ORAL HISTORY TRANSCRIPT

KENNETH S. KLEINKNECHT
INTERVIEWED BY CAROL BUTLER
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BUTLER: Today is September 10, 1998. This is an interview with Kenny Kleinknecht for the Johnson Space Center Oral History Project. The interview is being conducted in Littleton, Colorado, by Carol Butler.

Thank you for agreeing to talk with me today. I greatly appreciate it. We'll begin, if it's all right with you, back when you first became a part of working with NACA [National Advisory Committee for Aeronautics]. If you could tell me a little bit about what your job included, the different projects you worked on.

KLEINKNECHT: I started in Cleveland, Ohio, at Lewis Research Center—I guess at that time it was the Aircraft Engine Research Center—in December of 1942. We were then doing cooling work on airplane engines for the military, the B-29, the P-47, the P-51, and then we got into icing research. We had a B-25 with de-icing equipment on it, and a B-24. When everybody else with any sense was on the ground, we were out searching for ice.

I wasn't a pilot. I was just an engineer. We did flight tests on the first U.S. jet airplane, a Bell P-59. In 1951, I transferred to Edwards. That was [the] High-Speed Flight Station. There I was very fortunate, as I have been throughout my whole career, but I worked with all of the research airplanes, the X-1, X-2, X-3, X-4, X-5, X-15, the Douglas Sky Streak, the Douglas Sky Rocket, XF-92 [and others]. Then I left Edwards in October of—I don't

remember what year it was now, 1959, and went to Langley. I can't even remember what they called the Mercury Project then.

At the time I thought that, well, it's a good step to get back to Washington, which was my home, because at that time the Space Task Group, the Mercury Project, was supposed to eventually wind up at Goddard in Maryland. Then along came one of the best political supporters NASA has ever had, Lyndon Johnson, he and I think it was Congressman [Robert S.] Kerr from Oklahoma decided NASA ought to have something in the Southwest, so we wound up in Houston, which was the last place I had ever thought I would live. I had always heard about the big-talkin', full-of-hot-air Texans, and having lived in California, they didn't have any use at all for Texans, but we were very pleasantly surprised when we went to Houston. They did everything for us they said they would do. and even more. I think they're the friendliest people of any place where we've lived.

BUTLER: When you did go in, then, to work with the Mercury Program, how did your background experience with all high-speed aircraft and testing help you in the Mercury Program?

KLEINKNECHT: Well, of course, we had had the X-1, X-2, Douglas Sky Rocket, which were manned rocket research airplanes, so we had the experience with rockets and with operations of research or advanced airplane.

BUTLER: Moving into the Mercury Program, what were you initial responsibilities working with Bob [Dr. Robert R.] Gilruth?

KLEINKNECHT: I was a technical assistant to Bob Gilruth when I originally went there, and worked very closely with Walt [Walter C.] Williams, who had moved just a month before I did, and he asked me to come back there. So I was mainly a technical advisor to try to apply and interject my experience into the Mercury Program. Of course, at that time there wasn't much hardware. We still had a long way to go. I don't remember what year it was, I guess about 19[62], I became manager of Mercury Project. It wasn't called a program.

BUTLER: When you became manager or slightly before that, you were involved with establishing some of the facilities and procedures used for the program at Cape Canaveral?

KLEINKNECHT: Well, as a matter of fact, the leader down there at that time was [G.] Merritt Preston, who I had worked for in Cleveland in the forties, and Scotty [Scott H.] Simpkinson was there. In fact, the nucleus of the people that went to the Cape were from the Lewis Research Center in Cleveland, and I knew most of them, so we could sit down and talk and exchange ideas, but the program was altogether different then.

At that time they built and tested the Mercury in St. Louis and then sent it to Cape Kennedy, and they tore it all apart and changed it and put it back together and tested it again. It was completely controlled and run, really, by engineering. At that time there wasn't any politics, fortunately. We may have still been trying to get it in the air if there had been politics involved like today. All those people from Cleveland had also had experience in operating, testing, check-out, and operating advanced aircraft. They did some research on ramjets and small missiles that they dropped from the B-29 on Wallops Island.

BUTLER: That was before the Mercury Program, the B-29 tests?

KLEINKNECHT: Yes.

BUTLER: While you were working on the Mercury Program and while everything was being put in order and the procedures while they were doing the tests on the capsule, then it was time for the first flight, MR-1, Mercury Redstone 1. You were involved in the decision as to whether it was flight-ready. Then, of course, when the launch came, there were a few little difficulties in that the rocket didn't actually go up, but the capsule continued its procedure as well. What do you remember about that particular flight, and what was learned from that?

KLEINKNECHT: Well, to say the least, it was a surprise. The Redstone ignited and lifted off, I think, one and a half inches. When it lifted off, it automatically shut down Redstone, which, fortunately, settled back down upright, and as far as the Mercury spacecraft was concerned, it had flown into space. The booster had shut down, as it was supposed to, and the escape tower was jettisoned. The spacecraft thought it was through its mission. It was back down to—I don't remember what it was, 100,000 feet or something like that, and said it was back in the atmosphere and jettisoned the attitude reaction control propellants and threw out the parachutes.

Of course, the rocket was sitting there, still completely fueled and pressurized, which was a very dangerous situation. No one really knew at that time what had happened or what could happen. Of course, they knew that it could blow up. So the critical thing, where do we go from here, how do we deactivate or safe the Redstone? There were suggestions all the

way from shooting holes in the tanks to depressurize them, to going up on the gantry and trying to find out what the status of everything was. Of course, that's what finally happened.

We learned that a lot of things are automatically sequenced during the mission. We found that what had occurred was we called a relay race in this sequence, the relay worked a little faster than it had in the past, and that's what shut it down. So there was a lot of analysis on the sequencing and time intervals and so forth. Fortunately, that was the last time that ever occurred.

BUTLER: That must have been, like you said, a surprising sight to see that rocket just sit there and the capsule go on and do its job.

KLEINKNECHT: The Mercury spacecraft—it was called a capsule at that time, and we always tried to get it changed to a spacecraft, and before the end of the program, most people were calling it a spacecraft, but nowadays they still go back and call it a capsule. There were other names like "man in a can." There was an MIS, and I can't remember what that stood for—"man in space" I guess. Some people said, "Well, this is going to be a MIS," but that didn't happen either. But anyway, the capsule had performed exactly as it was supposed to have. Of course, that made us feel good.

BUTLER: Sure. Absolutely. And after that, there was a couple other unmanned tests, including some with the chimpanzees.

KLEINKNECHT: Yes. I don't remember much about those, except I think they were unnecessary. It turns out before Al [Alan B.] Shepard's [Jr.] flight, the medical profession got very deeply involved, and they were looking for all kinds of reasons why we shouldn't fly. In fact, it was questionable for a while whether we would fly. Ironically, Joe [Joseph A.] Walker had before that time flown the X-15 on a very similar trajectory to what Al Shepard's was going to be, and he didn't have any trouble with weightlessness. X-15, there was nothing automatic about it; it was all manually controlled or even nothing controlled from the ground, by the pilot, and he did everything he was supposed to. In some interviews some of the doctors would ask Joe, "Well, how do you know you didn't pass out while you were up there?"

He says, "Well, I'm back here, aren't I?" [Laughter]

Joe was a very good friend of mine. We worked together in Cleveland, and then he went out to Edwards, I think, just two or three weeks after we went out there.

BUTLER: It must be interesting to look at a comparison between the Mercury spacecraft and those rocket planes like the X-15. I know there's been some discussion about if they had pursued the rocket plane-type Programs such as the X-15 and the Dyna-Soar, that we might have gone in a completely different direction with the space program. Do you have any thoughts on that?

KLEINKNECHT: Well, I don't think we would have gone in a different direction unless you consider winged vehicles a different direction than ballistic bodies, but that was one of the things that Walt Williams and I, when we were in California, weren't sure that the ballistic body was the way to go; it should be a winged body. Of course, the Dyna-Soar was under way, and I

don't know whether we would have had a space shuttle or a space station any sooner if we had gone that way.

A lifting body, the X-24, there were two or three of them, Martin built one, were always proposed. When the Mercury contract was awarded, I wasn't involved, so I didn't know, but all the programs after that, one company or another proposed a lifting body similar to the X-2[4], and that never happened until recently. I think the X-38 is a lifting body. That bothers me, because the pilot can't see anything.

