NASA JOHNSON SPACE CENTER ORAL HISTORY PROJECT
ORAL HISTORY TRANSCRIPT

RICHARD W. UNDERWOOD
INTERVIEWED BY SUMMER CHICK BERGEN
HOUSTON, TEXAS – 17 OCTOBER 2000

BERGEN: Today is October 17, 2000. This oral history with Richard Underwood is being conducted for the Johnson Space Center Oral History Project at the offices of the Signal Corporation. Interviewer is Summer Chick Bergen, assisted by Kevin Rusnak and Tim Farrell.

We're so glad you came by today to talk to us.

UNDERWOOD: Great.

BERGEN: I was hoping you might give us a brief background on your career prior to your coming to NASA so we can get a little bit of your history.

UNDERWOOD: Well, going way back, I was in the Navy in World War II, in the 7 Seabee Battalion, which was an amphibious assault ammunition stevedore battalion. We carried the Marines' ammos [ammunition] for them to the beaches.

I had the GI Bill, so I went off to a university, [University of] Connecticut, got a degree there, then did other work at University of Wyoming, Colorado School of Mines, because I got interested in earth sciences and what have you, and George Washington University in Washington, D.C., when I went to work for the U.S. Army [Corps of] Engineers there. I was a naval officer assigned to the Army Engineers at that point because of an expertise in photogrametry and geodesy that the Army used and the Navy really didn't.

Got to go all over the world on aerial photographic surveys, some for intelligence purposes, many for mapping and geodetic information to determine the size and shape of the Earth, how we could launch intercontinental ballistic missiles with some degree of accuracy. Traveled many, many places.

While in Honduras one time I met a very beautiful young lady and we got married. She's over in Nassau Bay right now. Forty-five years later, we're still married. Five children, put them through universities here in Texas.

Let's see. Once I married my wife, the problem was, she was a foreigner, and I had special military clearances. They were very unhappy, the fact I married a foreigner. I had a general tell me I should be shot without a trial; I was a traitor to my country for marrying a foreigner. They pulled me off the high-flying airplanes, the U-2s and other very exotic airplanes, and sent me back to the B-17s. I'm deaf, as I said, in one ear because of 4,000 hours in B-17s. In fact, the one I stepped out of that day in Honduras and met my wife is at Ellington Field right now. It's one of the few surviving B-17s, because it was used in aerial survey work, and the ones that were bombers were all destroyed after the war when better bombers came along. But nothing beat the B-17 as a reconnaissance airplane till the U-2 came along.

Went back to the 17s, after I got married, on projects for the military and State Department and joint ventures and all that. When I got sort of sick of traveling with children, I wanted them to grow up in the country and not an itinerant life around the world, I went back to Washington and they assigned me rather mundane work to do, and I decided I was going to go to work for [United States] Geological Survey in Denver [Colorado] because I had trained on their equipment when I was at Colorado School of Mines, which is in Golden, right next to Denver.

At that point I got a call one day from a guy with a heavy German accent, that said, "They tell me you know something about cameras that fly high."

I said, "Well, up to 70,000 feet."

He says, "Do you think one could work at half a million feet?"

I says, "Well, that would be in space."

And Dr. [Wernher] von Braun says, "Well, let's give it a try. Come to Alabama. I want to talk to you." So he was Army ordnance, Army rockets, which are the best in the world compared to the Navy or the Air Force, ones which always blew up. The Army ones always flew.

I went down there and talked to him, and we began to hang some cameras on the early Redstones. Then when we determined they didn't know where they went when we shot them out of Florida—there were only two launch pads at Florida then—we got the Air Force guys back in that we used to lay out a grid out of northern North America over the poles into the Soviet Union so we could launch an ICBM [intercontinental ballistic missile] with some accuracy into Moscow or Sverdlovsk or wherever you wanted to go.

But then we took it down the Atlantic [Ocean] all the way down to the Antarctic, and that became the Atlantic Test Range. We could figure out down on the geoid back on the spheroid the exact shape of the Earth and how the geometric changes in the earth and the magnetic changes in the earth and the density changes in the earth caused missiles to not fly perfect trajectories. We knew what was going on.

Then I went back to Corps of Engineers at that point. The reason why I was loaned to von Braun was I didn't have Q-clearance and he didn't need one. And did other things in Washington, and then got loaned back to what became NASA at that point on several projects,

particularly the echo balloon satellite projects, because they had problems and we used photogrametry to solve the problem. We could orbit the echoes.

Then people I had met there out of Langley were establishing Space Task Group, which began the operation down here, and after this place started up, they asked me if I'd go to work for NASA instead of being borrowed from them from the Corps of Engineers. So I came to Houston thirty-seven years ago, and that began NASA at that point for me.

It was mainly the use of photogrametry and what have you, which would have been in the Earth Resources Program to a certain extent. I had been all over the world. I had seen aerial photos from high altitudes of the whole world, and if I look at an aerial photograph out the window of an airplane, I know exactly where I am anywhere in the world, because every little piece of ground has a signal that it gives off.

So it sort of went through the Mercury, which was a rather mundane operation. The photography was really nothing on Mercury, but it did prove that with the right equipment you could do very interesting studies of the Earth on the synoptic view, this great view of the Earth that looks for hundreds of miles in many cases all the way to the horizon, and over a very short period of time. You know you orbit the Earth in ninety minutes. An airplane takes quite a bit longer. You could look at very large areas all done the same day, same weather conditions, same atmosphere, eliminate a lot of the problems. Say you want to photograph Cuba. I worked on that project for the aerial photos. It took a year. From a satellite, you could do it in a matter of about six minutes. So even the sun hasn't moved very much during that period of time.

So I remember after Gemini IV, when Ed [Edward H.] White [II] did his space walk, we had a camera around there that Ed took outside mainly to look at the outside of the machine, because it was very badly damaged, the early ones, the Mercs and the early Geminis. Some

engineers said it happens on the way up, and others said it happens on the way back. Two different attitudes of engineering to fix it. We said one day in a meeting, "Why don't we photograph it when it's out there. Then we'll know whether the damage happened going up or coming back."

White took thirty-nine pictures, and [Robert R.] Gilruth and [George M.] Low and [Maxime A.] Faget and all the designers and what have you were looking at these pictures on this magnificent roll of film, and we had it spread out in the lab there. Dr. Gilruth says to me—I'm down all alone looking at the other end of the roll, and he says, "Hey, Dick, all the action's up here."

I says, "Well, I don't think so, Dr. Gilruth. I think it's all down here."

And he came down and looked and he said, "Well, those are just pictures of the Earth."

I said, "Yeah, but we're looking at things that no human being had ever seen before, parts of Africa and other places. You can see what really goes on." I explained all these things to him.

He said, "Well, from now on, your job is to work with the astronauts to be sure they bring back great photographs of the Earth and then eventually when we go to the Moon." So that's how it sort of evolved at that point. It evolved into this machine to take the lunar photographs on the surface and in orbit both.

BERGEN: Was that the pivotal point of management at NASA's change in attitude toward photography?

UNDERWOOD: Toward space photography, yes. That was the pivotal point at that point. Before that, Walt [Walter C.] Williams at Mercury didn't want any cameras. At first he didn't even want a window, you know. We called those guys "spam in a can" at that point. You shoved them into a thing the size of a 55-gallon drum. They're going to sit in there in the dark or with a periscope to look. No, no, no. We figured they'd want a window. Of course, they're test pilots, and test pilots survive by the contact between their visual observation and their brain, on it's either time to get out of an airplane or to do something so the airplane and you will survive, and we felt they wanted a window. Then they put that little window in front of them on the Merc. And we felt they might want a camera. They began with a very simple operation.

But it was always a great antagonism, because cameras weighed and cameras took up space, and they're concerned about grams, and we're putting machines on that weigh ounces, that sort of thing, you know. You want to go between the two systems. There was a great deal of objection to carrying cameras.

Then [John H.] Glenn [Jr.], he carried a $19.95 camera that he had to buy himself, because they said, "We don't want a camera. It's three orbits of an Atlas, of all things. And Atlases tend to blow up. It's too heavy and you won't make it. We're going to restrict the weight." Then, of course, they shot him straight east to get the rotation of the Earth, to give him 1,000 mile-an-hour boost when he went off the launch pad.

He bought a Ansco Autoset $19.95 camera, carried as personal equipment on the weight they let him carry that way, and a roll of film, Eastman color negative. Two rolls were ultrasonically spliced together and loaded in the camera, not in a cassette like you usually buy the 33-mil, and then the camera was sealed so you couldn't open it except with special screwdriver. That way we got 70-some photographs.

But John had the problem operating the camera with the gloves and everything, and trying to wind the film, so [M.] Scott Carpenter was given a Zeiss robot which you wind up ahead of time, has a spring mechanism, and every time you hit the button, it took the picture and advanced a half frame, so it took half-frame 35s. That didn't work out too well.

[Walter M.] Schirra wanted to carry his personal camera, which was a Hasselblad, and Dr. Williams said, "Man, that's a big machine. What's wrong with this camera that Wally had?" Wally had these 70-millimeter slides taken at Indianapolis [Indiana] at the time of the big race, the Memorial Day race, and he's down in the pits with [Andy] Granatelli and these other guys, noted personalities of the time, with his camera, photographing these magnificently colored automobiles, racing cars. They're beautiful. They're beautiful on these big slides. He felt he'd get beautiful pictures from space.

So they wanted to know why he couldn't carry the camera. It was worked out, with various people looking at it, that the leather outgassed—they had leather on them in those days. This one doesn't [referring to his camera]. And made them look pretty, so all cameras had leather on them in those days. It outgassed. If you took the leather off, you had stainless steel, and the sunlight coming through the window bouncing off it could permanently blind him. So you don't want blind astronauts. You got outgassing from lubricants. You had a viewfinder in it. This one doesn't have a viewfinder, because they're useless out there. And they weigh a lot and they're made of glass. If you break one, all this stuff floating around in there.

