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EDITED ORAL HISTORY TRANSCRIPT

RICHARD H. KOOS
INTERVIEWED BY JENNIFER ROSS-NAZZAL
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ROSS-NAZZAL: Today is August 22nd, 2023. This interview with Dick Koos is being conducted for the NASA Oral History Project. The interviewer is Jennifer Ross-Nazzal. Thank you again for taking time out of your day and mastering Teams today. Appreciate it. I thought we would start by talking about your interest in engineering and science as a child.

KOOS: Yes. As a child, that's interesting. My dad, this was back, must have been in the '40s, my dad subscribed to *Collier's* magazine and the *Saturday Evening Post*. As I was in elementary school, I didn't read the magazines, but I did look at the cartoons they usually had throughout the magazines. One in particular that I remember illustrated a city block fenced off for construction, at least the big machines in a big hole in the ground suggested that a big building was in progress. There were knotholes in the fence; there was a child looking through from his level, an adult at his level, and a dog at his, all looking at what was going on. What intrigued me was how did they get all that stuff, or who thinks about how getting all that stuff to build a big skyscraper, as I imagined it. It was always intriguing how people planned these things. How they'd do big things.

In high school I'd be asked what I wanted to be when I grew up. I remember saying "Well, something in science." My folks encouraged college for me because my dad had to leave school at the sixth grade because his dad died at an early age. At the time sons of the family would work to help the family. Fittingly, at age twelve he worked in a candy store. Mom went

to school until the eighth grade in a white-one room rural schoolhouse with a two-seater outside. They hadn't had much exposure to higher education except they knew it would be good. So something in science, really technical, was about as specific a vision as I had, even later as my college years approached and even when I went into college. I guess, it was, basically, get started then see what my way ahead would be. But it was something besides manual work as dad knew so well. I started out with a two-year program at a small liberal arts school. In Iowa there are three state universities: Iowa State Teachers College at the time [now University of Northern Iowa, Cedar Falls], Iowa State [University, Ames], and University of Iowa [Iowa City]. All had arrangements with the Iowa Conference liberal arts schools. They had a two-year program that prepared you for going on and what field to pursue after transferring to the major schools. It's like community colleges work now.

I started out with that idea. I got some of the pre-engineering and basic science. Then I became interested in history, economics, and business and some of the other liberal arts. Looking back, I think it was very good for me over the years. In my junior year I decided to stay at the college and adjusted my schedule to graduate from the University of Dubuque with a BS degree in math and economics, so I thought. For my junior/senior year I had scheduled too many history courses. My counselor promptly told me I was not going to meet requirements to graduate.

ROSS-NAZZAL: Oh no.

KOOS: I had decided to stay there instead of transfer to Iowa. I switched over to math and economics, which fit requirements. Wasn't all that great a student really, however. Taking what

I did I feel sparked interest in a broad education. In fact, I had read that a broad education was encouraged. I think that advice proved to be helpful as time went on.

But let's see. You're interested in what happened afterward, I guess. I graduated, and would you believe? I still didn't know what I wanted to do. I knew what I didn't want to do was be an actuary for an insurance company or something like that. Boring! I did know that much about what I wanted.

The summer after graduation, I joined the military for three years, so I could get to one of their technical schools and ended up at Fort Bliss [Texas] at US Army Air Defense Command. They put me in the missile guidance maintenance school. They already had antiaircraft guided missiles, the Ajax and Hercules, deployed around metropolitan areas. That was a whole year of school. Then we went for a few months up to the range camp where they test-fired the missiles. I don't know how much detail you want to hear about all this. They had a firing range where they used the missiles to shoot down radio airplanes. At first, I was in supply handing out blankets. I asked for a transfer to an office that was developing a prototype computer, a model for the air defense systems, for war games. The hands-on experience, learning about guided missiles in the 1950s, was a wonderful boost to my interest and I think being hired by NASA.

I worked in an office with an IBM [International Business Machine] 650 which had "big" drum memory, running on vacuum tube electronics. When you'd run it, the room would get hot. It would shut the computer down. But I did get some experience in machine language, how to plan what I wanted to do and punch the cards, collate, and assemble them with the program and run it. And it worked okay.

That's about all the actual experience I had, but it taught me what you could do with a computer. At that time, they used FORTRAN. Of course that's old. Now our cell phones would

more than swallow an old computer like that. It took about 45 minutes to run the model on the 650. We went over to Fort Huachuca in Arizona and ran it on a 1100 or 1102. I can't remember the exact model. It ran in 3 minutes.

ROSS-NAZZAL: Describe how you used the computer.

KOOS: It was a prototype program. You set up a model of an air defense system where there were airplanes at a certain speed, altitude etc., heading at their target. It's like today's Patriot missile defends Israel. It was something like that, only in the early stages. You'd run it, and it'd tell you how many airplanes were shot down protecting whatever community. They had them all over the country at that time around metro areas. I didn't even know anything about computers before joining that office.

I was in for three years. In 1960 I started thinking, in August or July, I better start thinking about what I want to do when I get out of the service. On the dayroom magazine shelf I ran across a pamphlet or booklet that was really a resume service. It had pages and pages—it wasn't terribly big—but it had a lot of companies of different kinds, and some now that don't even exist, like Kresge's and Woolworth's and Sears, Trane Air-Conditioning, Sperry, Remington Rand, the computer company. One page was NASA.