BUTLER: That is kind of different.

KLEINKNECHT: It's sort of a cross, hybrid, between a ballistic body and a winged vehicle, and it has some favorable attributes.

BUTLER: Going back to Mercury, now that you have these unmanned tasks and Alan Shepard had his flight which was successful, then President [John F.] Kennedy comes along and says, "Well, let's land a man on the moon by the end of the decade and return safely to Earth." What were your thoughts at the time?

KLEINKNECHT: Let's get busy and do it. [Laughter]

BUTLER: No questions about the difficulties involved? Just let's go out and do it?

KLEINKNECHT: No, I never thought about the difficulties. I thought about how can we get it done. It certainly was a challenge, but I think technologically this country can do everything it sets its mind to do, if it has the resolve, and, of course, we need the support of the Congress more and more. It's funny, the way things change.

When I was at Edwards, of course, NACA had a small headquarters office. I don't believe there were more than probably sixty or a hundred people in it then, but we were charged with the programs that we were doing, and the goals were set, and we flew our missions, and after we flew them, we'd tell headquarters what we had done. Now it seems like every time anybody turns around, they almost have to get the approval of the White House before they can do anything. In those days, the people that did the work were accountable for their actions and they knew it. Of course, the organization was small, and everybody knew everybody else, which helped communications, and you had mutual understanding and respect for who you worked with.

Now it seems like—in fact, since the shuttle disaster, seems like nobody's accountable for [any]thing, but everybody's accountable [for everything]. Something that Jim [James E.] Webb did after the Apollo accident because there was some problem with assigning accountability, he hired two contractors, Boeing as the technical integration contractor, and General Electric was quality and reliability contractor. It was clear, I don't think we needed them, but Jim Webb was probably the smartest, wisest, most perceptive administrator that NASA has had. He realized that that was the thing that had to be done. So there was somebody besides NASA that would be accountable.

I said we didn't need them. They had fine people, and they did good work, but in my view, we could have done it anyway, and maybe we couldn't have. It's been proven that Jim

Webb was right many, many, many times. He predicted about the right cost of Apollo when everybody else was saying it was going to cost less, and I think if it hadn't been for him, NASA would have been altogether different today. But the world changes and everything within it has to change.

At the time NASA was created, the administrators were responsible for the administration of the agency, and [Dr.] Hugh [L.] Dryden, who was the mainstay of NACA, respected all over the world as deputy administrator, and he took care of the technical aspects of the programs. Now things have changed. I don't think there are very many technical decisions—I don't even think we have the best technical leadership, and that's not to criticize any individuals. The agency's got so big that it's not just mature, it's an old bureaucracy now, and everything seems to be politically driven. Really up through Apollo, there was good technical leadership and, indeed, people that had their hands dirty in aircraft projects, programs, had hands-on experience, not just what you read out of a book.

BUTLER: Hands-on experience is always a good thing.

KLEINKNECHT: It sure is. Nothing can replace it.

BUTLER: Definitely not. Following on with some of the various Mercury missions and then you did become manager of the Mercury Project office, when John Glenn's mission was launched and they detected a potential problem with the heat shield, were you involved at all in the discussions under way?

KLEINKNECHT: Yes. That was a very scary moment in the program. The instrumentation had indicated that the heat shield had been released. If that was true, it would have burned up the skirt, and the heat shield would have burned up before landing. It's hard to tell. In fact, the whole spacecraft could have burned up. With the shock attenuation on the couch, should it have failed, John Glenn possibly could have survived a landing in the water, but we'll never know. We're just fortunate that it was a faulty indication and everything worked as it was supposed to.

BUTLER: Yes. It's very fortunate that we'll never know what would have happened. I'm sure he's glad of that, too.

KLEINKNECHT: Well, as he said, if that heat shield didn't work, it could have ruined his whole day. [Laughter]

BUTLER: Yes, that would definitely do that. [Laughter]

KLEINKNECHT: John Glenn, too, is a very, very fine man. John never talked about anything that he did; he only talked about what we did. He never tried to point any fingers at anyone for having been responsible for the question about the heat shield. Some other astronauts over the years have liked to take credit for everything that worked and was good, and liked to point fingers at the other people for things, even though they were things that they did and wanted, pointed fingers at other people for the things that weren't good. In retrospect, though, each and every one of them are and will be fine men. They stick their necks out, and they ought to have a little leeway to criticize.

BUTLER: Again, like you said, and as John Glenn has said, it was a team effort. They couldn't have done it without all of you there helping everyone with it.

KLEINKNECHT: Yes. I don't know whether John Glenn coined the phrase "on the shoulders of giants" or not, but that phrase was coined during those days, and I guess there's a history or some book out called *On the Shoulders of Giants*.

BUTLER: Yes. It's the history of the Gemini Program. It's quite appropriate, I think.

KLEINKNECHT: Yes. Well, the trouble is, there's not enough giants to go around anymore. There's so many people involved, and it's getting more and more complex, but when you look back, the X-1, I think it was eleven months from signing the contract to when it made its first glide flight in Orlando, Florida, and it was down there for a glide flight because the rocket engine wasn't ready, so they decided to test it down there. At that time there probably weren't over 6,000 people. There weren't even that many. There probably weren't 2,500 people in the NACA, and that was a great step.

There's always the two schools of thought, that when you came up to the sound barrier, everything was going to fall to pieces, it was like a brick wall, but it was done in a very short period of time, I guess before the industry realized that they could milk the government for so much money. Having gone so far and go back to Mercury, the government established the requirements. Of course, the project was started and the contract was issued before we really knew—we knew what the shape of Mercury would be, but not much else. So there was a lot

of—call it changes, a lot of definition that hadn't been made, and each time you created a new requirement, it cost money. Some people call that overrun. I don't consider it overrun. I think that's growth.

If we waited on any of the programs till we had a full definition, you could get a better price quote or estimate, you'd probably never get there. You get started and you set the ambitious schedules, and you do your best to make them. Of course, my responsibilities, I always thought of safety first, technical requirements, then schedule, then cost. I've been very fortunate. During my tenure of manager of the various projects, no one has ever been injured or gotten hurt on a project I was managing.

BUTLER: That's very good.

KLEINKNECHT: There aren't many people around that have worked with all of the research airplanes and all of the manned space flights.

BUTLER: Not many at all. You're quite fortunate to have had that wide range of experience.

KLEINKNECHT: I just happened to be in the right place at the right time—places, I guess.

BUTLER: Absolutely. Looking at some of the other Mercury missions, you talked about Glenn's a little bit, [M. Scott] Carpenter's was the next flight, and there were a few problems with that.

KLEINKNECHT: Not with the flight. There were problems with Carpenter. Well, before John's flight was Gus [Virgil I. "Gus"] Grissom's flight. He was a good friend and neighbor. For some reason the hatch blew off. Never did determine exactly why. But John's mission was almost perfect except for the scare, and then Scott's, he got too busy chasing fireflies, and he forgot when he was supposed to fire his retrorockets. Good thing we had a good Navy. They were able to get to him.

Looking back, when I first went back to Langley Field, the Mercury spacecraft was so heavy that they weren't sure that it could fly one orbit, much less three. So we started working on weight reduction, and I guess there were some small improvements in the performance of the Atlas booster. The weight got down to where we had a good margin for three revolutions.

When Wally's [Walter M. Schirra, Jr.] flight came around, we determined that if we controlled the weight and maybe saved a little more—and incidentally, you don't save weight by shaving thicknesses of materials, you save weight by taking something you don't need and throwing it out—that we could do six revolutions. So we committed that mission as a six-rev mission, and that came off fine.

I guess the biggest problem with that one was control of the environmental control system. Wally had a little valve that he had to turn to increase and decrease the cooling, and it didn't perform very well. We later found out that a technician, when he was assembling the valve, it called for a little lubricant, and he thought if a little will do a little good, a lot will do a lot of good, so he put too much in and it tended to block the passageways. I can't remember all these.

Then [L.] Gordon Cooper's mission. By then we had confidence in a one-day mission. I don't remember what, twenty-six revolutions or something like that, it turned out more than a day, and that was essentially uneventful. Then Al Shepard's mission was supposed to come along, and we had prepared the spacecraft for a three-day mission. We were really proud that we were able to get that out of it. Al's medical problems—well, let's see, they didn't come up yet.

We went to Washington with Al and other astronauts and Gilruth and Williams, trying to sell a three-day mission, and Jim Webb listened very, very attentively, and when it was all over, he said, "I don't think we ought to do it." We were all very disappointed, thought he didn't know what he was doing, but his rationalization was, well, we've done everything we said we were going to do and we've done more. We have nothing to gain and everything to lose. If we had had a serious mishap on that mission, it might have even ended the space program. So again, in his wisdom, he made the right decision.

BUTLER: In the middle of the Mercury Program, they decided to move the manned spacecraft center down to Houston. So you had to keep some people up in Virginia to finish off the Mercury Program and yet send others down to Houston.

KLEINKNECHT: Essentially, of course, Max [Maxime A.] Faget's engineering group was involved in all of the engineering decisions, but essentially the Mercury Project stayed in Virginia. I don't remember whether it was completed. Yes, it was completed when we moved to Houston. That really didn't create a problem. We arrived in Houston on the 3rd of July 1962. I spoke earlier about how friendly the people were in Houston. They had a parade. I guess that

was the official move. Still didn't have anything at Clear Lake. We were spread in, I think, as many as twenty-three locations around the city. I worked in the Farnsworth Chambers Building until Mercury was finished, and Gemini in the Federal Building downtown. So, Mercury wound down and Gemini wound up. There was overlap, but it was a very, very easy thing. There was really no transition because it was all the same people, pretty much, at NASA and certainly at McDonnell, during Gemini. I was at the Farnsworth Chambers until Mercury was over, then I went on Gemini as deputy manager to Chuck [Charles W.] Matthews, and their offices were downtown.

BUTLER: One last question on Mercury. You talked a little bit about the proposed three-day mission for Alan Shepard. This was shortly after the Russians had had their Vostok III and IV that flew in tandem, then there was some talk about taking the Mercury spacecraft and modifying them to be able to fly and maneuver. Was there much discussion about that?

KLEINKNECHT: So little that I don't even recall it. You know more history than I do. [Laughter]

BUTLER: Obviously it wasn't very feasible.

KLEINKNECHT: Well, it wouldn't have been a very smart thing, either, I think, to dilute our effort on Gemini to modify—as a matter of fact, by the time the program was over, Mercury was an antiquated piece of equipment, as most all of them are almost by the time they fly, it takes so long anymore.

BUTLER: Moving into the Gemini Program, then, even though there wasn't a lot of transition, there must have been some lessons that you took from Mercury and applied to the Gemini Program. Were there any specific things that stick out in your mind?

KLEINKNECHT: No. One of the lessons we learned, to pay attention to detail, self-discipline, and accountability. While we learned a lot of things about how to put things together, Mercury was a nightmare, when you looked inside, of wires and tubes running in all directions. Of course, it was small, so small the astronauts couldn't hardly breathe, much less move. We installed ejection seats in Gemini. Whether that would have been better if needed than the escape tower, we'll never know, but there was a lot more room. Like Pete [Charles C.] Conrad [Jr.] on his flight said, he could turn over in his seat.

BUTLER: That's quite a feat. Moving into the Gemini missions, Gemini 3 was the first one with Gus Grissom and John [W.] Young, and they were able to take the spacecraft out, do some maneuvering and test it out. Right before they flew, the Russians had a space walk, so there were some discussion about putting the space walk, then, on Gemini IV, and I guess there was some—

KLEINKNECHT: Very, very little.

BUTLER: Very little?

KLEINKNECHT: I don't recall that we thought we had to react to the Russians, and it really didn't mean anything. They were clearly ahead of us. We thought we should proceed on plan carefully and safely and do the things when we were ready. In fact, that's how we decided to do—I guess we called it the stand-up EVA on Ed [Edward H.] White's flight. When we talked about that, there were some leaks. When we were talking about it, the news media wanted to know why we didn't get up and go out, and my comment was, well, you have to learn to crawl before you can walk. So we just did stand-up.

I think EVA has been blown all out of proportion. It's a part of space flight. If you're going to accomplish anything, you have to do it. Of course, when you're EVA, you have one thing between you and the hostile atmosphere of space. In the spacecraft, you have the spacecraft itself, constructed of hard materials, and EVA you have a soft material in a suit. A puncture could be very disastrous. But it's certainly hard work, and you can't do it without preparation. I can't remember the number of the flight or even the astronaut, it must have been the one after Ed White's that did get out, and they found out that they couldn't do things they thought they would be able to do. Up until that time, underwater training was sort of below the dignity of an astronaut. After that flight, they accepted underwater training, and, of course, it turned out to be the best simulation that we have of zero gravity.

BUTLER: Still used today.

KLEINKNECHT: Yes, and getting bigger and bigger. We had a small tank at JSC, but Werner Von Braun sort of—I don't know what you'd call it—did it without anybody knowing. He

converted a hangar into a large underwater facility. Now I guess that's closed down, and Houston has the biggest and the only one. That's where it should be.

BUTLER: It's where they do all the training for the astronauts. It's a logical place for the tank.

KLEINKNECHT: Yes.

BUTLER: After the first Gemini missions were successful, then it came time for Gemini VI, which was Wally Schirra and Tom [Thomas P.] Stafford, and they were supposed to go up and do a docking with the Agena, but their Agena failed, and they couldn't go up in time. But the next mission coming up was the two-week-long mission, Gemini VII, and so the decision was made to send the two up and do a rendezvous. What was some of the discussion about doing that? Was there a lot of concern about whether it was possible to do or not?

KLEINKNECHT: No, I don't think there was any concern about whether it was possible to do. There was concern about whether we could get ready to do it, both the flight control and get the second spacecraft ready. Walter [F.] Burke and John [F.] Yardley of McDonnell in St. Louis—Walter Burke was vice president in charge of all space activities, and John was—I don't know what his title was then. He had been manager of Mercury and had moved to Florida. I can't remember whether it was towards the end of Mercury or when Gemini got ready to fly. Anyway, he later became associate administrator of space flight, one of the most technically competent men I've ever known, were responsible on behalf of McDonnell, of saying they could get everything ready. Of course, there was the processing at the Cape, whether you could get in

and erect the spacecraft and get it off. Everybody had a positive, can-do attitude and didn't try to rush anything, tried to be thorough, and we did it.

BUTLER: Certainly did. It was quite successful. Of course, there was almost a little glitch in the plan when Schirra and Stafford were getting ready to launch for the rendezvous and the others were already in orbit. I guess there was an abort on the rocket and it had started to ignite and then shut down, and they almost ejected from the spacecraft. I guess that would have canceled everything if they had ejected.

KLEINKNECHT: It sure would. I guess Wally was commander of that flight, and I don't know what possessed him to not eject, because when it shut down, no one knew why and whether that was just the beginning of a very bad course of events or not. Wally had had experience, because he'd had several other aborts on the pad. I think he had—in fact, I know he had more aborts than anybody else. So he was experienced in that. He didn't like the idea of landing at Cape Canaveral.

BUTLER: I can understand that.

KLEINKNECHT: In fact, that was one of his big worries on Mercury, on the Mercury flight, that they have an abort and use the escape tower and they'd land back on the Cape, and there was so many gantries and tanks and everything, that he wouldn't have any control whether he would land on one of those. That would have been disaster. In fact, he always held it against George [M.] Low that George didn't tell him all of the risks involved with landing back on the Cape

and, indeed, the launch rules which, if the winds were just right, of course, you had a higher probability of landing back on the Cape than in the water.

BUTLER: There must have been some concern, too, since the spacecraft was built to land in the water, which would absorb some of the shock, and so landing on land would be even a harder landing [unclear].

KLEINKNECHT: It would have been a harder landing, there's no question about that, but the couches and the struts that supported the couches are shock absorbers. The struts were designed to protect you for a land landing. Of course, you didn't know, if you landed straight down, that was one thing, that was fine, but if the spacecraft were swinging and you landed nose down or heat shield…[up], it would have been much more severe.

BUTLER: Fortunately, that never happened.

KLEINKNECHT: Yes. We had a lot of good luck until Apollo, and then something came back to haunt us that never should have been, but we were lucky with the 100 percent oxygen atmosphere within Mercury, and Mercury sure had more potential for short circuits and things, with all of the wires intermingled and run all over the place, and then they could get inside to work without stepping on them. But we got through Gemini until the Apollo accident happened and we paid the penalty for 100 percent oxygen.

BUTLER: Unfortunately.

KLEINKNECHT: Yes. Well, you know, you can look back and you can think, you know, if all these things were going to happen and you can't have 100 percent success all the time, they all happened probably at the best time that they could have happened during the program.

BUTLER: I suppose that's a good side for it.

KLEINKNECHT: Yes.

BUTLER: At least we were able to learn from the mistakes and the problems, and move on.

KLEINKNECHT: Yes. Again, I have to refer back, politics didn't drive anything in those days; the technical merit and technical readiness did. There were a lot of concern about people getting "go fever" and that somebody would overlook some little detail and it would come back to haunt us. Fortunately, again, I never felt that we were pressed to do anything that we weren't ready for. So although schedule was important, it didn't take priority over safety.

BUTLER: Talking a little bit about flights with difficulties, Gemini 8 had the problem of the stuck thruster, and the astronauts were spinning, and they finally did get control. I'm sure that was a pretty scary time back down on the ground.

KLEINKNECHT: [Laughter] I think it was a scary time up in the sky, too. Yes, I don't remember too much about that except Neil [Armstrong] did a tremendous job of turning the right things off and getting it back under control. That had to be a pretty hairy ride.

BUTLER: I can't imagine. It must have been something.

KLEINKNECHT: But Neil [A. Armstrong] was the kind of guy that was very cool-headed, and I believe if he was flying and somebody said, "Hey, they just turned the world around, and you're going to fly right back into the Earth," it wouldn't have fazed him. He would have done what he had to do and done it right.

BUTLER: Sounds like he was a good man, then, for the program.

KLEINKNECHT: Very good. That's another thing. I think, in retrospect, probably for every flight, the best astronauts were picked for that particular flight, not for what was…[expected] to happen, but for what did happen.

BUTLER: Some providence there. Also on Gemini, there was some discussion about a paraglider.

KLEINKNECHT: Well, not just discussion; there was a lot of money spent. Rogalo [phonetic]—I don't remember what they called his. Anyway, it was an offshoot of Rogalo at Langley Field developed, and it initially was supposed to have a paraglider, but it was designed so you could

also store parachutes. The paraglider development just didn't come along quickly as we would liked it to have, but we reverted back to parachutes. I think there was even some discussion of having a landing gear similar to the LM, something that could be extended, but that never happened.

In fact, George [W.] Jeffs, who was another very, very technically competent contractor at North American, was the project manager on the paraglider. It was sort of a side development from the mainstream of Gemini. I wasn't too much involved in that. But I didn't care much for George Jeffs at that time, but after he came back to Downey and was involved in Apollo, I got to know him better, and I had just about equal respect for him as I do for John Yardley. George was the kind of guy at the end of Apollo—you probably think I keep trying to get to Apollo and you're not finished with Gemini, but that's perfectly all right. As we were winding down Apollo and on every other program, too, there's always been a question of how many people can you get rid of, how many people do you have to hold on to with experience for "what if" happens.

And George Jeffs cut way back [on people]. There was what we thought they ought to have and what his, Rockwell people—I guess it was Rockwell at that time, North-American Rockwell—thought they ought to have and what George Jeffs thought they ought to have, and he was below all of them, and he said, "Kenny, my attitude is, let's go back as far as we can, and if we need more, we'll put them back on, instead of keeping them all on the payroll and adding to the cost of the program," and there aren't many people around like that. Most people, once they've created an empire, don't want to just hold onto it, they want to keep it growing.

BUTLER: Sounds like an interesting man to work with.

KLEINKNECHT: Very much so. He laid everything out in the open, everything was above board, nothing swept under the rug. You always knew what was going on.

BUTLER: Talking about Apollo, you began working with it a bit back in 1961 when you were on the Source Evaluation Board to pick the contractors. How did the board evaluate the contractors? How did you decide on who would be the best one to have the contract?

KLEINKNECHT: Just like you do all contracts. Sometimes there's politics involved, and, I don't know, there might have been some politics involved there, but I think it was maybe more experience, but you create guidelines of what you're going to score on, on cost and schedule and technical proposals, reliability and quality. Like all source evaluations, you determine how much weight you're going to put on each one of these things and turn many, many people loose in various groups to evaluate various aspects of the proposal. When you get finished, somebody's supposed to come out ahead.

I think probably Rockwell, because of their experience with the X-15, the fact that they proposed more what NASA wanted—I can't think of the word now—responsiveness is always a thing that gets graded, too. It's almost, did they tell me what I wanted to hear? But anyway, did they propose what we wanted instead of something they wanted? I don't remember what McDonnell proposed, but it was a little different configuration. That wasn't exactly what we wanted. I don't know about cost. I don't remember cost. I don't know how anything could cost less in Los Angeles than in St. Louis.

But I think we picked the right contractor there, too, and they sure took the brunt of the Apollo fire. I always considered that the performance of the program was varied. Sometimes it was 51 percent NASA and 49 percent contractor, and other times it was the other way around, but basically the government was so involved that nothing could happen that was 100 percent the fault of the contractor. NASA took no responsibility for the Apollo fire. North American, or Rockwell, whatever it was at the time, took full responsibility... They gave up their fee. They worked for, you might say, nothing, although I think the industry has better bookkeepers than the government, and even though it looks like they're working for nothing, they have to make something to stay in business. Anyway, they took full responsibility and turned to, to fix it. It worked.

BUTLER: You were involved in helping to get the program fixed and back on track after the fire.

KLEINKNECHT: Yes. I was still on Gemini, and I moved over to Apollo three days after the fire. I guess the first thing I focused on was the hatch. Rockwell had really moved out on the design of a hatch that would open outward and the crews wouldn't be trapped. I'm not sure in the case of the fire whether that would have made any difference with 100 percent oxygen, because it was just like that, the snap of a finger, everything happened. But anyway, I think they must have given a lot of thought earlier to an outward-moving hatch, because they were able to do it without major modifications to the primary structure of the Apollo.

BUTLER: The people working on the Apollo command module at the time, both at NASA and on the contractor's side, did they change at all the way that they went about doing things as a result?

KLEINKNECHT: I don't think so except create more paper and cost more. The investigating committee, and I can't think of who the head of it was, I don't know whether he was the director of [Langley]…Center at the time or had been—I guess he had been director of…[Langley]. He was from headquarters. They fixed more things that didn't have to be fixed, and in the course of the whole investigation, they didn't just focus on the cause of the fire, but a lot of things they did had to be done. One was to put all the wiring in—you call it route them through trays and they called it "combed it" so each wire was side by side running in any direction, they didn't overlap and get intertwined, and then provide covers so you could get in an work without damaging. Both the wiring and the plumbing, but I believe—no, I just don't remember how many million just that investigation cost us. I guess, in retrospect again, you're a lot better to overreact than underreact and err on the side of safety instead of unsafe practices.

Of course, I knew most of the people, but I wasn't working directly with them before the fire, but I don't think it changed generally the way they thought or didn't change the way that I thought. It's always managers and directors and presidents of companies that aren't interested in detail, they only want the bottom line, like the cost or the schedule. It started out, they said I was always interested in attention to detail, starting with Mercury, and I read every piece of mail that come into the project or program office from Mercury through Apollo.

BUTLER: So eventually Apollo did get back on track through efforts of everyone, and Apollo 7 was the next mission, went up and was technically successful, the spacecraft worked well, and the decision was made then to send Apollo 8 into orbit around the moon. How controversial was that decision or the discussion surrounding it?

KLEINKNECHT: It wasn't controversial at JSC, and it wasn't controversial at Rockwell. It was controversial at Grumman, and I think primarily because Grumman wasn't ready to fly, and that put them in the spotlight. There was just a positive "can do" attitude at JSC, and headquarters supported it. I don't remember who was administrator then or who was associate administrator for space flight, but it must have been Sam [Samuel C.] Phillips, who was another fine, understanding, technically competent director. It got full support, and the astronauts wanted to do it. There was no question in their mind, as long as we thought we were ready, and they didn't get pushed to go before it was ready.

BUTLER: It went and was quite a success. It orbited the moon on Christmas Eve. That must have been quite a fascinating experience, to hear the broadcast and to realize that we finally sent someone.

KLEINKNECHT: Well, it was, and I don't remember whether we could see the moon for Apollo 7 or not. For Apollo 11 we could, and it was just fascinating and exhilarating to go out and look and say, "Hey, those guys are up there." That's what that painting by Rockwell depicts. He didn't have us all together like that. He came and talked to each of us, and then he had his

photographers, and they asked us to sit in a chair and look up like you were looking at the moon, and then he put it all together in that montage. I was fortunate to be in that, too.

BUTLER: That is a really neat painting.

KLEINKNECHT: They kidded me at Rockwell that Norman Rockwell was related to Rockwell the company, that they had a hard time getting him to put me in the picture. [Laughter]

BUTLER: Some nice camaraderie there.

KLEINKNECHT: Yes. Well, I made some fine friends throughout all this time, and I also spent two years in Paris with the European Space Agency as a deputy for European operations to John Yardley. I didn't want to go over there. I thought, golly, I'd been through Paris before, and I wasn't too impressed. I didn't understand any French. I thought they'll all be talking their own language and I won't know what was going on. But I was received with welcome arms. Their program director, Michael Bignier, could speak French, German, English, and a little Spanish, and in the two years I was there I'll bet I could count on the fingers of one hand the times that I was present that he spoke French, and every time it was in a meeting of some kind, and he'd apologize beforehand. He said, "I'm sorry, Kenny. I can't express what I want to say in English," so he spoke in French, and then one of the other fellows would translate for me.

But it was a tremendous experience. They did a good job. In fact, I haven't heard anybody complain about the Spacelab. Of course, we, as Americans—that wasn't my responsibility being over there was to help and support them, thought they couldn't do it without

us, but they knew what they were doing, and it was just amazing to find that thirty years earlier every one of the countries in the European Space Agency had been fighting, and here they could sit down and work together, sometimes better than we could between centers at NASA.

BUTLER: Talking about that a little bit, the interaction between centers of NASA, it was difficult at times. How did you find ways to make it all work? Just compromise and negotiation?

KLEINKNECHT: JSC just knew what was needed and how to do it, so finally we convinced everybody that it was their idea. No, there were some—I don't think you'd call them conflicts. Competition, I guess. But the jobs were originally distributed properly. The boosters were at Marshall, the spacecraft was at Johnson. Of course, Johnson was the only one that knew how to build a spacecraft. I've got to give the credit to Bob Gilruth, Max Faget, and Caldwell [C.] Johnson, I think, for the original overall conceptual design, and Bob Gilruth for his super leadership. There really weren't many controversies there. What we needed in a booster sometimes changed.

Of course, the boosters weren't always at Marshall [Space Flight Center]. Atlas was military and technically managed by Aerospace. Marshall did the Redstone and the Jupiter and the Saturn. They had experience there. They were the only ones, I guess, when Mercury started that had really built launch vehicles, the V-1, V-2. I don't remember whether there was any difference between those or not. I guess V-1 was a ramjet and a V-2 was essentially a Redstone or maybe a Jupiter, and then that evolved into a Redstone. They're built just about the same way.

The big difference with Marshall was that they built things first and then they contracted, and JSC built components, like small reaction control jets and components, environmental control system, but we contracted initially for the total vehicles with contractors. And Langley did—I guess it was Langley and Ames—did the wind tunnel work. But as the agency grew, kept getting more and more overlap. Like Ames got in the environmental control business and Marshall in the water tanks, and I can't remember all the things. But you keep getting duplication at the two centers, and they'd have headquarters reviews and decide they were going to straighten it all out, and then they would on paper, and six months later everything was back again.

BUTLER: Some of the discussions between centers revolved around the decision of how to get to the moon, whether it was Earth orbit, rendezvous and lunar orbit, or direct ascent. Were you involved in those discussions at all?

KLEINKNECHT: I was aware of them, but wasn't involved. In fact, that decision was made, must have been 1962 when I was on tour with Mercury. They sent Mercury on tour to, I think, sixty-two countries, and I went to Sydney, Manila, Tokyo, Seoul, then brought it back and left it at the World's Fair in Seattle. I think John [C.] Houbolt at Langley was primarily responsible for—well, he wasn't responsible for the decision. He was responsible for development and selling the concept. I don't remember what JSC's position was—Max Faget's. I can't remember the fellow at Ames. I don't know whether they were direct or not.

That's the thing that's always amazed me and worried me. Golly, you can't make an appointment and meet somebody on the corner downtown at the right time and the right place.

Here we are on the moon, and we can do all the right things at the right time for the command module and lunar module to meet on the back side of the moon to come home.

BUTLER: Pretty impressive engineering and planning.

KLEINKNECHT: Yes. If we still had to use Marchant calculators, I guess we'd still be trying to figure out how to do it.

BUTLER: Well, eventually it was figured out, and Apollo 11 then became the first one to land on the moon. Were you in the control center at the time? What kind of thoughts were going through your mind when it landed?

KLEINKNECHT: "I hope we get back." In those days at the Cape, the Cape had control until the launch vehicle cleared the tower. As soon as it cleared the tower, there was all kinds of hoopla raised in the control centers, but everything was just beginning. We had to get back safely for anything to be a success, so people at Houston didn't get so excited about clearing the tower.

BUTLER: When they were experiencing the problems during landing, with the computer errors and having to override the computer, did that cause a little bit of uncertainty in mission control?

KLEINKNECHT: Well, yes. I don't know how much uncertainty. I guess the uncertainty was were we going to land or not, and Neil made the right decision. Of course, there was still questions of whether the moon's surface was a very thick layer of dust or whether it was hard.

At that time there were people that thought that there was so much dust that they wouldn't be able to see anything, but it wasn't quite that bad. Again, they had the right man at the helm.

BUTLER: Didn't sink into the dust, and they avoided the boulders and they came down. It must have been [unclear].

KLEINKNECHT: And, you know, if it had been unmanned, I'm quite sure we probably wouldn't have landed, but that's what a man was able to contribute. He's a little more flexible than computers. Computers only know what you tell them, but he can see and analyze the situation in real time. That's why we have manned flight up to now. I'm not sure for the future. It's, of course, always been a controversy between the pure scientists and manned space flight people of whether the man is the right way to go, because it costs quite a bit to put a man on board. With Apollo 13, without the man we wouldn't have gotten back.

BUTLER: Apollo 13 was certainly a scary time, I'm sure.

KLEINKNECHT: That's the understatement of the day. [Laughter] At that time, I guess it had only been talked about, really, recently about Gene [Eugene F.] Kranz's attitude that failure was not an option, and they all proved it.

BUTLER: It took everybody pulling together to make it happen.

KLEINKNECHT: Yes. Sometimes you wonder why they need all those people on the ground. They keep talking about having fewer of them, but when something like that happens, you're sure glad you had them and so well trained.

BUTLER: Absolutely. Well, you switched over shortly before Apollo 13, I guess, to working on the Skylab Program. What were you initial duties involved in that program?

KLEINKNECHT: Manager. Well, not really. While Gemini was still going on, I was chairman of source evaluation—I think I was chairman—for Skylab, for JSC. I worked on the requirements and evaluated the contract and awarded it to—well, we didn't award it. We recommended. An evaluation committee only recommends, and in this case it was the administrator that made the selection. We recommended McDonnell, and that was primarily because one of the requirements were that they would use as much of the Gemini hardware as they could. One of George [E.] Mueller's requirements was, I think, that they use the hatches, so Skylab was built around Gemini hatches. Anyway, McDonnell won it because they knew what hardware was available and how to use it, and they were competing with Grumman. Grumman wasn't as familiar with all the hardware.

[Telephone rings. Tape recorder turned off.]

...and Grumman didn't know as much about the hardware as McDonnell did, and labor is cheaper in St. Louis than in New York, Bethpage. I don't remember when they became McDonnell-Douglas. Before Skylab was flown, it was McDonnell-Douglas. So they got the contract, and it was to be done—it was McDonnell-Douglas, because it was to be done at Huntington Beach, and that was initially a Douglas facility, not McDonnell, but Douglas.

I think Skylab was—I don't know just how to say it, but George Mueller and Werner Von Braun pulled the coup of the century in selling Skylab. But it was a S-4B stage—matter of fact, it was called a workshop, not a space station, and indeed it was a space station. But they started out to use existing hardware except for the Skylab module. It would be flown in two years, and that must have been 1964. It was going to be flown in two years. Well, every year it was still two years ahead. But the Congress was focusing on Apollo, so they left us alone, and, of course, the program grew. They added Apollo telescope mounts and then the Earth resources experiments. There was something else added. I can't remember what it was. Bill Schneider [phonetic] said we accomplished 130 percent of what we set out to do—we added student experiments—what we set out to do, and it cost less money, because initially there were going to be many more flights. It was called Apollo Applications, I guess it started out, and then turned to Skylab.

It was a true space station. It was almost another—well, it was a fiasco, but we got out from under it on the first launch. Again, we would never have been able to save it if it hadn't been for the man. The initial goal was seven days, fourteen days, and twenty-six days or twenty-eight days, anyway, each doubling it, and we did—I don't remember what we did. I think it was fourteen. I can't remember the first one, but then we did fifty-six days and then eighty-three days.

It started out with the overall Skylab—well, the workshop had to be activated by going EVA and removing the dome off of the—in fact, at one time they called it a "spent stage" workshop because it was a stage that was used to launch it and then convert it. Well, it was changed to being all outfitted on the ground, which was another good decision, and, of course, that added to the time.

We finally—I don't remember when it first flew. '71? About '69 it turned out it was two years from then, and then, of course, after it was over, there was all kinds of discussions about reboosting it and saving it and reactivating it. It was decided we wouldn't do it. It was only thought it would be up there for, I don't know, two to three years or something like that. It wound up being eight years.

During the development, we addressed the issue of whether we should be able to deorbit it or not, and decided—and I guess that was reviewed at the presidential level—that it wasn't necessary. There was so much water and it'd be such small [unclear] that it wasn't really endangering people when it came back in. Well, it turned out, it stayed up over eight years and spent millions of dollars trying to figure out how to control its reentry. There was very, very little control they were able to exercise, but it reentered and didn't cause any damage. Then there was discussions and money spent and studies to reboost it, and even discussions of using the shuttle to reboost it. I don't know whether we could have or not. It had to dock, an MDA, Multiple Docking Adaptor, and then it was a long piece of hardware that wasn't designed to be pushed around, although we did exercise control.

The multiple docking adaptor was another thing that had been added in the course of the definition of the program. But I'm glad that they never were able to reactivate—well, I shouldn't say "able." It could have been reactivated. There was a lot of systems that were not at 100 percent performance level, but we would have just poured more and more and more money into it for doing more of the same. We couldn't do much different than we had already done, and that would have diluted attention to the shuttle.

BUTLER: Before we get to shuttle, there was Apollo-Soyuz then. Were you heavily involved with that project?

KLEINKNECHT: I was part of the time. At the time, I guess I was still Skylab manager when that got started, and then for two years or so, I was director of flight operations, and I was involved somewhat in it, but not particularly interested, other than that we did it safely. I wasn't too enthused about working with the Russians. The people that came over were fine people, and they're like, I think, every place in the world, the people are fine, the politicians cause all the trouble. [Laughter] But I don't think we got anything out of it, but they sure got a lot from us. Every report—of course, none of our work was classified, and they could get any report they wanted, and when they came over they got everything they wanted, and I think they learned more from us than we did from them.

In fact, in those days we talked about how antiquated they were, their systems were, and how they couldn't do the things we could do, but in reality, they could do exactly what they wanted to do, they did what they set out to do. I think they had more accidents, catastrophes, than we did. In fact, I know they did. But we learned how to work with them, and we learned from Skylab and from that mission an awful lot, but I don't think the current NASA is interested in what we learned. They're interested in selling the space station, and they talk about all we learned from the flights with the Russians, and I think we've learned the same things that we—in fact, a lot of the things I read in *Aviation Week*, things they learned, we learned in Skylab, but nobody wants to bother to even go back. I guess the corporate memory isn't there because so many people are gone. They don't want to go back and see what we learned. They'd rather repeat it at a very, very high expense.

Going back to space station, we had, I think, incompetent technical leadership when we were defining it for our country. I think we defined something we couldn't have assembled. Now it's altogether different. In fact, we call it our space station. I think it's a Russian space station, we just might happen to have a module attached to it. The Europeans did the…[Spacelab]. They developed it and delivered it to us free. We don't get anything free from the Russians. They talk about how much it's costing, and nobody has ever put the cost that we pay them for flying on their missions. I have never heard anybody quote the cost that we charge them for taking all that hardware up to repair the [*Mir*] space station, which are all the things that should be done, but I think we've set up a bookkeeping system to make sure that nobody knows how much we've given to the Russians for the space station.

BUTLER: Looking at—

KLEINKNECHT: Excuse me. Can we go back again?

BUTLER: Sure.

KLEINKNECHT: Skylab stayed up, I think it was about eight and a half years without having to be reboosted, and…[the International] Space Station, I think ha[s] to be boosted every eleven months to keep it up there. If the Russians can't build any more rockets, launch vehicles, we may not be able to reboost it if we ever get it finally assembled.

BUTLER: Hopefully they can smooth all that out.

KLEINKNECHT: Yes. I think the cost has grown from 8 billion to 11 billion, to 17 billion, to 25 billion, and some recent review says it's probably going to be more than that. I have to laugh every time I think about [Daniel S.] Goldin talking about how much money we're saving by going with the Russians.

BUTLER: Yes, that is an interesting perspective there that he has.

KLEINKNECHT: I'll go back to the shuttle again, and I talked about the Europeans giving us something, and the Canadians built the manipulator arm that, again, I haven't heard anything bad about, and they gave that to us. In fact, when we decided we would accept their offer, we estimated the costs—I don't remember exactly what it was, but General Electric raised an objection, and they said they'd do the whole job for 25 million. I think they said fixed price. I can't be sure of that. But anyway, the Canadians spent over 100 million, I think, to develop it, and, of course, it's obvious they, too, did a good job. The Japanese, we don't buy anything from the Japanese; they pay for all of their equipment. But everything the Russians do we pay for, and they're not even paying their workers. It's frightening what it may get to. Again going back, we talked about their antiquated equipment and what it wouldn't do, and now all of a sudden we can't build a big rocket engine, we have to build their rocket engines, use them, and we're launching on—well, I guess commercially, they're launching on some Russian launch vehicles. So you can see I'm not enthused with the participation with the Russians.

BUTLER: I don't think that's too abnormal.

KLEINKNECHT: Of course, I'm an old fogey now, and I'm not there anymore. Everything was a lot better when I was there. [Laughter]

BUTLER: Well, certainly we got a lot done when you were there.

KLEINKNECHT: Well, I was very proud to have been a part of all of it, and felt privileged.

BUTLER: Absolutely. After Apollo-Soyuz, you moved on briefly to be assistant manager on the space shuttle before then going up to headquarters and working on the Spacelab Program.

KLEINKNECHT: I didn't actually go to headquarters. I went to Paris, but was attached to headquarters for that stint.

BUTLER: What were your duties while you were the assistant manager of the Space Shuttle Program?

KLEINKNECHT: Well, I spent a lot of time working with the Canadians on the manipulator arm and worked with Aaron Cohen, I guess as an advisor as much as anything, although I conducted some of the reviews at Rockwell and conducted change boards. That was before I went to Paris.

BUTLER: Then you did go to Paris and worked on the Spacelab Program and forged some new relationships between NASA and the European Space Agency which have turned out to be pretty good.

KLEINKNECHT: I think so.

BUTLER: When you went over there, were they still in the design process of Spacelab?

KLEINKNECHT: Yes. Well, no, there was a lot of hardware. It was really in integration tests, I guess. Not everything was completed, because I went in September of '79, came back, I guess, in July of '81 or something like that—yes, July of '81. Going way back, I was on the review team—I can't remember the year, '75 or sometime around there—with Walt Williams and some people from Marshall that went over to review the status of the Spacelab and what their progress was, and, of course, we went to all the countries. The prime contractor was in Bremen, Germany, and there were—they called them co-contractors—in Copenhagen and Friedrichshaven, Germany. I can't think of the name in Spain, but in Paris and Belgium and England. We found that they were doing okay and thought they knew what they were doing, and everybody at NASA was worried about them. It turns out that they were ready long before the shuttle was. They could have delivered the [Spacelab] at least two years before it was needed, and there was concern about whether it would be available when needed.

BUTLER: Spacelab turned out to be a pretty successful program, quite a few successful missions. Do you think the bonds that were forged during that time working with the European

Space Agency and NASA, do you think they will be of benefit to the space program continually as we do get involved in more international programs?

KLEINKNECHT: Yes, I think so. I think there's a mutual understanding and respect there. They've demonstrated that they can do what they set out to do, just like we can. In fact, their Ariane 5 booster, I guess they're having a few technical difficulties, but that Ariane series of boosters has performed well. Again, we like to say that they didn't know what they were doing and they couldn't do anything, but they've done a fine job, and the same thing with the Airbus. We thought they wouldn't know how to build airplanes, but I see in the paper this morning that Airbus got more business out of the Farnborough [phonetic] Air Show this year than Boeing did.

BUTLER: Moving on then, after you worked on Spacelab and were there for a couple of years, you went on back to JSC, actually, and took control of the OV-102 Program to try to get the space shuttle off on time. Can you tell me a little bit about what you did to help that program?

KLEINKNECHT: Well, let's talk about how I got there. When I went to Paris, I said, "I'll be there one year to the day, and then I'm coming home." Well, after about nine months, they asked me to stay another year, and I enjoyed it quite a bit, so I decided I'd stay another year. I guess six or eight months later, they asked me if I'd stay another year, and I said, "Well, I'm willing. It's up to headquarters whether they want me to stay or not," and I was told that that was unheard of, that they wouldn't even ask a European to stay in a position like I had, because, see, I thought I

might be treated as a spy and all this kind of stuff. But I wasn't, so it's obvious that they had some confidence in me.

Anyway, like the day after they asked me that, or within the same week, John Yardley and Chris [Christopher] Kraft called me and asked if I wanted to come home and go back to work. They said the shuttle was going to be delivered to the Cape and there was a lot of work to do on the thermal protection system. They wondered if I wanted to come back and go down there and oversee that work, and I said, yes, I will.

So we came back. I guess we were only in Houston less than a week, moved to Florida. KSC and Rockwell were still responsible for the overall completion of the spacecraft, and I was responsible—it was called OV-102…manager, really, for the thermal protection system, and it was way behind schedule. …When it was delivered…everybody knew that it was behind schedule, but things were just sort of dragging on the West Coast at Palmdale, and they thought that it would probably be better to move it to the Cape and focus more on getting it finished than making changes. A lot of people thought that was a wrong decision. I think it was a good decision.

It turned out, I think it had somewhere in the neighborhood of 1,500 tiles on it when it got there and required a total of about 31,000 to be put on. So I went down there to manage and direct that. It was really a difficult situation. Everybody measured what we were doing by how many tiles we put on in a day. It turned out some days we had to take off more than we put on, and we didn't necessarily advertise that. It was not because of the work that was done down there or the work by the technicians; it was the work done by the engineers. The development of tiles was focused on thermal protection, not on the mechanical properties of how you put them on, and the bond just wasn't strong enough. So as more wind-tunnel data became available

and they analyzed, they found they weren't strong enough. So we had to take them off and reapply them.

Rockwell developed a process called densification, which—let me go back a little bit. The bond wasn't failing, the tile itself was failing at the bond line, so it would like pull the surface off. They developed a process called densification in which they measured the surface area of each tile, calculated the amount of liquid, called Ludox, that you would apply on it for it to penetrate about an eighth of an inch, and that strengthened this surface area. That liquid was measured, painted on with brushes, put in an oven and cured, and then each tile was reweighed to know how much weight they had added and also to verify that you'd put the proper amount of material on.

So it turned out, the engineers—I'll say this now. I guess I thought it at the time, but I never said it. I think they wanted to show how difficult this was, so we couldn't get answers that we needed on tiles. We had to wait days and days for answers that we should have gotten in hours.

But anyway, it turned out, before we were finished, we applied at the Cape about 65,000 tiles, which means that, overall, we removed every one of them at least once. And, of course, the tile thermal protection system was the umbrella for everything else. The launch pad wasn't ready, the launch vehicle wasn't ready, the KSC procedures weren't ready, the flight operations procedures weren't ready. Maybe, in retrospect, it all came together so maybe it wasn't too bad, but the cockpit installations weren't complete and the payload bay installations weren't complete. We spent money on trying to redevelop, or upgrade the astronaut maneuvering unit and take it along in case they had to get out and repair some tile. My comment on that the first time I heard it was, "Well, it would be fine to have that piece of

equipment but if we think we might need it, we really shouldn't be going." It turned out that was right.

The thermal protection system performed, really, better, I think, than anybody expected it to. We expected to have a lot more damage after the flight than has occurred, and I haven't heard much about it recently. I don't remember the numbers that people were predicting of those that would have to be changed after each mission. It was always much, much lower than that.

Rockwell also developed a process after they had done all the analysis and knew what the airloads might be on each area of the vehicle, a process with a vacuum attachment. We could pull-test each one of them and see that it had enough strength to stay on. We didn't get very good publicity during the time we were putting them on. I can't think of the TV commentator now, the old guy that just retired [David Brinkley]. He made me mad. He called—well, he didn't call; he had somebody call that I knew, for an interview about what the status was. I told him, and his report came out on the evening news, "The tiles keep falling off," and none of them ever fell off. Well, I can't say that. There might have been one that fell off. We found it on the hangar floor one morning. But some of them did come off during the transport mission from Palmdale to Cape Kennedy, and we had some that failed the pull test, and they had to be redone. It turned out that almost each tile had to be individually fitted and put on.

Initially they planned that they'd have areas, blocks, that they'd put together and they'd attach. They started that at Palmdale and did some of it at the Cape, but then when we found we had to take them off, each time you took one off, each one of these tiles was blueprinted and had an exact size for height and other dimensions so there was, I don't know, on

the order of ten-thousandths clearance between each tile and not more than about seventeen-thousandths difference in height. With a difference in height, the airstream could erode, and if there was too big a gap between them, the hot air could get down and actually melt the aluminum skin.

So it turned out each time you had to take one off, or in the final stages, each time you put one on, you had to make a pattern by putting—I don't remember whether it was plaster of Paris, but something like that in, with shims around it to create all the right dimensions, and then taking that and taking the tiles and machining with a gunstock milling machine that traced your pattern. Then it had to go back to Sunnyvale to have either the white or the black coating put on it and get back down there.

It got to the point where—I shouldn't say our big problem was, but the thing we had to focus on was a pipeline of tile ready to be applied. We had a lot of people that were ready to apply tile, but if the process didn't allow it to be ready or the pipeline wasn't full, then we had nothing to put on.

BUTLER: Of course, you want the tile right, like you said. Otherwise [unclear] to the spacecraft, and that would cause major damage.

KLEINKNECHT: Yes.

BUTLER: From everything I've heard, it's been pretty successful. They haven't had any problems with the tiles.

KLEINKNECHT: Not seriously. They've made some improvements. Oh, I shouldn't say "improvements." Some changes. Some places I think where they used to have tile that were about a half-inch thick, they use some kind of blanket, and there initially were some blankets. I don't remember exactly where they were used, but there's more of them used now.

BUTLER: The space shuttle was eventually finished then, and it was launched.

KLEINKNECHT: I went back to get ready to move to Colorado.

BUTLER: Move on to Colorado.

KLEINKNECHT: Paradise.

BUTLER: When you came to Colorado then and you were working for Martin-Marietta, what were you jobs and responsibilities there?

KLEINKNECHT: I can't remember all the details. I started working in an area that was doing NASA programs. Martin was building the reaction control [tanks]. I don't know if it was reaction control or OMS [Orbital Maneuvering System] tanks or both, and they built pyrotechnic [initiators], the standard pyrotechnic for the Shuttle Program and had the parachute program.

I worked there—I thought I didn't remember much about the past. Now it's a near term I can't remember. I can't remember what the times were. I did work on the Martin

proposal for the space station. I worked on the space-based laser project. I can't remember what that was called now. I think I want to call it Zenith Star, but I'm not sure that's right. I was manager of subcontracts on that Zenith Star.

In September of 1990, I took retirement and have done nothing since.

BUTLER: I'm sure you've taken time to just relax and enjoy yourself.

KLEINKNECHT: Well, I do a little hunting and play golf and fishing. I used to work in the yard, but I've got some vertebra that are out of place, I guess, in my lower back, and I have a pain in the hips now, in the right hip joint. I'm afraid I'm going to have to have surgery to get that fixed. They used cortisone, and that helps, but that's only a temporary crutch.

BUTLER: You said you've done nothing, but I think that's quite good.

KLEINKNECHT: Yes. And I've lived longer than three years after retirement. A lot of people don't live.

BUTLER: You've been very fortunate. It's good that you've been able to especially enjoy Colorado here.

KLEINKNECHT: Yes. That's a good part of it.

BUTLER: Looking back over all your years with the space program, when you first started, would you have ever imagined where it would all lead?

KLEINKNECHT: Well, I could foresee going to the moon, although I shouldn't say when it first started, because it first started with the X-1, really. That was the beginning of the space program. The X-15 flew high enough to be a space vehicle, and I guess up until then I didn't think much beyond Dyna-Soar. I guess after I was with Mercury for a short while I could foresee—well, Von Braun was the best space salesman that God ever created. He had visions of the moon, and people listened to him and respected him.

I'm sort of disappointed at all the credit he's gotten and the little credit that Bob Gilruth has gotten. Bob is really the father of the manned space program with Max Faget and Caldwell Johnson. Bob was never too outgoing. He just did his job and was a great leader, as Von Braun was a great leader. But I never remember Bob Gilruth telling anybody what they should do or how to do anything. He just talked with them long enough that they thought his idea was their idea and they went and did it the way he wanted it. Over the years, Von Braun got more credit, I think, than he should have. Well, I shouldn't say that, more credit. He probably deserved every bit of credit he got, but Bob didn't get what he deserved.

BUTLER: We've heard similar thoughts from others. He seems to have been a very good person to work with, a very good leader.

KLEINKNECHT: He was outstanding. Of course, I had worked with Walt Williams for nine years before we went back there, and he and I got along well together.

There is an incident—I shouldn't say an incident—a time when we first went back there and observed that NACA was monitoring everything that McDonnell did, but they weren't paying much attention to quality, and we decided that we ought to have some quality monitoring in St. Louis. We had some good inspectors. They were at the Cape. They had come from Lewis [Research Center, Ohio], too, so we had quality control and inspection at the Cape, but we concluded that we ought to have quality inspectors in St. Louis, and, of course, McDonnell had them. When the decision was made to send them out there in residence, one of the engineering leaders, not Max Faget, wrote a memo in answer to it, said that it would be fine. We could have inspectors out there as long as they didn't have anything to do with delaying the work. Of course, the whole purpose was, if something wasn't right, they had authority to stop the work. They finally came around and agreed that that was a good thing to do.

BUTLER: You talked a little bit about Walt Williams and Bob Gilruth and John Yardley and George Jeffs. Were there other individuals that were, in your opinion, very key to the space program?

KLEINKNECHT: I think all of the administrators up through Dick Truly, who I think got a raw deal—I think that his removal was a political move—but particularly Jim Webb. Of course, when you look back, it's kind of like the astronauts. We probably had the best administrators for the situation at the time each one of them was administrating. Others like Sam Phillips in Washington, George Mueller, Chris Kraft, Gene Kranz, Deke [Donald K.] Slayton. My deputy on Mercury, Bill [William M.] Bland [Jr.], he was a stickler for quality, a good man to have.

Walter Burke [and Fred Saunders at McDonnell-Douglas, Walter Kapryan at KSC, and Bill Lucas, George Hardy, and J. Bob Thompson at Marshall].

Well, go back to J. S. McDonnell, Mr. Mac, he took a personal interest in Mercury. Of course, he liked to hob-nob with the astronauts. We had some problems with—anytime [an] astronaut would think of something and mention it to J.S. McDonnell, the next day they'd be doing it. And it wasn't all bad. A lot of times the astronauts wanted to get some of their own personal—not a personal thing, but things that they personally wanted to get done, and it cost money. In a lot of ways, like I said earlier, they were sticking their necks out, and they should be able to get what they wanted, but it was kind of like at times we didn't have much control.

Mr. Mac would come to monthly review meetings, and he had his own meetings personally getting involved in knowing what was going on. Walter Burke. It's bad when you start naming names, because you always leave somebody out. Fred Sanders, he was on Mercury and went on to Skylab in Huntington Beach. George Jeffs,…Bill [William B.] Bergen, [and John Healey] at Rockwell...came, actually, from Martin headquarters after the fire. He took a personal interest in knowing what was going on.

After the fire, doing work in Apollo, you could only get so many people in it, and there was a lot of work to be done, so you had to schedule them in, and you had to inventory everything they took in and everything they took out to be sure they brought out what they were supposed to. But Bill Bergen would be down on the floor in the factory in the middle of the night, looking around just to look around and be friendly with the workers and know what was going on.

When Apollo was finished and they got ready to ship it to the Cape, they had an airplane to carry the Apollo command service module, and they had an airplane to carry the

paper. It turned out that [one] airplane could easily carry the command service module, but the airplane…wasn't big enough [for the paper]. I think they had to get another one. He coined a phrase, "Well, if we can't fly to the moon, we can stack the paper and climb up there."

Merritt Preston and Scott Simpkinson at the Cape. Of course, there were a lot of others, John Williams at the Cape, [Dr.] Kurt [H.] Debus, of course Wernher Von Braun.

George Hardy, he took the brunt of the cause, I guess, of the shuttle fiasco, but I'm confident that he wasn't a part of the subterfuge and the cover-up. Same way with Bill [Lucas]—I can't think of his name. He was the director of Marshall at the time. He was a very technically competent guy. I'm sure that they didn't tell him. Of course, that was part of his problem, if they didn't tell him what was going on, then he didn't have control of the direction of the center. But he got removed after that. I didn't think that was justified, but you always have to have some scapegoat to blame it all on. [Of course we should not overlook President Dwight Eisenhower who gave the initial go ahead for Project Mercury and Congressman Olin E. Teague who was a very staunch supporter of manned spaceflight.]

BUTLER: Sounds like a good group of people to have worked with over the years and to still be able to be in contact with occasionally.

KLEINKNECHT: Yes. Two years ago, I guess, or three years ago, John and Phyllis Yardley had their fifty-year anniversary in St. Louis, and we went to that, and last year we had ours, they came to ours.

BUTLER: That's great.

KLEINKNECHT: There's another one, Bob Malloy at Martin was manager of Skylab when I came on board. He's another outstanding leader, honest, told you everything the way it was. Another fellow, Gordon Stucker [phonetic], who recently passed away, who was a leader on the Earth Resources Project, and a fellow by the name of [William] Bill Bollendonk that worked for him. John [P.] Healey at Rockwell, on Apollo, he came on board from Martin, right after Bill Bergen did, and he was a spacecraft—I guess it was 101. I don't know. It was Wally Schirra's first Apollo flight. He was spacecraft manager for that. He worked various places since then, at Rockwell airplane plant in Georgia, and Fairchild, but he's living here, and we got together about a year and a half ago and have been playing golf until recently. I haven't been playing recently. He and I were—people could never figure us out. In review meetings we were at each other's throats about what should be done and had to be done, but after we got out of the meeting, we all went to the bar and had a martini together.

BUTLER: Well, that's a pretty good relationship.

KLEINKNECHT: He and Wally Schirra and I had a lot of our own meetings outside of the office.

BUTLER: Sort of off-site important meetings.

KLEINKNECHT: Yes.

BUTLER: The fact that you could argue the facts out in one meeting but then still have a social time together, that shows good respect.

KLEINKNECHT: One time at a meeting, they brought out—I don't know whether—I must have that downstairs someplace—they brought out a cartoon, and it was two vultures, and they called them Kenny and John, and John says, "Blood, hell! I want to kill the son of a bitch." [Laughter]

BUTLER: [Laughter] Oh, my. That's great. It shows a lot of spirit in the program.

KLEINKNECHT: Yes.

BUTLER: Looking back, what would you say is your most significant contribution to the space program, if you can pick one?

KLEINKNECHT: I really can't pick one. I guess I shouldn't be calling myself a leader, but I hope that I provided some leadership that added to the success of Mercury, Gemini, Skylab, Apollo, ASTP, and the Shuttle.

BUTLER: I think you certainly did.

KLEINKNECHT: Of course, there's only about ten thousand other people who think the same thing. [Laughter] Well, it certainly has been projects that couldn't be done by an individual,

and, in reality, an individual couldn't make them a success or a failure. It took a lot of people working together.

BUTLER: I think we've covered most of the topics I had down. Is there anything that we haven't talked about that you would like to bring up?

KLEINKNECHT: I don't think so. As I said, you know more about the history than I do. I didn't think I'd have much to say, but you asked all the right questions.

BUTLER: Luckily, I had some good resources. There's been a lot written about the programs and such, and was able to look at all that, and come up with a few. I thank you for sharing this with me.

KLEINKNECHT: You're quite welcome.

BUTLER: Very interesting.

[End of Interview]