So in the Mercury, Gemini, Apollo, you couldn't distort your body very well to look out the window of those spacecraft through a viewfinder, so they were taught to shoot from the hip, like "Gunsmoke," draw and shoot, get your target.

Also it had a focal-plane shutter, the Hasselblad 1000 and the 1600, and in zero gravity they didn't accelerate and decelerate at a constant speed. They were designed for 1 gravity and so were the springs and other things in the camera. So there were a lot of things wrong with it.

When Schirra was told this in a meeting, he broke down and started crying, practically, I mean just like a three-year-old kid who broke his favorite toy. Everybody thought that was rather unique, a number-one Navy astronaut and so on, the original seven guys. Dr. Williams, after a while he decided to give him his camera. So it was determined we'd modify one that would make it okay. Schirra carried it, and from that day on these things have been flying, because it's a magnificent camera.

So all the modifications that NASA talked Hasselblad into doing, in building even this camera, we talked them into building this camera, were the result of the space program, and that's why it's such a super reliable camera today, precision. Never going to fail you, because we didn't have a failure. The whole time I was there at NASA, we never had a camera fail. They've had them fail since.

BERGEN: I love this quote you wrote in *On the Shoulder of Titans*, where you said, "With Mercury, space photography was born. With Gemini, it struggled toward maturity so that Apollo space photography would give you and me, indeed the whole world an opportunity to reach out and practically touch the Moon, that Skylab would again look back toward a troubled Earth, back here where the real action is." Could you take us on that journey in space photography? You told us about Mercury. Just take us on that journey through Gemini and Apollo and Skylab and your direct participation in it.

UNDERWOOD: And the work I worked on mainly with the astronauts. Gemini III, [John W.] Young and [Virgil I. "Gus"] Grissom made three revs [revolutions], another short flight, and they brought back a short roll of pretty good pictures. They were busy, because no one really knew if Gemini was going to work okay. You had two guys on board and a very tough time line, and we felt lucky that they did get 20, 25 photographs, even though the roll could have taken quite a few more, because we were using very thin film, very special magazines that Hasselblad had built for us, and others had built some of the test ones in New York, J. Mauer [phonetic] Company and other people.

But after Gilruth and Low and others looked at the Gemini IV pictures, I'm explaining them all to them, all over the world, and how this was a valuable tool, then the emphasis began to change. So with [Gemini] V, you had a longer flight, mainly to see if they could live out there longer, and a lot of time. So let them take photographs.

So we worked out the orbits when they had time to do the photography or even in some cases changed certain things so they could do it, to get photos that geoscientists around the world would like to have from space, and worked it into the flight plan. That seemed to work out quite well. They brought back some absolutely magnificent photographs from V.

Then [Gemini] VI and VII would be the rendezvous with two spacecraft out there, and that would have to be done if we were going to the Moon later on. Everything was steppingstones to the Moon, going on up there. We also at that point had to train them to look at each other and take photographs and maneuver around each other so that the flight controllers and the planners and the other people would have a series of photographs that they could see exactly what happened out there in space and what problems might develop in a rendezvous or

docking or maneuvers between two spacecraft, and to cope with that sort of thing. So it became a double operation.

Well, VI aborted several times, VII went first, and then VI came after it. They tried to count them down. They'd go, "[Gemini] III, IV, V, VI." No. On a quiz program, you're missing the order. VII went before VI.

Then the other problem was that Frank Borman was unhappy because the lighting conditions were set up where Schirra and [Thomas P.] Stafford in VI would have the best lighting. So you almost felt like you were back up in Hollywood [California] or somewhere at this point. Good lighting versus bad lighting because of the position of the sun. The setup was that the pictures we knew in advance coming back from VI of the rendezvous would be far better than those coming back from VII, and that didn't set too well with [James A.] Lovell [Jr.] and Frank Borman. Pulling these names back thirty-five years now. [Laughter]

And that's the way it turned out. The rendezvous pictures that VI took and VII are magnificent, that Tom Stafford took at that point. Their flight was short, so their Earth-looking pictures were generally good, at least the ones that Stafford took were good. [Gemini] VII, though, had the longer flight, two weeks, because they were going for a record, duration record as well as the rendezvous. Their pictures were great, too, and consecutive runs over the same location turned out to be outstanding photographs.

They did a series on Florida, four consecutive revs, so you got the tropical area where there are short-duration weather changes. Over four and a half hours is a lot of weather change, and you can see it. The Earth is rotating underneath them, so the first time they're looking south from up over Savannah [Georgia], I guess, the top of the orbit, at Florida. The next time they're looking from south of Jacksonville [Florida] to the other end of it, a series of pictures. Then the

next one, they're looking more to the north. Then the final one, they're down over Havana [Cuba] looking at the whole of Florida. You can see all these weather changes. You need a million people on the ground to tell you what happened in four photographs from space out there, the Florida peninsula. So that proved that in long-duration flights you could get some good photography.

Then another problem was, a lot of the geoscientists around the world wanted photographs of certain areas, and you get fifty minutes of daylight and forty minutes of darkness, and they're scheduled in a series of times they're going to sleep. In those days, astronauts didn't sleep, because they're looking at this Earth out there. No one had ever seen this magnificent thing before, and they'd look out the window all the time and they're not going to sleep. So we would write up a little piece of paper and hide it in the spacecraft. I called it "photography for insomniacs." So during the sleep cycles, I'd tell them what rev and the time they'd get to places where I'd gotten letters from scientists all over the world, wanting photographs of that area.

The flight controllers couldn't understand why these pictures came back during sleep cycles. Nobody was sleeping out there. So that became a system through the rest of the program. We'd put the cameras on spacecraft and this piece of paper was in there. One astronaut knew where it was, so they'd get the pictures from that. Got a lot of great photos when, in theory, they're sleeping, not supposed to take photos on the later flights.

On the Earth-orbiting Apollos, the same way, and even into Skylab. Joe [Joseph P.] Kerwin was my next-door neighbor at Nassau Bay, and he flew on the first Skylab and it worked great there. Then the other guys realized we were going to do it, too, on the other two

Skylabs, so we worked out an awful lot of stuff for them that were on the so-called sleep cycles. The last guys were up there eighty-some days, so there was plenty of time to get things done.

So it went on from that standpoint. Then, of course, the next steppingstone was the dock. [Gemini] VIII hit that Agena and everything went crazy, and the motion pictures of that are stunning, you know because [Edwin E. "Buzz"] Aldrin and [Neil A.] Armstrong were going like—who was that?

BERGEN: [David R.] Scott.

UNDERWOOD: No, it wasn't Scott. Oh, boy.

BERGEN: Yes, it was Scott.

UNDERWOOD: Dave Scott was with them? Okay. Scott took the later one, yes. You look at those pictures, they're going like a 78 RPM [revolutions per minute] record. Well, you're too young to understand 78 RPM records, even probably 33s. How he knew where to reach and fire those retrofire pack and bring that thing under control and take a series of photos was very interesting. When they came back, I'd always get them to autograph a picture for me. When Armstrong autographed the one for me hitting the Agena, he said, "To Dick Underwood—Next time I'll do better." We didn't know what next time was going to be. [Laughter] But the pictures were of great value from the operational standpoint.

Then on the next flight, the Agena failed and they put that [augmented target] docking adapter [ADTA] up there, and the nose cone didn't come off. They took a series of pictures on

why the failure happened on the nose cone on the wiring operation, which was used to admonish the contractor. The contractor was saying that a space photo's not legal in law courts.

Then, of course, [Gemini] XI did it great. They even had a tether line hooked up to the Agena and were going round and round like this [Underwood gestures]. Unbelievable series of photographs. And XII did a similar thing. That ended Gemini at that point.

BERGEN: I read that you were able to get cameras on the unmanned Apollos for public affairs purposes.

UNDERWOOD: Yes.

BERGEN: Can you tell us about that and the results?

UNDERWOOD: Well, we wanted to test the first electrics, and we had them on there, that the operation would fire, the camera would turn on. When they went on up, it looked out the window, and they rolled it on over. The first one, I guess what was [Apollo] 5, I guess, was a short flight, and they wanted the picture also of the entry, so it worked all the way.

Then the next one after that was orbital, and that camera ran and ran and ran, took a series of pictures at a greater distance between photographs. So we had the orbital at that point also, and it looked down at the Earth. When they rolled it over and then they rolled the spacecraft, when it was rolling, barbecuing for heat control, information for flight controllers and the environmental guys, the life-support folks got a series of these pictures. Every now and then the Earth would roll underneath it.

They were a great series of photographs, but it gave us a good idea of what we were going to get on [Apollo] 7, when 7 flew, which was in many ways just to see if the machine would survive long enough for a journey to the Moon and back, but in Earth orbit. We had a lot of unique experiments on there that Schirra was a bit unhappy about, but the other two guys liked them, particularly Walt [R. Walter] Cunningham, and brought back some very interesting, unique photographs at that point.

Then, of course, we went to [Apollo] 8, which went to the Moon and back, and [Apollo] 9 also was Earth-orbiting, with the lunar module out there, and the training there was photographed the two vehicles, then after separation again. Then the rest of the time was Earth orbit. Lovell and those guys got some great—was Lovell on that one? No. It was [Russell L. "Rusty"] Schweickart and Scott. Great, great photographs in Earth orbit.

Then, of course, the other Apollos went to the Moon.

BERGEN: Did you feel that the photography experience you got on Gemini helped prepare you for Apollo?

UNDERWOOD: Oh, yes, and Skylab. Yes, and the Shuttles. Yes, and it put an awful lot of flight controllers and other people in other divisions at NASA at ease once they saw how things really worked out there, going from the computers, which didn't have the capacity of the ones today for simulations, to actual photographs to look at. They were always told to shoot the pictures the way the human eye sees it. In most cases, on the Moon nearly everything was done—how would you say? As they saw the scene and as things developed, not that much as photography

that was designed and thought out ahead of time, really, except panoramas of certain areas of certain stations and what have you.

On the last flight, [Eugene A.] Cernan sat down to photograph [Harrison H. "Jack"] Schmitt and the flag and the Earth in the background, which is one of the great photos ever to come out of the space program. That was a contrived situation, but 99 percent or 90 percent, 95, anyway, were the scene as you saw it and what you wanted to do so that people back home would understand what you're doing.

BERGEN: What did you do on the ground to prepare for the astronauts to take pictures in space?

UNDERWOOD: In space? Or in Earth orbit?

BERGEN: Just on their missions in general. What preparations did you have as far as preparing the equipment, the cameras, and what facilities? I know you developed a lab.

UNDERWOOD: Yes, I was the only supervisory aerospace technologist in that whole directorate, and that made a lot of people unhappy. They kept trying to fire one supervisory aerospace technologist in the directory, and I was the only one. But Gilruth and Low and other people were on my side, so it never worked out. They said they wanted me in that directorate so I could have direct access to the processors and the film and all these other things, and interface with the astronauts. I didn't do any real work in photographic techtometry lab other than interface with the people there on situations, and directly with the astronauts and people in Building 4 and the ninth floor of Building 1, who were really the ones who protected me

through the whole system of management there at that particular point, and [NASA] Headquarters. Mr. Webb and his successors thought space photography was great.

BERGEN: What types of resistance did you encounter?

UNDERWOOD: You mean in my directorate?

BERGEN: In trying to incorporate space photography into the missions.

UNDERWOOD: A lot of people felt that it wasn't of any great value. They were looking at a different drummer, listening to a different one. They had other things that they were thinking about, that here we're using cameras you can buy in a store that have been modified, and we're not carrying super systems like flew on U-2s or other things, and we really didn't want to, because we didn't want to get into the security business. Everything NASA did was in the public domain, and we didn't want to whack into that particular area. We wanted pictures that recorded it the way the astronauts saw it, and this camera with this lens is exactly the way the human eye works.

There were various people that had various objections, that it wasn't technical enough and it wasn't dedicated in many ways as the super part of the mission that went along with all the parameters that were important to the mission and zigzagged in between all of them into the flight plan and into the training system and all that. We just told them we wanted reaction of what goes on out there, and if an emergency comes up, you'll have the training to document that, which, of course, happened a number of times. They were trained, very well trained.

BERGEN: Tell us how you trained the astronauts.

UNDERWOOD: How you trained them? Well, a lot of people were involved in training, but my end of it was mainly to get these great Earth-looking pictures and things of that type.

Well, we knew exactly the light conditions generally from those altitudes. You're above the clouds, so you're not going to get changes from clouds. We knew where the sun position was. We knew the dynamics of the film, the lens, the camera, and knew that with rather common settings, where they didn't have to play any games with cameras, we could go to general settings and they could get a great array of photographs. The only time they wanted to mess around was when they were near terminators when the light dropped off. That happened in a matter of several minutes, but always go back to the normal settings if you deviate from the normal settings. I'd always be in mission control whenever they were doing that sort of thing, remind capcom or someone, "Have they gone back to the normal settings?" For the next rev or two revs from now.

But whenever they were flying, were going to be awake, I'd be sitting there in case they had a question, you know. I used the console in the weather office there, because it really wasn't needed when they were out there. The only time weather was really needed was liftoff and landing at that point, and what might come on in the meantime to change the landing site or the landing rev or something like that. Once you lifted off, that was a *fait accompli* at that point. Then the next thing was the landing.

So I had access to all that equipment and all the weather satellites. I could even tell where weather was all over the world. These were rather rudimentary satellites compared to

today's satellites, but you had the general idea. No point in saying, "Hey, we want you to get a picture of a certain area" when you know it's cloudy. There's no point in them either orienting the spacecraft and using fuel or staying awake or even looking out the window. And also we knew where the storms were and fronts and other weather things to tell them, "Hey, you're going to come up on a hurricane three hours from now," or something. "Try to get a series of pictures."

It was quite informal. We wanted it that way and the crews wanted it that way. You got a special rapport with them that many people I don't think had who were in the system, because in certain engineering areas and other, everything was strict and formal and timed and worked out all well in advance and monitored at that point, and had to be, because their lives were at stake. If the camera screwed up, who cares at that point? Except people wanting photographs on the rest of the mission. But it isn't life-threatening. And the camera was redesigned so it wouldn't be life-threatening. Of course, when it burned up on the pad, then we went to a different type of motor, because they were worried about things that made sparks at that point. So that was a change there. Other than that, the camera isn't going to be a potential problem for anybody.

So you had a different relationship with them than any of the others. The final briefing you'd give them at the Cape [Canaveral, Florida] the day before they'd fly, usually, and other guys in the division in Building 4 would make sure the cameras all worked, the film had been checked, it met all the specifications, film that was cut from the master roll alongside it would be checked in Building 8 to see if the radiation, the temperature, the humidity in space affected the processing of the film. All these things were watched rather closely and loaded on the spacecraft shortly before the flight.

I remember I'd always, after a while when I realized the value of the pictures, would tell some of them, "You know, when you get back, you're going to be a national hero, you're going to get a parade in your home town and maybe a parade in Washington, and you're going to have dinner at the White House and you're going to talk to a joint session of Congress. All through this time, all these computers in Building 30 are going to be punching information into big thick books about what went on in this system, that system, and the other system and so on. The only people who are ever going to look at those books are probably guys going for a Ph.D. in aerospace engineering or history of this sort of thing, and they've got a billion pieces of data on thousands and thousands of these books. That's their only value. But those photographs, if you get great photos, they'll live forever. Your key to immortality is in the quality of the photographs and nothing else."

Some of the guys would say, "Oh, Dick, you're crazy." And then the next day they'd say, "You know, you're right. I'll get you great pictures." So that was part of the motivation. And today those photos will live forever. They might say, "Who took it?" Neil Armstrong or Jim Lovell or all these guys took it, took the picture. They'll live forever.

BERGEN: You mentioned earlier about where you were during the missions. Is there any particular instance that stands out in your mind of any time during a mission, maybe something that was significant that you wanted them to photograph or something?

UNDERWOOD: Yes, things changed. Yes, there were a lot of significant things that would change on the Earth that we wanted pictures of, and to re-photograph. We always gave them some training, "If you see anything you don't understand, take a picture of it." [Charles “Pete”

Conrad [Jr.] photographed this famed UFO. We thought it was a defect in the film. It was in three photographs.

It was during the debriefing afterwards that Pete said, "What did you think of that UFO?"

I said, "What UFO?"

He said, "Well, I took three pictures of it on this one roll."

I said, "Gee, I thought you were taking pictures of the S-band antenna on the Agena and they were out of focus." It was a very definitive vehicle, not an artifact of any kind. It was a machine that was built by some humans somewhere in time, and we couldn't figure it out. We had no idea what it was or anything.

This went on for years. Every time I'd roll that roll from Gemini XI, I'd think, "What the devil is that?" We have no idea what it is, because we hadn't anything that we launched that looked like that. So maybe there are UFOs or something.

Then the Soviets released ephemeris data and the data on their Protons, which were very, very big vehicles. I looked at the pictures in *Av [Aviation] Week*, first release of Protons, and said, "Gee, looks a bit like this thing on Gemini XI." So I go back to it and I look at it, and, yes, it had the same general shape. Then I got the ephemeris for the Protons and the ephemeris for Gemini XI, and when Pete took the pictures, they were four miles apart over southern Africa at the time. So that's what we had.

But I guess it was ten years before—every time I roll that roll, I'm scratching my head. And we never mentioned it to anybody, you know, at that point, that this thing was in there, and nobody in the outside world caught it at that point. It was sort of like on Apollo 11, nobody wondered why we never released any pictures of Neil Armstrong on the Moon. Because there

weren't any. But we were told, "Don't mention it." And nobody in the news media picked this up. I can't figure that out to save my life, why every picture you released was Buzz Aldrin, because Buzz was mad at Neil, didn't take his picture. Got hundreds of the other eleven guys walked on the Moon, none of number one. Even PAO [Public Affairs Office] for a while thought of, "Why don't we say this picture by the flag is Armstrong? How do you know? You can't see his face or anything."

I said, "Well, there's some nine-year-old kid out there who's a space groupie and he knows every aperture and wire and seam in a spacesuit. The day after you publish it, the *New York Times* is going to have a letter from a nine-year-old kid saying, 'No, you're wrong. That's Buzz Aldrin.'"

"Well, don't mention it." So that's the way that sort of worked for years. Nobody brought that idea up. A lot of things weren't mentioned and got away with from that standpoint.

I guess it was Shuttle 9 when the photo editor from *Av Week and Space Technology* was looking at some of those pictures. It was in a high inclination, one picture, and they were all cleared by the military. He said, "What's in this picture?" Snow on the ground, little circles spread out, almost like a spider web.

I said, "Oh, that's a clear violation of the SALT [Strategic Arms Limitation] Treaty by the Soviet Union. Those missiles aren't supposed to be there." Well, of course, they put it on the cover of the magazine and everybody from the Secretary of Defense on down the line wants me put in front of a firing squad for telling him that. I said, "The man asked a question. You guys released the photographs. You said there was nothing of value in them. If you didn't want the world to know that we know the Soviets violate their treaties and violate all treaties, you

should have restricted the photo." But I had a bad reputation in DOD [Department of Defense] and the Pentagon for a number of years after that.

BERGEN: Talking about your photo identification, could you take us through that process that you went through in identifying those pictures?

UNDERWOOD: Yes, I prepared the lists on everything up until when I retired on each flight, and I worked day and night on them to get them out so people around the world could have them. It was a labor of love; you didn't get paid for it, because they didn't pay you overtime or anything. I wanted to get this information out to the world, so they could use the photographs to study various things.

So the rolls came back and we gave them very tender loving processing in a very slow process. It wasn't until later in the missions that we considered the state-of-the-art process, but it delivered perfect photographic processing, even though it was a slow process and some people complained about that. "You've got these machines to run the roll through in six minutes. Why are you taking five hours?" But it's an open machine, and if anything goes wrong, you can cut the film at that point—we had rehearsed all this—and yank that piece out and put in a neutralizing chemical in vats that were all lined up there at that point to neutralize the film at that point, then recycle. Can't do that in an enclosed machine. You had no idea what's going on till it pops out the end, whether it's torn or one chemical didn't work property or something like that. So that's why we went through that process.

Then they get developed. Then we would make a master, because we didn't want to fool around with the original. One, it was on very thin base. It was a little thicker than Saran Wrap,

but one-fifth the thickness of the film you and I use, and it was on polyester, because the acetate buterates disintegrated in time in space. We didn't want it handled, the original, but very seldom, so first a master was made and we looked at that, really.

The original, we suspended it between two rolls. It never touched anything. Just generally said, "Yes, it's a good one," and we put it in the printers, which didn't run like most printers where it comes in contact, it's exposed, it rolls up, they separate and roll up. Ours came in contact and stopped print by print by print. So our resolution was simply higher than you would get, say, off a motion picture film or something like that. Then we numbered that master.

Beyond that, you would print from the numbered master, but the original had no numbers on it and was never numbered, to this day. So what was released beyond that would be a third generation. Then we would make another series of a certain amount of unnumbered masters and then physically scratch the numbers into them so we would have some second-generation stuff to look at, because no one's ever going to look at the original again.

The only people we printed from the original usually was National Geographic Society, and that would go to a specific frame that they wanted, because their man would come down and look at it, and it would go in the system, it would stop, it would go into a liquid gate and print it. Anybody else, in our opinion, didn't have a good enough reason at that point. [NASA] Headquarters set it up that way specifically, "You're not going to print from the original for just some guy saying, 'I need an original,'" and all that, because the dropoff between the original and the way we made these other masters was insignificant. But if you made a fast print, there was a pretty good dropoff. But most people aren't looking for that type of information. But an awful lot of people say, "I want a copy of the original," you know, and they really don't need one. We

set it up so that the modus operandi would eliminate for 99.9 percent of people going to an original, and for most other people going to a numbered master.

Then I'd then get them, and I had all my maps and I knew the flight and I knew which sequence the [film] magazines were used, so I knew generally what revs a certain mag was on, and just go through the roll, knowing where the pictures were probably taken.

But then they used to like to play games with me. They'd look at little atolls in the middle of the Pacific, and on the tape you'd hear them say, "Hey, we're going to fool Dick Underwood and take a picture of this atoll. He won't know where it is." Then I'd know where they were, you know. We used to have a ball going around with those guys on their little old atolls that I wasn't supposed to know where they were. But it all worked out.

I developed a list and had the photo number and would go back to reconstruct, within a minute or so, the time that it was exposed, the location, and the time from liftoff and the GMT [Greenwich Mean Time] time, because Houston time was no good to anybody except to anybody who lived here, so GMT time, or time from liftoff was important. Anybody who knew the liftoff time could work it that way.

Then a general identification which was often tailored to geoscientists more than public affairs or like that. Public affairs would get the ones they liked, and I'd give them a nice big writeup on those pictures so they could release them or any of them that came in that way, but the lists, I'd go through the lists and roll by roll by roll by roll. I don't know if you've seen any of those old thirty-some-year-old lists, but they're still around. They still get used. People call me at home now, "I've got your list from Gemini IX. Tell me more about picture number so and so." That sort of thing still goes on.

But that's how it worked out. That's when the flight control guys very often determined in the GET [Ground Elapsed] Times, a lot of them were taken during sleep cycles. But they're great photos.

BERGEN: Tell us about your interaction with other scientists. You talk a lot about them using the photos. What interaction did you have with them?

UNDERWOOD: Well, they knew my position in the system and by either calling me or writing me a letter when they had the general idea where the spacecraft was going, you know, "Can you work it into the time line? I'd like to get some updated pictures of this area." Some were archaeologists. They were all types of geoscientists. Some of them wanted to look at certain phenomenon no one had looked at before. Some of them wanted to see what the change was between a picture taken on Gemini V and one on Apollo 9 or something like that. Then the constraints were always the low-inclination orbits, because most of the world is not between 28 North and 28 South [latitude].

When the later flights came in where they did go farther north, information—a whole new ball game opened up at that point, because we could photograph parts of Europe and most of North America, just to tell people you draw a line from San Diego to Savannah, anything north of that in the USA we're not going to get unless they're looking toward the horizon to the north. And a lot of people were pushed out of shape about all that. I still am pushed out of shape the fact we haven't gone polar orbits, where you get the whole planet at the same time underneath you, all the time. Instead of 10:30 in the morning, a nice time for photography, it'll always be 10:30 in the morning underneath the picture.

So that would be part of the situation, depending on what they wanted and why they wanted it, can we work it in. It turned on a lot of people, and a lot of people, when they first saw them, realized this was a very valuable tool. Like Bob [Robert E.] Stevenson, who was even going to fly on one until he got ill and was placed by, I guess, Paul Scully-Power maybe.

Bob was at the Bureau of Commercial Fisheries in Galveston [Texas], and he went to a meeting in Houston one day, I guess it was probably around January of [19]'66, maybe. Maybe February or March '66. And he's driving back to Galveston and he drives by Webster, says, "Gee, I'm going to go over to NASA [Manned Spacecraft Center] and see if I can get a look at some of these space photographs, see what's in them."

They directed him over to me, and I set him up at a light table. He wanted to look at the Gulf of Mexico. He rolls a roll of film, and five minutes later he looks up and says, "You know, Dick, I've learned more about the movement of commercial shrimp in the Gulf of Mexico in the last five minutes than I knew in the last five years." So Bob became the advocate of space photograph in oceanography and wrote a paper on it, and then it spread out through the system. So it just grew and grew and grew from that standpoint. More and more people got interested in them and wanted them.

BERGEN: What's the most unusual request you've received?

UNDERWOOD: Unusual request? I think the most unusual request came from a guy, I have no idea who he is or where he is, and they weren't U.S. space photography; they were Soviet space photographs. How he got a hold of them, I have no idea, but he didn't have any idea where they were taken. He was, I think, at the Ural Mountain Astronomic Observatory in the Soviet Union,

but somehow he could smuggle these negatives to a friend at the Nikola[us] Copernicus Institute in Krakow, in Poland, and that guy got them to somebody in East Germany, and that guy got them to the Max Planck Institute [for Astrophysics] in Bochum, in West Germany, and that guy got them to me. He said, "This fellows wants to know where these pictures were taken."

I'd look at them and I'd determine where it was, and I would send them to a guy in Bochum in West Germany, and then they'd go back through the system. About four months later, back through the system would come a "thank you" to me. To this day I don't know who the guy was. I know he was in the Soviet Union and he wanted to know what was in these pictures. One of them he sent me was the first one we had of Tunguska, where that meteor went in 1908, into Siberia. They were flying far enough north, the Soviets were, because they launched farther north. He got that and others in certain areas.

So I don't know whether he was a geoscientist or whether he was a guy that was interested in meteorites or whether he is an astronomer or what, who he is or where he is or what he's doing today or whether he's still alive or anything. These pictures would come in. They were sort of strange. That was the first look I had of Soviet photography, because they were very, to this day, you know, don't let you see much photographs.

BERGEN: How did that compare to American space photography?

UNDERWOOD: The Americans' were in the public domain; anybody can get any picture they want, anytime they want. All they've got to do is request it, if we've got the budget money to make it for them.

BERGEN: Was the quality comparable?

UNDERWOOD: No, no. Well, you go to the Soviet Union, like on Apollo-Soyuz, the words "quality control" are not even in their dictionary. They have absolutely no concept of what you're talking about when you mention quality control. None whatsoever. It's like talking to a wall or talking to a three-year-old kid about atomic physics. And we're talking about quality control in a photographic process, which has been around since C.E.K. [Kenneth] Mees came up with it first in 1920, you know.

Another interesting one was on Apollo 8, where [William A.] Anders overexposed a roll of film by ten stops, and they were the first pass behind the Moon. It was a Super Royal XPAN ASA 10000 film. He exposed it at 64. The magazines were all coded and he put the wrong one on, because he told me when he was coming back from the Moon that he was tired, and put the wrong mag on. But when he was supposed to photograph these very unique things on the way home that scientists believed were in space and we worked out all the pointings and other information to record the Legrangian points, some people say there's a lot of dust and other things there, all these other, zero-gravity points between various things out there, and the human eye can't see them and from the Earth you couldn't see them because of the atmosphere. Out there, with ultra-fast film, if anything's there, you're going to see them. So he's ready to do the first experiment, the film's shot orbiting the Moon, overexposed, ten stops, eleven stops maybe.

So I guess it's two o'clock in the morning and they're on their way back from the Moon, first thing on the way back, and my phone rings and capcom says, "Hey, Bill Anders wants to talk to you."

So I hop on my bike in Nassau Bay, drive through the night into mission control, and Bill puts it, "What if I used a Super Royal XPAN like it was Plus X?"

I said, "There ain't no what-ifs. You done done it, because it's three o'clock in the morning here, you're 200,000 miles away. We talk what-ifs in meetings in the real live world. You've done done it."

He says, "Well, yes, I put the wrong mag on the pictures of the far side of the Moon," and all this. "What can you do?"

I said, "Well, you destroyed the latent image. We'll think about it, but thanks for telling us. Either we're going to process the roll of film in advance and know we're going to get one as clean as a window pane or we'll think about it."

Then the next day, brought it up with our photo scientist, who was a Ph.D. out of Rochester Institute of Technology, who had scholarships from [Eastman] Kodak [Company], and he said, "Yeah, I remember reading something like that when I was a student, of massive overexposure of film." Then we went to the Kodak research. They searched their papers. They went back into the early twenties' paper that C.E.K. Mees did when he was chief of research at Eastman. For about forty years he was chief of research. He's the father of color film, I'd say, and the father of quality control. Probably the number-one photographic genius in all of history.