I filled it out and sent it in. It was just basically a resume. They'd send it around to all these companies. I got a call one day from Chris [C.] Critzos in STG [Space Task Group]. He asked me if I knew about America's man-in-space program. I thought back to Saturday afternoons between ball games, when the military services would have half-hour PR [public relations] programs. The Air Force showed all these Atlas missiles. They'd light off and

explode on the pad with a big ball of fire. I was thinking are they thinking of putting somebody on top of one of those things? I thought, "Well, this has got to be some really future program. That ought to be good because I could learn. I'd have time to learn something. That'd be a really good thing to do."

I said "Yes," which was probably the best lie I ever told.

ROSS-NAZZAL: You sounded convincing?

KOOS: Yes. Then he said, "Fill out a government application for work." I did that, left the Army, and came back here to Iowa. I think it was a week or two later. He called me, and I had received their offer. He said, "Have you gotten our offer?" I think I was about as blunt as what I'm saying now. I said, "No. What is it?" He told me, "It's $6,345 a year." I thought well, that's good. I hadn't seen the letter of course.

A few days later I did get the offer. I saw all these pictures at Langley Research Center [Hampton, Virginia], wind tunnels and all those kind of things in a brochure. I saw wind tunnels on the campus with engineers running them. And I said, "Oh boy. I accepted this offer, and I hadn't had any aerodynamics or any of that." But I did have that exposure to the guided missile and the systems that make it work and some limited experience in computers. What I have learned lately is that in those years computers were so new that an offer or somebody that knew anything about computers, they were favored to be hired. So I just lucked out. The timing was perfect.

ROSS-NAZZAL: Did you have any idea what you would be doing? You mentioned seeing all this aerodynamic stuff. Did he mention this is what you'd be working on?

KOOS: The man-in-space program. I thought it was a far-off thing. How could you launch someone on one of those. No, there was nothing specific, no job description.

ROSS-NAZZAL: You hadn't been following Mercury at all. You hadn't followed the selection of astronauts?

KOOS: The Sputnik flew in 1957, I was on the train ride from Ft. Collins, Colorado, where I did basic training. When I checked into the barracks, I heard about it. In the Army there's a lot of loose talk about stuff. There were stories about cars mysteriously stalling on the highway from El Paso north to Roswell, New Mexico, and aliens from space that were "seen" there. Having heard Chris mention our manned space program for the first time, although, for me at least, it was a little new to me. I didn't take to the Roswell thing; it didn't seem real even as I would eventually work putting man in space.

For some reason I missed the selection of astronauts or anything real about spaceflight except seeing the launch attempts that failed. When you're in the service, you didn't read much news except exploding of missiles. Guys didn't say much about it even though there was talk about conspiracies, etc. All Chris told me when I was talking on the phone with him was how to get to the Langley Research Center. And of course, the offer amount which was fine with me. I said, "Oh, okay, I'll get a map out and drive over." So, I did. The letter said report on September 19th, so I did.

ROSS-NAZZAL: Were you married by this point?

KOOS: Oh, no. It was high school, college, service, and work. I suppose that was the normal for the fifties. A job would come first. The only real full-time job I had was between school years during the summer months. I worked for the local county surveyor crew, working on country roads out here in Iowa. So, like a lot of events to come, it was a new adventure.

I just drove my car. I don't remember what day of the week it was. I knew it was Hampton or Newport News. Driving into Newport News I missed the nice little Holiday Inn on the outskirts of town and didn't see where I was going, so I had to stop, look at the map, find out how to get to Hampton, because I knew it was there. I found the old Langley Hotel in the little town of Hampton. Of course, with this name, I said, "Oh, Langley Hotel, it must be not far away." I got a room there over the weekend. Through the weekend I was driving around and found my way over a small bridge onto Langley Air Force Base. That's where Langley Research Center was with the Air Force had a fighter unit there. I just drove around in the fall, by September trees were very pretty. Virginia is a very pretty state.

I must have seen the sign that said Space Task Group, so I said, "Oh, okay, this is where it is. This is where I go." I guess it was a Monday. Whatever, it was the 19th of September. Found the little trailer, mobile home, to go through all the administrative stuff. They said, "Well, just walk across the street to that building." Across the alleyway from the offices was a wind tunnel.

Offices were all nice-looking brick buildings. The street was lined with beautiful trees. Said, "Well, this is not too bad." I walked over, and there was Chris Critzos in the hallway. I

guess they must have told him I was on my way. He said, "We want you to meet Chris [Christopher C.] Kraft, so just go into his office over here. He's in a meeting; he'll come see you. I looked around his room and saw on his desk a picture of an Atlas missile that was all in flames right off the launchpad. For sure, he had that right in front of him just to remember. I knew that. I said to myself, "Oh, wow, it's really an Atlas they're going to use." It gave me a sense of how serious about getting things right they were.

Then he came in. We talked a little bit, mostly welcome and introductions. I'm not sure what we said, but then Chris Critzos took me down the other end of the hall. It was a room at the end of the building with a green tile floor. