these is the Chinese [Great] Wall and the other is the Fort Peck Dam [Montana].

ARMSTRONG: I would challenge both. We could see continents, could see Greenland. It stands out, just like it does on the globe in your library, all white. Antarctica we couldn't see because there were clouds over Antarctica. Africa was quite visible, and we could see sun glint off a lake. It might have been Lake Chad. I'm not certain which lake it was, but we could catch that reflection, sun reflection.... But I do not believe that, at least with my eyes, there would be any man-made object that I could see. I have not yet found somebody who has told me they've seen the Wall of China from Earth orbit. I'm not going to say there aren't people, but I personally haven't talked to them. I've asked various people, particularly Shuttle guys, that have been many orbits around China in the daytime, and the ones I've talked to didn't see it.

AMBROSE: I've read interviews in which astronauts have used the word how "fragile" it is, looking at the Earth. It's a lovely phrase.

ARMSTRONG: And I think everybody shares that observation, and I don't know why you have that impression, but it's so small, it's very colorful—you know, you see an ocean and gaseous layer, a little bit, just a tiny bit, of atmosphere around it, and compared with all the other celestial objects, which in many cases are much more massive, more terrifying, it just looks like it couldn't put up a very good defense against a celestial onslaught.

BRINKLEY: When you came back, and you had the quarantine and—well, let me—I mean, did you realize your life was going to be changed forever now, you were now the first man on the Moon, that the President of the United States would want to talk with you and they'd want you to tour American cities and travel the world?

ARMSTRONG: I don't know how much I—I don't remember how much I might have expected that, but in Gemini, President [Lyndon B.] Johnson had sent me on a goodwill tour of South America. So I'd had some experience with what the nature of those kinds of activities were. And of course we were so happy that we had completed that flight and essentially got almost all our objectives on it, and it allowed the guys in the next flight, subsequent flights, to do far more aggressive science and exploration and so on. So we didn't care what they wanted us to do. We'd have been pleased to do anything at that point.

BRINKLEY: You've had what I consider to be one of the most fascinating parts about your career is why you were the absolute right person to be the first person on the Moon, because you've kept a kind of dignity to your mission, which is, it seems to me, that you did your job and then you did not

keep in the face of the public eye. Armstrong is known with Apollo 11 all over the world, but I don't think anybody in a grocery store would recognize you in America, and that's something you must have had to work at to achieve.

ARMSTRONG: Well, I recognize that I'm portrayed as staying out of the public eye, but from my perspective it doesn't seem that way, because I do so many things, I go so many places, I give so many talks, I write so many papers that, from my point of view, it seems like I don't know how I could do more. But I recognize that from another perspective, outside, I'm only able to accept less than 1 percent of all the requests that come in, so to them it seems like I'm not doing anything. But I can't change that.

BRINKLEY: I've seen a thing of the number of honorary doctorates you're offered and how few you take, and you really are very select in what you do. And you also seem to—

ARMSTRONG: It's very difficult to turn down Sister Frances Marie [Thraikill, College of Mount St. Joseph, Cincinnati, Ohio]. [Laughter]

BRINKLEY: You can turn Harvard [University, Cambridge, Massachusetts] down, but not Sister Frances Marie. [Laughter]

Well, after that, did you play any role—well, after you left the astronaut corps, shortly after Apollo 11, you took a position as Associate Administrator of Aerospace.

ARMSTRONG: Yes, Deputy Associate Administrator of Aeronautics [at NASA Headquarters, Washington D.C.]. I went back to aeronautics, from whence I came.

BRINKLEY: Yes. Was that something that you had premeditated all along, that, "When I'm finished with this mission, I'd like to get back to doing that," or did it evolve after seeing a bit of the—you wanted to get back to your roots in a way?

ARMSTRONG: No, no, no. It didn't come that way. It wasn't anything I desired. It was the Administrator [asking] if I would help him in that area, and it was an area I felt comfortable with and knowledgeable about, and I was glad to have the experience, although I think everybody should have to go to Washington and spend a little time, just to see how difficult it is to run this country and do penance there.

It's a frustrating place for me because so much coordination and greasing the skids goes on in Washington that by the time you've gotten around to everybody, the first guy's forgotten what the subject was. It's really hard to get things done there, and it's amazing to me that anybody can get things rolling from Washington, just because of the nature of the place.

AMBROSE: Let me ask—we're both academics. That's where I've made my career. That's where Doug has made his career. You've been an academic. Tell us about that. How did you decide to go to [University of] Cincinnati and do you enjoy the teaching and the research, and what part of the academic life was what you expected it to be?

ARMSTRONG: I'd always said to colleagues and friends that one day I'd go back to the university. I've done a little teaching before. There were a lot of opportunities, but the University of Cincinnati invited me to go there as a faculty member and pretty much gave me carte blanche to do what I wanted to do. I spent nearly a decade there teaching engineering. I really enjoyed it. I love to teach. I love the kids, only they were smarter than I was, which made it a challenge.

But I found the governance unexpectedly difficult, and I was poorly prepared and trained to handle some of the aspects, not the teaching, but just the—universities operate differently than the

world I came from, and after doing it—and actually, I stayed in that job longer than any job I'd ever had up to that point, but I decided it was time for me to go on and try some other things.

AMBROSE: Well, dealing with administrators and then dealing with your colleagues, I know—but Dwight Eisenhower was convinced to take the presidency of Columbia [University, New York, New York] by Tom Watson when he retired as chief of staff in 1948, and he once told me, he said, "You know, I thought there was a lot of red tape in the army, then I became a college president." He said, "I thought we used to have awful arguments in there about who to put into what position." Have you ever been with a bunch of deans when they're talking about—

ARMSTRONG: Yes. And, you know, there's a lot of constituencies, all with different perspectives, and it's quite a challenge. Nevertheless, it's one of the strengths of our country.

AMBROSE: Oh, I love being a teacher, and I never would have done it any other way. But I remember once being with some colleagues, and they were complaining about, you know, we're not getting paid enough and they're overworking us, and so on, and I just exploded. I said, "Listen,"—this was at LSU [Louisiana State University, Baton Rouge, Louisiana]—"you've got the state as your patron, and they're paying you to teach nine hours a week on exactly what you want to be doing, what you want to be teaching, and they're paying you to read exactly what you want to read, the literature of your field. And you're telling me that you're being browbeaten?" They never could get the point of what I was saying.

BRINKLEY: I was curious, did you play any role in planning at all after Apollo 11 in Skylab or the Shuttle, Space Station, or even future missions to Mars?

ARMSTRONG: Not very much. I was on the Apollo 13 Accident Board, and during that time period was when I was invited to go up to Washington. So then I was sort of overwhelmed by my new duties in that new role, which I enjoyed, but gave me little time to be concerned about the problems of the day at Houston.

BRINKLEY: Would you like to see us go to Mars?

ARMSTRONG: Yes.

BRINKLEY: Do you think it's possible?

ARMSTRONG: Yes. I think it's doable now, but very expensive and probably not within reasonable expectation of being able to be budgeted in the near future.... I guess the great hope is that we have a breakthrough someplace that would make that problem much less awesome than it appears at this point.

AMBROSE: Or space out the time a bit. It's not the cold war anymore, and it's not a race. So you could space out the time frame and cut your annual cost quite a bit by doing that, I would think.

ARMSTRONG: Still, it's still a big number—

AMBROSE: Still a big number, yes.

ARMSTRONG: And—

AMBROSE: It's a big effort. It's got to be done.

ARMSTRONG: I hope.

BRINKLEY: Were you disappointed, Mr. Armstrong, after Apollo 11, after the halcyon days of the Kennedy and Johnson administrations, and now it's the early Nixon years and you're going to the Moon, that the Nixon administration started cutting NASA budgets and there's starting to be due to Vietnam and other concerns in society? After Apollo 11 and all that interest, it started becoming almost commonplace to walk on the Moon and for NASA to go, and the program kind of petered out and lost interest instead of continuing to ride the wave. What do you attribute that to?

ARMSTRONG: Oh, I think it's predominantly the responsibility of the human character. We don't have a very long attention span, and needs and pressures vary from day to day, and we have a difficult time remembering a few months ago, or we have a difficult time looking very far into the future. We're very "now" oriented. I'm not surprised by that. I think we'll always be in space, but it will take us longer to do the new things than the advocates would like, and in some cases it will take external factors or forces which we can't control and can't anticipate that will cause things to happen or not happen. Nevertheless, looking back, we were really very privileged to live in that thin slice of history where we changed how man looks at himself and what he might become and where he might go. So I'm very thankful that we got to see that and be part of it.

BRINKLEY: Do you ever hope to go back in space? Is that something that you'd like to do one more time after watching John Glenn go back up recently as a—

ARMSTRONG: If they offered me command of a Mars mission, I'd jump at it. [Laughter]

AMBROSE: But I read in one of the interviews that it's going to be two and a half years, was one of the astronauts'—and that the proper models to look at are not Apollo 11, but look at Lewis and Clark or Vasco da Gama.

ARMSTRONG: Exactly. That's awfully good advice. Yes. Yes. Exactly right.

BRINKLEY: We're almost finished here, but I did want to touch on the presidential commission on the *Challenger*, and you were one of the commission members picked. How and when were you asked to participate on that?

ARMSTRONG: It was very soon after the incident, and I can't remember the exact date, but it was a matter of a few days later. The president was very interested—I shouldn't say "interested." He was content with the use of presidential commissions to look at various issues, and sort of in keeping with that viewpoint that he had on how to look at various problems, he jumped on the chance to use a presidential commission.

He selected Bill [William P.] Rogers to chair it and asked me to vice-chair. I had enormous admiration for the way the chairman conducted his job. He sort of had a very good appreciation of Washington and what the needs of the public and the press and the Congress and all these constituencies who each had their own interests from different angles, so he was able to understand what their needs were and try to find ways to accommodate them, and asked me to head the investigation of the accident itself. So he was "Mr. Outside" and asked me to stay inside and come up with what happened.

We had 120 days to come out with a report, which we met. It was a very hard-working commission. I think we came up with the right answers. It's never been effectively challenged. It was a national tragedy, but we learned a great deal from it, and the subsequent Shuttle program has

benefited greatly from the things that we learned and the things that we were able to do in improving the Shuttle during the time period that it was being redesigned.

BRINKLEY: Were you very familiar with the Shuttle program and the inner workings of NASA before you joined the commission, or had you kind of punched out into the private sector so much that you weren't that much on top of what was happening?

ARMSTRONG: I didn't know the inner workings of the Shuttle's systems, components. I knew the program in a macro sense—objectives, techniques, and general strategies. But I didn't find that to be an extreme disadvantage. We had the availability on the commission and reporting to the commission of very knowledgeable people from every aspect of the technical side of the business, and it didn't take the commission long to get up to speed and understand what the elements of the problem were.

BRINKLEY: The Apollo program closed in 1972. Is it surprising that we haven't gone back to the Moon in so long, and did you ever imagine that it would take so long for people to return, for us to return?

ARMSTRONG: Well, had you asked me that question thirty years ago, I probably would have said, no, I can't imagine that we'll make such a small number of steps over the next three decades. But looking back on it, I find it fairly understandable in the light of conflicting requirements for resources that the country has. It has a lot of other important challenges. I suspect that we'll get some chances.

And there have been remarkable things done. If you look back and see where we've gone in the unmanned side, the probes that we've investigated the outer planets and comets, landed on an asteroid, just what opened up with the Hubble [Space Telescope] and others, the known volume of

our environment by millions of light years, it's remarkable what has happened in the last thirty years, and I think we'll get some more chances.

BRINKLEY: In Ohio do you have your own telescope? Do you ever look up and use your telescope in a recreational kind of way?

ARMSTRONG: [No, but I often enjoy looking at the night sky.]

AMBROSE: When you were talking about how remarkable it was, this has been pretty remarkable, too [holding book *Shuttle-Mir: The United States and Russia Share History's Highest Stage* by Clay Morgan]. That's a political development that would have been unpredictable in 1969.

ARMSTRONG: Yes. That's quite true. That's quite true.

BRINKLEY: Well, in closing here, I just wanted to ask you, what do you see for the future of manned and unmanned space flight? Do you have any feelings of where it's headed? Maybe a better question is, where would you like to see manned and unmanned space flight head, to keep pushing the envelope?

ARMSTRONG: There's an increasing interest to go back to the Moon. There's been enough time now that there are a lot of persuasive reasons why we could benefit from a return visit.

I personally hope that we'll go on to Mars. I think that will create enormous excitement and increased understanding of at least the near part of the solar system.

But I can't predict what will happen. What happens is going to depend on a variety of forces and functions that can't be controlled. It's like herding cats.

BRINKLEY: Although you're an engineer and proud of it, do you ever use your imagination for reading science fiction books and trying to envision what it might be like 1,000 years from now or 500 years from now or 200, or do you try to always deal with what seems to be the next step in the practical world?

ARMSTRONG: I'm having a little trouble with next month right now. [Laughter] It's fun to look ahead, but candidly, I don't have the ability that some of those wonderful science fiction writers of past generations had. They turned out to be quite perceptive in many ways, and I wish I had a fraction of that ability.

BRINKLEY: Are there any of them in particular that you read, like Jules Verne, or somebody that you learned to admire, in retrospect, their writing?

ARMSTRONG: Well, I have a complete set of H. G. Wells, and in reading it now, I find I'm less enthusiastic about his writings than I was when I was a much younger man. But nevertheless, the creative ideas that they have put forth, that have caused a thousand ... of other people to think in new ways, has been very important to the progress of civilization.

BRINKLEY: Do you ever get—well, when these movies come out, like *Star Wars* or any sort of space films, are you attracted to watching them just to see, you know, how they're portraying space in the future? Do you take the time to, out of your curiosity just to see, look at those sort of things?

ARMSTRONG: I thought *2001*, which was many decades ago now, was a very fine film, very authentic in terms of the way space looks and the way vehicles move and trajectories and so on. Many of the more recent space fiction movies have much less realism than *2001* did. They're more exciting, but not realistic.

AMBROSE: Students ask me, "Doc, there's nowhere left to discover. We've had Lewis and Clark, we've had [Ferdinand] Magellan and so on," and I say, "Listen, the Twenty-First Century is going to be the great age of discovery. Ninety-seven percent of the ocean's floors have never been looked at. Where Bob [Robert D.] Ballard is right now is just the cutting edge of it, and Mars, and then who knows what after that? The Twenty-First Century is going to be the great age of discovery."

ARMSTRONG: I think you're right. I hope you're right. My expectation is that we're not going to run out of new stuff to look at.

AMBROSE: No. Ninety-six percent of the world's plants have never been described by a botanist.

ARMSTRONG: I didn't know that.

AMBROSE: It's just amazing. You want a cure for Alzheimer's? It's growing out there, right behind us. We just haven't discovered it yet. [Laughter]

Well, a little quick story on that. Thomas Jefferson was a great believer in for every disease of mankind, there's a cure growing here on Earth, we've just got to find it. So one of his instructions to Lewis was, "Tell us what those Indians use for medicine." Lewis' mother was a folk doctor, herbs and so on. So Lewis, from Ft. Mandan [North Dakota], the first winter out, wrote back to Jefferson to report on what had been discovered so far. He said, "When the Indians get a toothache, they chew the bark of the willow." The bark of the willow is aspirin. That's all in the world aspirin is, is the bark of the willow.

ARMSTRONG: I didn't know that.

AMBROSE: Yes. So I know there's a plant out there that's going to cure Alzheimer's. I just don't know what the name of the plant is.

BRINKLEY: I guess we should, I think, get ready to wrap this up. My last question is, you seem to have always gone through your life in your own kind of very methodical way, and you've had a lot of people that have been part of your team or that you've worked with. Has there ever been an individual who's really had a major effect on the way that you've decided to look at life and the way that you want to live your life and carry yourself, whether as a teacher or father or—?

ARMSTRONG: I think it's the summation of the influence of twenty or fifty people, each of which was significant, but not overpowering.

REBECCA WRIGHT: Well, if you don't mind, before we end, one of the efforts of our team as a team is that usually, because we're all oral historians, at the end of our oral history, the person who is facilitating usually asks the rest of the team members [if they have questions], because sometimes some issues might come up that we didn't get a chance to [talk about] — would you object if I asked our space historians if they have a question or two for you?

ARMSTRONG: Okay.

CAROL BUTLER: I have a couple of questions, actually. Early on, you mentioned that during the space program you were 98 percent focused on your job. I was curious as to how much you were aware of situations in the country around you as you were going about your daily job—so much was going on in the '60s—and whether that impacted you at all.

ARMSTRONG: I was certainly aware of the traumas that the country was experiencing at that time, and I believed that those problems were ones with which I was poorly equipped to contribute. They were outside my experience, outside my training, and I've always believed that however attractive it might be to get into areas that are interesting, you shouldn't do it if you're not qualified.

BUTLER: The other question that I wanted to follow up on was that you had mentioned that you were involved for a short time in the Apollo 13 investigation before you went to D.C.

ARMSTRONG: Yes.

BUTLER: So I wanted to follow up and ask, first, while the mission was going on, if you had any involvement during those efforts, and then what your specific role was in that investigation.

ARMSTRONG: I think everybody that was here was involved, not just crew members, but there were people all over the center that were involved in many ways. I was involved in simulator work and in several different things that we were trying to do, alignments and burns and things that were outside our experience base in the past. There were a lot of people doing that.

I'm reminded of the *Apollo 13* movie, which I thought was an exceptionally good movie. I thought in all the essential elements of that flight and its aftermath ... were accurate. They did take literary license, and appropriately so, because there's no way an audience can follow as many people as we had working on the problem. You have to cut it down to some ten or fifteen people so that the audience can remember who's doing what. I thought that they did a good job of that. But each of those one individuals who was doing something in the movie was probably really fifteen people doing that kind of stuff.

BUTLER: And after the accident, then, what was your involvement in the investigation as to what happened and what were some of those findings?

ARMSTRONG: As I said, in the middle of that investigation I got transferred out to Washington and no longer participated in the day-to-day activities of that commission. But they had good people, and they did come up with the answers.

BUTLER: And had quite a successful rest of the program.

ARMSTRONG: Yes.

BUTLER: That was all the questions I had. Thank you.

KEVIN RUSNAK: I had a couple, too. While we're talking about the investigation board, you gave us an overview of your involvement with the *Challenger* presidential commission, and one of the things that's been said about that is the *Challenger* investigation was very different than Apollo 1 because that was sort of an internal investigation—

ARMSTRONG: That's right.

RUSNAK: —and they kept the politics out of it. A lot of the NASA guys we've talked to said that was really a better way to do it than the way *Challenger* was handled. Could you give us your perspective, as someone who was around for both of those events?

ARMSTRONG: I agree with those gentlemen that it would have been preferable to do it internally, and I think it could have been done well. But the reality was that there was a national involvement.

It was so striking. It was on the news. Everybody in the country saw that happen or at least saw the replay of it in the news that day, and the possibility of keeping it internal was remote. I'm happy that the commission took a diligent responsibility and acted, I think, in a responsible manner and did a credible job of spending a lot of money in finding out what happened, and it probably was well spent.

RUSNAK: Well, during the course of the investigation, you probably had a good chance to see what NASA was like in the mid-1980s internally, how they were functioning. Can you compare that to the NASA you had left over a decade earlier, in the 1970s?

ARMSTRONG: NASA, like many organizations, [has] a continually evolving character. It centralizes and then decentralizes, and centralizes then it decentralizes. In my recollection, it probably went through five cycles like that. When the new guy comes in, why, he thinks we ought to do something a little different than we have, and changes the reporting relationships or the responsibilities' allocation. It's no different in the commercial world. They do similar things in industry, go through the same cycles, and that's neither right nor wrong. It's just the way things are.

RUSNAK: Well, then I had a few specific questions. One of the gentlemen we had in here some months ago was Bob [Robert L.] Carlton, who was a flight controller, who was on the LM Control console. He was recalling the lunar landing and the events shortly thereafter where he and his colleagues were having quite a few moments of tension because there was a problem with the LM descent engine. There was a piece of ice stuck in one of the fuel lines. So they were thinking some real problems were going on. I was wondering if you could give us your perspective, what you knew sitting there in the LM, and what you knew of what was going on on the ground.

ARMSTRONG: Well, we were spring loaded to the suspicion position at that point. We recognized that right after landing, where you had to do thermal conditioning surrounding the craft, that it hadn't seen before with all that hot surface underneath it and cold on top, that there were going to be all kinds of conceivable difficulties with plumbing and valves and pressure systems, relief valves and so on. So we were ready to leave if we had to, and we were listening carefully to their instructions. But I can't remember the details of what we were thinking at that point in time.

RUSNAK: Were you at least concerned enough that, "Yeah, we might actually have to abort"?

ARMSTRONG: We ... were quite cognizant of the fact that we might have to do that, and we were prepared to do so, and we were going through all the procedures that would allow us to do so if we were required. But I think the problem was isolated in a reasonably short period of time, as I remember, and the pressure was off then to really start sweating out a takeoff.

RUSNAK: As I said, I think the guys on the ground ended up a lot more nervous than you and Buzz did in the LM.

ARMSTRONG: Yes.

RUSNAK: Once you got out of the LM and you're going down the ladder, you're in this environment that requires you to have a space suit. I mean, you've got to have this protective garment on to keep some internal pressure and protect you from micrometeoroids and heat and the cold of space, all of that. How did actually functioning in the suit compare to how you were trained for, and what were some of the difficulties in operating on the Moon in this, learning to walk around, pick up rocks, all of that?

ARMSTRONG: Everything was easier than expected. It was easier to walk. It was easier to maintain balance. We didn't have as much trouble with the temperatures inside the suit as we thought we might have. I can hardly say good enough things about the way the suit and the backpack, the so-called PLSS [portable life support system], operated, fully up to our expectations and better.

RUSNAK: Had you had any input in the development of the suit, other than your usual training, that sort of thing?

ARMSTRONG: Not so much in the development of the suit, no, but we had participated in a lot of testing and spent many, many, many hours inside our suits before flight, in the chamber and under vacuum and temperature and all kinds of conditions. So we felt pretty comfortable and confident that the suits were going to work okay.

RUSNAK: And on all the flights, I don't think they had a single problem with any of the suits, at least that was mission-critical.

ARMSTRONG: I'm not aware of any serious problem.

RUSNAK: Just one final question for me. As our colleagues here pointed out earlier, you seem to take great pride in being an engineer. So I was wondering, through your career as an astronaut, how much time did you find to actually be able to do engineering types of things, to get your hands or your mind around these engineering sorts of problems that you would be facing, either as a flight crew member or in some other technical assignment?

ARMSTRONG: I'd say throughout my seventeen years at NACA and NASA, a very large percentage of my time was involved in real engineering work throughout that entire time period. I found that

other former engineers who had become senior managers at NASA still occasionally tried to be engineers now and then. [Laughter]

RUSNAK: I guess a follow up to that just before we go on. Did you have much work with Max Faget and everyone over in Engineering and Development Directorate?

ARMSTRONG: Some of the guys in the [astronaut] office had more work with that directorate than I did. My collateral responsibility usually was in the simulation and training area, so I spent more time with FCOD [Flight Crew Operations Division] than I did with Max's gang, but others spent a lot of time there.

RUSNAK: That was all I had. Thank you.

SUMMER CHICK BERGEN: I have a couple. If I may ask you to reflect again on Gemini VIII, in history we find that Gemini VIII tends to be overshadowed by later things, the Gemini program as a whole even, but as we've talked to so many people, engineers and people that worked in mission control, I oftentimes ask them about the—they cite Gemini VIII as probably the closest call, overshadowing even Apollo 13.

In light of what was accomplished in that mission, the docking, which was so important, and then the critical incident of the nearly fatal craft malfunction, yet the human element able to overcome that malfunction, what were the consequences of that for the Gemini program and later program and maybe the lessons learned from that important mission?

ARMSTRONG: Well, the requirement was to fix that so it didn't happen again, and they did alter the systems such—they changed the wiring on the control system so that they could isolate all that kind

of systems and allowed a more deliberate ... diagnosis of the problem. So that was the hardware side.

To me, it re-emphasized the fact that you've got to expect some of these things are going to go wrong, and we always need to prepare ourselves for handling the unexpected. And you just hope those unexpected things aren't something that you can't cope with.

So throughout Apollo, everybody I knew was always saying, "What if?" and, "Is it possible that this could happen?" And, "What will we do?" Just that process of continually questioning built your confidence in your ability to handle whatever comes along.

BERGEN: I have one more, a little bit broader-perspective question. I'm from a generation that has no living memory of the Apollo program. What we learn is from watching the videotapes, what's written in history. You've talked about how you've enjoyed teaching students. What would you like people of my generation and those to come, that don't have a memory of the space program during the time you were involved, what would you like for us to take from that part of history?

ARMSTRONG: I can't be critical of your generation, because I recall when I was a teenager, a boy, I thought that everything that happened before I was born was old ancient history, and I really didn't think I needed to know all about it. But with respect to aviation history, I really enjoyed it. I really learned all I could. But I wasn't a big fan necessarily of everything else. So I can't be critical of some other generation. I suspect you'll come along, given a little chance. [Laughter]

WRIGHT: If you have no more, I certainly would like to thank you gentlemen, on behalf of the Johnson Space Center and Mr. [George W. S.] Abbey, for taking your day and spending it with our project. You certainly have made an historic impact on our project, and we thank you all for your time.

[End of Interview]

[Also assisting with the interview was Sandra Johnson of the Johnson Space Center Oral History Project team.]