Dr. Mees did it with a verichrome film, which doesn't record red very well. Your red Ozarka on that [cup], if I had verichrome took the picture, it looked like a clean cup, you know, "dead in the red," we used to say about verichromes. He did the same thing and ran some experiments with it, came up with some ideas and wrote, "No one will need this technique." Houston, we need the technique fifty years later, forty years later, forty-three years later, I guess. No, fifty years later.

What we did, we ran some experiments out of our aircraft at Ellington [Field] by vast overexposures, and we ended up we bleached the latent image in the film with a bleach of all the silver. Then we dissolved out all this bleached silver. So at that point you get a clear sheet of film, clear as that window pane. Then for a very, very long period of time we developed a molecular type of image that's in a photograph that you and I have never used because we don't have time to expose it. That went on for eight hours. Then we fixed, washed, and dried it. We got some grainy but magnificent pictures of the far side of the Moon at that point.

So we had to go back to the guy who'd ran an experiment five years before I was born, to have had him rescue us. A man from his grave rescued us at that period of time. So you don't want to turn your back on your predecessors in your profession. They've done some remarkable things. Those pictures exist today because of that.

During the whole process, you know, it's in the dark and Anders is in there. "What are you doing now?"

"Well, we're trying to save your butt at this point. We're not going to lose that roll of film. Thanks for telling us. If it had gone through the normal process without you telling us that night, it would have been totally destroyed. We wouldn't have had all these great pictures of the far side of the Moon from the first orbits of the far side of the Moon by human beings." So.

BERGEN: Shows how important communication is.

UNDERWOOD: Yes. And it exists today.

BERGEN: You were talking about working with Eastman Kodak. What was your relationship with them?

UNDERWOOD: A lot of trips to Rochester. [Laughter] In some horrible weather. Well, Bill Campbell [William S. Vaughn?], when he was the CEO [Chief Executive Officer], and Louis [K.] Eilers, who followed him, were very interested in what we were doing and told folks at Eastman Research and Eastman Development and through the whole system, "Work very closely with these folks in Houston, and anything they want done, do, and come up with new ideas, going into systems that we haven't released yet, even," maybe that we'll use in future film types that come along when there's a viable financial reason to improve film quality. If somebody's willing to buy film X, buy a billion dollars' worth a year, if you don't have a better film Y and release it, usually, until someone else might be beating on your door in Japan or somewhere.

So we had full access into the company and full access to the chairman of the board, and the chairman of the board loved those photographs. I used to even go up to Rochester afterwards, after a flight, with my slides, to show them to the board of directors and the managers and even, in the big auditorium, all the people that were involved in it at Rochester. Sometimes I'd do five programs a day in their big auditorium so everybody that worked at the company, practically, who wanted to see space photos could see what happened on these missions.

It worked out great. We had an absolutely perfect rapport with the company, its directors, its personnel, right on down to the people who made those films, you know. There was a tender loving care system from when they mixed the emulsions, when they checked the

base, put them on the base, checked the film, spooled it, gave us the cutting maps, where they came out of the master rolls. All the information was perfect. So we always had a good system working for us from that standpoint, and we'd have the best possible film and techniques to develop it.

The E6, which is their standard ektachrome process today, was a modification to the E4, which was the standard, which we called E5 and they market as E6, so they went E1, E2, E3, E4, E6. A lot of people wonder why they didn't use E5, and that was system for special aerial types of these films that we used and a few other people later used. So that worked out very, very well from that standpoint. It was just a delightful bunch of people to work with and know that they were going to deliver their very, very best to us and we didn't have to worry about some line in a contract or some other things. It was all done on telephones, you know, the whole thing, between people who wanted it to work. Other companies, people were looking at paragraph so and so in a contract and arguing it out for three months and other things would go on. We never had to put up with that at all, all the way through the system.

A lot of our NASA buddies who were in other systems said, "Boy, wish we could do this with XYZ aerospace corporations," and electronic corporations and all these other things, wish they had the rapport with them that we had with Eastman Kodak, because even though they weren't going to make any money, but in the long run they sell a lot of products which improves systems and say, "Our film took the first pictures on the Moon. Our film was always carried in space," and so on down the line.

But then when Apollo came along, they come up with this idea of "They're going to the Moon, to a strange place. They're going to bring back some bug and that bug's going to do in humanity. We don't want anything to come back that way." So they built Building 37, the

Lunar Receiving Lab [LRL]. Nothing came out of it, you know, for a month, nearly. They burnt the air they breathed. We had to have a photographer in there. But everybody wanted the film out, you know. Neil Armstrong's going to walk on the Moon. Everybody wants to see it tomorrow. We're saying, "Nuh-uh. When they come out, we'll get the film out a month from now. Then they'll see it." So this didn't set very well in Washington, because we don't want to fool around with that film.

Well, they then decided we would have to decontaminate the film or kill any of these bugs that might do in humanity and get the film out. Well, we started playing games with that, and everything we'd come up with would destroy the film because it was a pretty potent situation. You had to come up with something that would kill all these bugs that didn't exist in the first place on a film, and not destroy the film. This film wasn't designed to go through that sort of thing.

So they worked out systems and film was destroyed, other systems, and came up with better ideas, and finally came up with an autoclave using ethylene oxide, I guess it was, as a vapor at a given temperature. The film was okay, and they decided, "That's what we're going to do." So our guy in the lab would take the exposed undeveloped film, he would roll off the spool into a contact with the material that held it about this far apart, where gas could get in between equally through everything, and fans to blow it around for a fairly long period of time, and the film would get the full treatment of ethylene oxide and kill all these imaginary bugs. Terry [N.] Slezak was trained to do this. He's going to down in the room in there.

So when the film came back, Gene [Eugene G.] Edmonds and those guys off the aircraft got it back and got it to Ellington and brought it on down, it goes into the Building 37, of course, there's a series of NASA photographers taking historic pictures of all this going on. And we get

in there and then they've got the viewing room where astronauts would talk to people. You've got three sheets of glass between you and them, and the air they were breathing was burnt, and Terry's going to be in there for a month.

He opens the box and we want to look at it, and he picks up a magazine and he reads the serial number on it, brushes it, reads the serial number, and he puts it down, he's got moon dust all over his hands because you get this vacuum welding on the Moon, almost like iron filings on a magnet type of deal. He looks at his hand, and John [R.] Brinkman says to him, based on a very famous TV program at the time, he says, "Terry, in ten seconds you will self-destruct." So Terry was the first guy to be contaminated with moon dust. So that's his great claim to fame, one of his many claims to fame. But we all got a big laugh out of that, you know.

Well, while all this was going on and they're on their way back from the Moon and they're running the final tests in this equipment in Building 37, Fred Southard in the photo lab would run the tests and teach Terry and everything how it's going to work. He took this supposed Moon film, put it in the material, put it in this big container, shove it into the autoclave, turn the system on, go for a break. It's going to be a long period of time. Come back, open the door, pull it out, and the film has melted. And they're on their way back from the Moon. He comes over to the lab with this roll of film that's a clump of melted plastic at this point, and oh my God. [Laughter] Called the boss and everybody. "Hey, we have a glitch in the system."

So it just happened that they went over there and they realized that at one point in the system it dripped liquid ethylene oxide, drip, drip, drip, and it was the first time that he had shoved the roll in there and it would drip on the film. Any other time he had put it in the

autoclave in a different location and it came out clean and killed all the bugs that didn't exist. This time, by pure luck, he shoved it over there and melted the film.

So we then realized what was going on, so we called the guys in Building 9 over there, and they built us a stainless steel cover to put over it just in case it dripped anywhere else in the thing, and we marked it. "You're going to put the canister here," which is a long way from where it drips. We won't even worry about the drip. It drips and it evaporates on the stainless steel, unless there's film there and it melts the film. So that all worked out fine. But we had this umbrella built, stainless steel umbrella built, so that even if it did drip at any point in the system, there's no way it's going to get on the film, and readjusted the fans a bit so it would circulate the ethylene oxide through the system, and ran it for 1.4, the normal time we figured, and added time to it just in case.

Had Terry and Fred not put that thing in the corner, if we had done that with the original film, you'd be interviewing me a little differently today, or people would have been for the last thirty, "Why did the film melt? The first guy to the Moon." So that was an interesting time, too. A lot of interesting times in photography, even though it was just a small, small part of the NASA budget, one of those pictures worth a quarter, film, and people are spending billions for other things that often didn't work. Film always worked.

BERGEN: Tell us about the Apollo photographic instrument package that was used on Apollos 15, 16, and 17.

UNDERWOOD: You mean on the J flights?

BERGEN: Yes.

UNDERWOOD: Well, that was a U-2-type camera, an early-type U-2-type camera. In other words, the camera was twenty-five years old, I guess, at that point, and it took a photograph, it had a swinging optical system of catadyoptic [phonetic], folded optic [phonetic], and would photograph from horizon to horizon, and in certain areas they wanted these very, very detailed pictures of it all. It was programmed into the flight. You had a guy up there going around all the time anyway while the other two were down below, and it gave him some activity. It took these ultra long rolls of film.

First, of course, CIA [Central Intelligence Agency] and those people didn't want us to have access to those cameras, even though they were old and obsolete, and finally it was arranged to get the cameras. Then they didn't want us to have access to the film. So what good is the camera if you don't have any film? Then they finally got access to the film. Then you need a really big processor, a special processor, and they weren't about to get access to the processor. So the system was nil for earlier flights.

Then finally General [Frank A.] Bogart, I guess who was number-two or three guy at NASA Headquarters, knew the assistant chief of staff for intelligence in the Pentagon, and went to General Bogart and told him, "Hey, we've got to have a processor."

He said, "Well, I'll see what I can do about that."

You know, no point in modifying the spacecraft costing millions of dollars to put a system into that bay if you're not going to have all the units to do the work, because if we developed it, we didn't have the equipment. You'd have to cut it up in pieces, because this roll

of film, you know, is like a mile long, and develop it, and not in the type of system that it was designed to get the maximum amount of information out, and that's what scientists wanted.

So then I get a call from a guy at Hill Air Force Base in Ogden [Utah], and he says, "We're going to put a processor on a machine and send it down to you. Been ordered to by the Pentagon."

So I said, "No, no, no, I want to come to Utah. I want to look at it. I don't want something that's been through Vietnam."

He says, "This is brand new, never been used."

I said, "That's a $15,000 machine."

He says, "Yeah, I know. I hate to give it up." [Laughter] "But I've been told to."

I said, "Well, you load it on your C-135 and you bring it down to Ellington, if it's still in the original crates from when it was built."

Then we had to modify part of the building and actually kick some of the NASA clinic folks out of their area for a while, because we shared the main floor with part of them, put this big long machine in there. That's how we developed that film.

But they were spectacular and really detailed pictures. There were two cameras. There was also a standard mapping camera, modified mapping camera that took pictures of very high geometric precision, and the other camera from horizon to horizon took very high reconnaissance-type photographs. So you put the two together, you see what you're looking at. Then if you wanted to really measure in detail what you're looking at, you went to the other film to make precise measurements. So it was a good combination.

Of course, the one camera looks straight down and these machines never got very far out of an equatorial orbit, because they had to be to the landing sites, was the determining factor, so

a lot of pictures came back in the equatorial or near-equatorial orbit. This one north was 20-some degrees, I guess, or so from lunar equator. Then, of course, when they went, you'd usually have half or two-thirds of the far side of the Moon lit up, which was good, because nobody had been there before.

After the first flight, scientists wanted more, and it just went on. The last three flights, we got great photographs. Then someone would have to go outside on their way back and rescue the film and pull the magazines, and there are great picture of Ron [Ronald E.] Evans on the last flight, pulling magazines. Jack Schmitt got in the open hatch, taking the pictures of Ron pulling them out and handing them back in, and they'd bolt them to the floor of the machine for the entry. But they were great.

Then Ron and others would occasionally tip it up and look at the lunar horizon. I forget whether it was 15, 16, or 17, where you got an Earth rise. Each picture, you know, is six foot long, and you've got these pictures of that Earth coming up, just spectacular of that, instead of looking down. So they were of very great value to scientists, in my opinion, or even today if you're interested in the Moon.

Unfortunately, we couldn't go polar. I don't know, I think if we hadn't cut the program off, but maybe by 19 or 20, had we had those flights that had gone polar, we'd have got the whole Moon, which would have been of much, much greater value, just the way going polar would get the whole Earth, but they abandoned that pad at Vandenberg [California] and spent all that money for nothing, and don't go polar. To me, why this space station is not a polar orbit, to me is one of the great tragedies of the 20th century. Well, it will be the 21st century starting in seventy-something days. So probably the number-one tragedy of the 21st century will be that the space station isn't in polar orbit. It's in ridiculous orbit.

BERGEN: You mentioned lunar mapping. Were you involved in the early lunar mapping in determining the landing sites?

UNDERWOOD: I got involved in the Lunar Orbiter even before we went to the Moon, to determine where to land and all that. The mapping was done usually through the Geological Survey and Army Map Service, Corps of Engineers, who I worked for and knew all the people there, because most of them then who were getting into management positions were guys that I worked with there when we were GS-7s and GS-9s working all over the world together. We were all out of universities either in 1950 or '51, and down to this day we're still in close contact because we all worked all over the world, all married foreigners. We all got in trouble because of that.

Whenever we have a get-together in San Antonio [Texas], where the Inter-American Geodetic Survey moved to and a lot of guys retired there, the guys are all Americans and the women are from all over the world, the wives are, you know. So it works out pretty good from that standpoint. You wonder about it sometimes when these countries would be in conflict with each other, if the women were going to talk to each other and that sort of thing. You know, wives. I remember during the famous Honduran-El Salvador Soccer War, my wife's Honduran, a very good friend of mine married a Salvadorian girl, and they became close friends. I went over there and they were going to have a meeting, the war's going on, and they get together and they look at each other and give each other a big embrace at that point. So something beyond the Soccer War, the work of their husbands in aerial photography was far more important,

photographing the world. It's that way even down to today, though we're all in our seventies now.

The early days of aerial photography worked out good from that standpoint into the lunar system. Then back when I got loaned to what became NASA there one time, we used photography taken through Earthbound telescopes of the Moon, taken in various locations over a period of 100 years, nearly, at that point. The Moon vibrates and tips and tilts, so we got maximum that way. Then we'd get the photogrammetry so we could make contour maps back in Army Map Service. Corps of Engineers would make contour maps for NASA, before we put the satellites around the Moon and anything had gone to the Moon. So we had a close working relationship with the Army Engineers, the Defense Mapping Agency, it later became, pulled it out of Engineers. They were the best people at mapping, and then Geological Survey people knew an awful lot about lunar activity. That's Gene [Eugene M.] Shoemaker. Of course, we're close with Gene, and Elliot Morris [phonetic] and a few others that were at [the United States Geological Survey, USGS in] Flagstaff [Arizona], and they got involved in astronaut training and what have you. So we always had a close relationship with those people.

We used Flagstaff telescopes often to check the accuracy of the lenses in these cameras, because we could photograph stars and we knew exactly where the stars were. You could see if there was any distortion in lenses or mechanics of the system or what have you. That was at Flagstaff. The aerial cameras were always tested at Phoenix [Arizona], because Phoenix is the most closely controlled geodetic area on the planet, because the Salt River Project came along to build the great dams out there during the depression, and to keep geodesists working, they had a program where they would put a first-order station every section, intersection. Usually they're thirty, forty miles apart. In Phoenix Salt River Basin they're a mile apart.

So if you flew an airplane over it with an aerial camera, if there was any distortion caused by the airplane, if it had a window to look through or something in the camera, you could immediately know down to the micron something was wrong. We tested all our equipment over there, too, from that standpoint. The U-2, we flew them out of Groom Lake [New Mexico], or what they now call Area 51 at NACA [National Advisory Committee for Aeronautics] we had on them, 301, 302, 303, the first three, but we did the work over at Phoenix. They had to fly south to Phoenix to make sure the U-2 cameras and what have you, particularly the—I was only involved with their mapping cameras in the U-2s, never involved in intelligence cameras.

That worked out, using the telescopes. And our relationship with Geological Survey in Denver, we could check every lens, make sure the lens in the system was going to work property, no distortion in the system of any type. Then that would be recorded data, and if somebody made a print and you knew the exact measurements in the original and with the cross hairs, which were a centimeter apart, plus or minus a micron, on the lunar film you could then reconstruct something in anything you had, as long as you had two crosses, to perfect geometric positioning. That's why we built that lens and put it in the camera, because nobody can go back with a tape measure. [Laughter] It worked out pretty well.

It was a very informal system, which made it great for everybody involved, I think. There was no strict reading of contracts, and the people that worked together were that way. Even going back with McDonnell [Aircraft Company], I remember they wanted to carry an ultraviolet experiment. I guess it was on [Gemini] X. No, XI, Gemini XI. It was a last-minute deal and we had the equipment to do what we wanted to do, and I called Paul Backer [phonetic] at McDonnell in St. Louis and tell him what we want to do. On the telephone call he says,

"Look. I'll get on an airplane tomorrow morning for Melbourne [Australia] and you get on one from Houston, and I'll pick you up, and driving up to the Cape we'll talk this over."

So we immediately figured out where we could store the lens and the filter for ultraviolet photograph, and where we'd have to cut some foam in one of the storage areas, put the lens in, paint blue around it, seeing as it's ultraviolet, store the filter, change the astronauts' flight plan data so we knew where it was, put the pages in the flight plan for the experiment and how it could be done, and the time to be done, and the angle, pointing angles to look out the window and take the pictures of what to him looked like nothing out there, like taking a picture of a wall. But it's certainly ultraviolet information, you know. And came on back.

It was all done informally, two round-trip tickets, one from St. Louis [Missouri] and one to Houston, to the Cape and back, a day at the Cape, it was all done. Nobody saying, "Let's look at—" like when we want to do it on Apollo, on 7, you know, North American [Rockwell Corporation] was quite different in their approach to things, because they had built military airplanes and everything was done by spec and contract and modifications to the contract. We were going to put it on the one that burnt up, so that changed the plan, too. But that's the way it worked. It was very informal.

I think it was the most informal part of NASA, was photography, and working relationship with everybody, camera manufacturers, film manufacturers, shutter manufacturers, right on down the line, it was a very informal working relationship between Jeff Brimmer [phonetic] and Reagan and Thompson and all the other people that were involved in various areas, you know. Mine was, of course, in the photo end of it, what came out of the photos, while other people were involved in the building of the machine, the testing of the machine. But they all had to interface, so I got involved with those people and the crews. They wanted good

photography. That's what I used to tell them, you know, "That's your key to immortality." [Laughter]

BERGEN: We're running out of tape now, so if we could take a break. [Tape change]

Okay. I was wondering if you would share with us your perspectives on Skylab and how that was a change in space photography from Apollo.

UNDERWOOD: Yes. The main thing was the long durations of the flights and the fact that they were in a high inclination. So it opened up a whole new world. A lot of scientists want a lot of things done and programmed a lot of things in. We had a six-lens camera on there to look at the electromagnetic spectrum. We had four black and whites and we had a color infrared and normal color, and with the black and whites in there, you could create a color situation you wanted to withdraw information from systems. So it was rather important from that standpoint. With the long duration, you would probably get more opportunity to do certain areas because you could wait for weather.

We had a crew that really wanted to do it, plus we had other camera equipment. And then they had the handheld, these two, so they could do things on the spur of the moment, look at things, record what was going on. We also had the 35-mill [millimeter camera] on board so they could record very well what was going on inside, and they could also use a flash, which you couldn't do before. So there was a much better total documentation of what was doing on, and they all knew what had happened before that, what they couldn't do and what they could do in their photographing experiments and all the "gee whiz" stuff floating around and other things. So they brought back a superb group of photos.

The second team, of course, got a chance to see what the first ones did, and certain scientists wanted repeats of certain Earth-looking photographies at that point, and that could be worked in.

Then the third team was gone for eighty-some days, so that worked even on top of that. They could carry longer, more film, and the problem became pretty much radiation effects on long-duration flights with very thin walls in spacecraft. Of course, we had that lead-lined vault on there, which a lot of people objected to because it was weight. A lot of people felt that amount of weight could be used for other scientific experiments in their particular bailiwick that they thought were more important, so there was a lot of conflict in some areas for a while, in certain areas. But they also, with the long duration, repeated on the same flight certain areas, to get it eighteen days apart, I guess, sort of thing.

And crews that really wanted to do the work but were going to get a lot of radiation and so was the film. We were monitoring it back here to see what we would have to do to modify the process to get the optimum data out of the film.

BERGEN: So it changed your equipment you had to send up there and then what you had to do when you got it back.

UNDERWOOD: Yes, and we were going to get a certain amount of graininess to the film and color change due to the three emulsions react differently to radiation. If you look at what came back from the long flights with Shannon Lucid, you wonder whether that was cruel and unusual punishment to keep her out there that long. It was, you know, pure and simple. There's nobody that can say it wasn't. You look at the films, you can see what happened to the films. And she's

getting the same amount of radiation, you know. I'd say Shannon got the same amount of radiation as probably 100,000 X-rays. But I don't know what the tradeoff was. In space station you don't need long-duration flights. And nobody's going to Mars, so you don't have to worry about that.

BERGEN: Not yet.

UNDERWOOD: So, yes, the information brought back looking at the Earth from Skylab was monumental compared to other things. Also it was in the public domain, so that was the first time you could tell the world that the Soviet Union was a basket case. You had pictures to prove it. And the Soviets were saying, "That's American propaganda. You're putting the dirty air in the pictures. You're putting the dirty water in the pictures by mechanical means. Our cities are clean. Our streams are clean." You know, at that point we realized that probably the greatest tragedy in human history was the Union of Soviet Socialist Republics. I mean, the tradeoffs of what they do for political system, unbelievable, you know. One, they stood 45 million people against the wall and intentionally killed 45 million of their own citizens. Now, what level of humanity are they at? And it hasn't changed. So you realize what was going on in that country and could release the pictures at that point, because they went 60 North [latitude].

BERGEN: Speaking of the Soviet Union, what type of involvement did you have with ASTP [Apollo-Soyuz Test Project]?

UNDERWOOD: With the Apollo-Soyuz?

BERGEN: Yes.

UNDERWOOD: Well, mainly it was the fact that they really didn't know much about photography and they knew nothing about quality control. Of course, they were supposed to release to the U.S. everything they took within a month after they got back, and they got back before we did and they never released anything, to this day. Well, they released a few certain pictures they released to the world, but the treaty obligation has never been met. We released everything to them and ours was superb stuff. It was a unique relationship from that standpoint. I guess there are still people in Moscow who might be shot for bringing it up and continuing to bring it up over the last twenty-five years or more.

Pictures of the Earth. They didn't have better systems than we had. They had a lousy process system. They used lousy film. When you talk quality control, they got their film out of a bin in an area like you and I would get nuts and bolts. You can ten, you pull out ten. You checked them over when they looked at it, they weren't the same emulsion. Some of them had already expired film dates, this sort of thing. And they're going out on a spacecraft. Ours were rigorously checked from the moment it was coated on the emulsion and controlled temperature, humidity, everything till it went on the spacecraft, and kept track of when it was beyond control. They had no idea what we were talking about when we talked about that sort of thing. Then, of course, we didn't get their pictures. So it's an interesting world and still is.

BERGEN: After ASTP was Shuttle, of course. Plans for Shuttle started long before then. How did the Shuttle Program affect your area of space photography?

UNDERWOOD: Well, we had the big machines and plenty of room, but it's a busy piece of equipment. The early flights, you had two guys on the first few, but they still found time to do photography. They didn't have good windows, and that sort of pushed us out of shape, because we had all those years to put good windows in, between the end of Apollo or Skylab and the first Shuttle. We had six and a half years of nothing, other than ASTP, and that was nothing but politics.

To this day, I feel we should have had optical-quality windows for them to look through, look at the Earth. They spent all those billions building that machine and weren't willing to spend the money to put a decent window in. At least one overhead should have been that way and one front window should have been that way, in z-local vertical, and one cargo-bay-looking window should have been that way, with quality to transmit all the light and the flat mode.

But pictures came back. They became, after a while, rather repetitive, because the things just flew the same system pretty much over and over and over again. I keep wondering, when I look at them, all about the politics of it all. We didn't mention a lot of things back in the early days, and a lot of things aren't mentioned today, but why are there no pictures taken on all these flights of the Soviet Union? They spend half their time over the Soviet Union. Why are there none taken of China? There's some interesting areas of China on the development of this planet that have never been photographed. Only certain areas of this planet are being photographed from space today, and yet it's all in the public domain and they say, "Oh, we're too busy." You're always too busy when you're over China. You're always too busy when you're over the Soviet Union. You're always too busy when you're over Iraq, Iran, Afghanistan, India, Pakistan.

I know the flight plans, how they work. So it's interesting from that standpoint. So the world isn't learning anything about these areas, from that standpoint. So I wonder about that when they roll the stuff. Two ways: the pictures either don't exist or the picture's not released. That's a violation of NASA's charter. But they got the better satellites up there to look at these other areas.

The general picture that's taken with the camera are of value to people who are not in the intelligence business, and these aren't of any value to them anymore. They're of value to people who want to know how the world fits together and what changes are going on, what's going on. Is global warming the fact that there are 7 billion people now and generating energy, or is it a natural cycle? I think it's a natural cycle, with the natural cycle being like this and what's going on being like this. That's my opinion, looking at a million of these photographs. But they're not getting data in certain areas to prove it.

Here you've got the most massive engineering project in human history going on, the Three Gorge Reservoir in China. Not a single picture. And who the hell is running that operation over there? Can't they even read a newspaper? You know. Not a single picture. We've known for fifteen years what they're going to do. And it isn't what they say they're going to do, you know, because the engineering of what they're going to do and what they say they're going to do are two ends of a spectrum. So what they release is trash and everybody believes it. Even people at Smithsonian [Institution, Washington, DC] believe it. I did a program recently with Discovery Channel. They believe it. I say it's garbage, you know. What they're building and what they're doing is not intended use of the project.

So with modern space photography I wonder what is going on and why, since I left. I was for the first twenty-five you know. They've done seventy-five since then.

BERGEN: You mentioned that now we're using satellites probably for a lot of those things. From your perspective in space photography, what's the value of humans in space versus just taking pictures.

UNDERWOOD: Humans in space from space photography?

BERGEN: Yes.

UNDERWOOD: They make a mental decision to do something. It's not programmed three years in advance at MIT [Massachusetts Institute of Technology, Cambridge, Massachusetts] or Caltech [California Institute of Technology, Pasadena, California] through a machine. They see something and they say, "Gee, we ought to get a picture of that." An automatic system that's programmed years in advance, one doesn't see it, it doesn't take the picture of that, that point of view. They put the brain to work if they've been properly trained to put the brain to work. And I wonder about that sometimes. I don't know what the relationship is between the people there. I'm not privy to it anymore, and really don't want to be. I like to look at the pictures that come back, like I keep saying.

I was at Cape Horn [South America] last March. We don't have any good pictures of the Cape Horn area. The finest weather in forty years when I was there. There was a spacecraft up there in a high-inclination orbit that could photograph southern South American Cape Horn, and the tie between there and the Antarctica. Not a single picture. Who's in mission control telling these people what's going on about the planet? And why aren't they telling them? And why

aren't the pictures being taken? It's the same old simple Earth we looked at in Gemini days with rudimentary satellites with Kent Nagler [phonetic] and other people from the Weather Bureau or NOAA [National Oceanic and Atmospheric Administration], it's called now. We worked together very closely, and Solz [phonetic] and others. They'd be on the telephone from Suitland, Maryland, "Hey, hey, three orbits from now they're going to be near this sort of thing. We've seen it on a satellite. We think it's neat. You might not realize it. What we want is neat and different." But we do. Tell them.

So that's my viewpoint on it today. I have a rather hostile viewpoint on what they're doing today and why they're doing it or even if they're doing it. When I can look at a weather satellite and say, "Hey, this spacecraft is up there, there's one up there now, there's a certain thing they ought to be photographing," and I know that 99 percent of the time they're not going to take a picture of it. Well, I know there are scientists around the world that would love a picture of it. So I'm wondering about the continued value of it.

They keep going 51 degrees [latitude] now, that puts them fairly far north, but they're not photographing that part of the Earth in that area. 51 is not far. It should have gone polar. The full system should have gone polar. And the Soviets picked the orbit, 51 degrees, and you've got a whole planet out there. It doesn't go to Moscow, doesn't go over a lot of the world's capitals, doesn't go over half of Europe, most of Siberia. Doesn't go over Canada. Then the other way, 51 South, what do you cover? A good part of the southern South America. You go to Cape Town [South Africa], you go south of Australia, but you don't learn anything about the Antarctic, you don't learn anything about the Arctic. What's really going on in global warming and ice melting and all these things isn't going to be available.

BERGEN: Looking back over your career with NASA, what are you most proud of?

UNDERWOOD: Most proud of? In my own?

BERGEN: Yes.

UNDERWOOD: Well, I guess the fact that I was involved in the Apollo Project and very closely with those who used the camera to bring back the pictures, and being the first human being to see them. Like on [Apollo] 17, you know that one full Earth? More people have seen that photo than any in the history of mankind, and I saw it first. I was the first person to see that photograph. It was wet in a processor in Building 8. When I saw it, I said, "Boy, that's it," and it was on 17, the last flight, because they went at night and went translunar over Madagascar so they had a full-lit Earth because of where they were headed for on the Moon. It was the only circumstance that brought that picture.

And the fact that I kept telling Jack Schmitt, who was a geologist, "That will be the classic picture. Make sure you get it after you go translunar," you know, and Jack worked it into his schedule and got the series of them, because that one's at 28,000 miles. That's a perfect picture and he aimed it beautifully.

But the lunar, because that was the goal at that point. It was the last goal that Americans had. After it was all over, Walt[er] Cronkite said this is a goal-oriented country and that when the nation began, we were 3 million people spread out from Maine to Georgia, a little narrow band along the East Coast, and fifty years later, Americans were standing on the shores of the Pacific, a continent away, and the next fifty years, we inhabited a continent and nobody had ever

done that before and nobody will ever do that again. And he said, "It's those people down in Houston, Texas, they were the last Americans with a definitive goal," and we achieved that goal thirty-one years ago. And there's been no goal since then, you know. This camera made it so that the whole world can see that goal.

So that's the way I've always felt about it. That's part of a generation of Americans that was born in the Roaring Twenties, as they were called, child of the Great Depression, saw some horrible things, yanked into a war at the age of sixteen, you know, at that point, got that GI Bill, educated, came to a changing nation after the war with an education. Learned a trade that NASA could use and got to them because I married a foreigner. You know? And what came out of this camera and working with the people that took the pictures, and still knowing them, where they are, have got their phone numbers at home. They call me every now and then, those that are still alive.

Being part of it, that was tops. Nobody else could, because these are the key to immortality and the key to immortality of the space program and the key to immortality of the second half of the 20th century, maybe. All through, they modified. Good camera to do a specific job. Seen a lot of changes. Well, it's anodized, so it won't reflect, doesn't have a viewfinder. People think that makes it cheap. They had to aim it properly. Big magazines so they wouldn't have to worry about changing them. Thin film, big thing to change them. Do it quick, electric, don't have to wind cranks or anything. Big tabs so they can adjust. Big button. Those space suits, you know. Not a little button hidden somewhere to take the picture. They never had to change lenses except when they were inside the spacecraft in zero G and this atmosphere, sleeve atmosphere. They could do it very easily. Didn't have to worry about it when they were in a space suit.

Just certain modifications by people just telling [Fritz] Victor Hasselblad one day, "If you do these, your camera will be on the Moon." And that was his motivation. Of course, we showed him. He was one of the first people to see the pictures, not because he had anything to do with NASA other than his engineers building the camera, but he wanted to see them when he came to Houston. That night we showed them to him and a few other people, you know, that were down here at the time, Mr. [James E.] Webb and Bob Gilruth and all the folks here and others.

Then what was unique from that standpoint, we showed them the crew over there, the ones they were interested in. We had the big glass slides at that point. This project had gone on and I had been at work, I guess about forty hours, and it was in the morning and I realized that thirty-nine people had seen pictures of someone walking on the Moon, mainly in Building 37 and Building 8, the only place people had seen them, some as film, some as projections in Building 37.

And I cut the glass slides and I got the big glass slide projector, which weighed about fifty pounds, and I brought it on home. I wanted the first people outside that gate to see someone walking on the Moon would be my children and my wife. I walked in the door of the house and my kids are having breakfast, and my eldest son, who's now a banker in New York, turns to his brothers and sisters and said, "Ah-oh, Dad's going to show us some more of that junk from space." [Laughter] So that's the generation gap. So that was the way it worked. But they got to see them before anybody else did, before even PAO.

BERGEN: What a privilege.

UNDERWOOD: Yes. "Junk from space."

BERGEN: Having been in a generation too young to remember going to the Moon, I appreciate those pictures.

UNDERWOOD: I guess the people you talk to, you've seen that difference in the atmosphere in the Center, in the people, in always carrying that goal up here. "I've got to do it right. Someone's going to take it to the Moon."

BERGEN: How do you feel now about all these pictures from space being on the Internet?

UNDERWOOD: Being on the Internet? I think that's great. I have a son who's a computer engineer and I've got a daughter who's a computer engineer. She has a big job at Dell now, but she did an internship here and IBM here, and so did Rob. He was IBM here. But NASA doesn't pay them anything, you know. No one can earn $200,000 a year at NASA, and here some thirty-year-old kids are earning $200,000 a year now.

Rob says, "You've got to get a new computer, Dad, because you can have access to those pictures faster." And all that. The one I got was a 486 DX that could compete with mission control when we went to the Moon, and it's absolutely totally, you know, school kids won't even look at it today, but I can sit there, get the thing, go out and have a soda pop, come back and got the picture. I'm traveling so much, that's why I haven't updated it, but I'll do that. For 500 bucks I can get 100 times the capacity or 1,000 times the capacity I have on that machine.

Yes, I think it's great people can have them. There's some flaws in the system, though, for certain things. You want a picture of London, first picture of London comes up, a lousy picture. Second picture of London comes up. Lousy. Thirty-ninth picture of London is a good picture, outstanding picture. So having access to the system is a little different, and to me, when I want to know what's going on, I go over to Building 224 and roll the film. I can see everything leading up to a picture and beyond it.

And also when I put a glass on there, I'm looking at 200 lines per millimeter or 100 million pixels, you know. If you put a glass on what comes off the Internet, you see a bunch of little dots. You have no idea what they mean. Because people are used to a television screen and they're used to the resolution of a television screen or they're used to the resolution of a paper print. They're not looking at 200 lines per millimeter; they're looking at 15 lines per millimeter. And they're happy. But you can't see airplanes flying like you do when you put a glass on the original film or boat wakes or these fine detail, but at least they're there. I think scientists then hopefully can still get in the system and get copies from a master as a transparency if they need them, but they try to get away from that. They want quick, dirty, cheap, is the real NASA mission.

BERGEN: Is there anything else that you would like to share with us that maybe I haven't asked you?

UNDERWOOD: I think we've looked at pretty much everything from that standpoint. Yes, they're on the Internet and they're available to those that want them. I guess that's the end goal at this point, and hopefully it will continue to be that way and there won't be hackers out that are going

to screw up the Internet and NASA decides it's too costly to make them available to everybody and start restricting them. But to go back through everything, there's a wealth of information there. I don't know how many people on the Internet look at the lunar stuff and the development of the system, but it's all there for them if they want to do it, and look at change over the last nearly forty years from [Alan B.] Shepard's first ride in [19]'61. Nearly half a century's gone by.

I still feel it here when I look at Mercury pictures and what happened, the changes and the potential that perhaps wasn't realized because of the interface with the Defense Department and their paranoia. When I had a general tell me I knew too much about a U-2 and then wasn't needed anymore, I said, "Don't you think those Soviets know something about a U-2?" You see, they're not very bright, but they're not stupid. But that was the paranoia. It was at the end of the [Joseph R.] McCarthy era, you know, so it was a different world at that point.

But it got me into NASA, or what became NASA, so from that standpoint it worked out good. I would hate to have spent the rest of my career in Washington or something like that. We always said in Washington we existed as a family; when we came to Texas, we lived. That was the difference. And that great university [University of Texas] in Austin took great care of my five kids, which I don't think could have been done in Maryland.

So all done in serendipity, you know, knowing as a naval officer more about photogrammetry and what have you and the Army needed it, and getting loaned to the Army and staying with them, getting loaned to what became NASA through NACA, and NASA, and coming down here when this place started. Certain people saw the work I did through Langley, and then getting, through Bob Gilruth, into working with the astronauts and not worrying about the operation of the laboratory and that sort of thing. Once we got the Earth Resources Program going, someone else worried about the laboratory.

BERGEN: We sure appreciate you sharing your contributions with us.

UNDERWOOD: I'm glad you have it now. All of us, when we get together for a pizza or something about three or four times a year, always say, "You know, what will the people in the future know about what's going on, what happened and why it happened and how this unique group of people worked together?"

BERGEN: We on this project have had a real privilege of getting to learn about that, and it's definitely been a privilege.

UNDERWOOD: And you look back, like at Apollo 13 where there were battlegrounds and how to safe that spacecraft and wondering if this guy's opinion had prevailed over that guy's, would they have come home and so on. But we had a guy that always made the right decision, or it turned out that way, you know, Gene [Eugene F.] Kranz, a natural-born leader. Gilruth, natural-born leader. The top were naturally born leaders. When you get up in the morning, you wanted to work for them. I don't see that today.

BERGEN: I think you had something very special then.

UNDERWOOD: Yes, and it had never been done before, so it was something new. So no one could tell you, "We used to do it this way." [Laughter] I don't know whether that's the problem

in building automobile tires today or what, but, you know, it hadn't been done before. So we pretty much set it up what we thought would work best, and the results proved it out.

BERGEN: And we're thankful that you made sure that we have good pictures to remember it by.

UNDERWOOD: It's like when they made the movie of Apollo 13, you know, I went out to California, talked to the people who were going to finance it, not the people who were going to make it, and I had all the copies of the originals. I said, "You can't make a movie on Apollo 13. Nothing much happened on Apollo 13. It all happened in Mission Control Center." So there are people who don't talk to each other today because of what happened in Mission Control Center, over arguments, I mean heated arguments, on how to do things. We were sitting there listening to them sometimes, because photography got involved to record certain things. So they put the action in the spacecraft, which made a good movie, but the argument happened on the ground. I said, "It would be like watching the paint dry, a movie of what really happened on the spacecraft. 'Hey, man, throw that switch.'"

We set the data up on how to use the camera with the long lens to photograph the service module. In the movie they're oohing and aahing it like looking over the edge of Grand Canyon, you know. You only saw it for a short period of time. That thing was rotating in one axis, rotating in another, and they've got to set the platform for an entry, you know. But it made a good movie. But you sit there saying to yourself, "Didn't happen that way. Didn't happen that way." [Laughter]

Good. Well, great. We've shot two hours.

[End of interview]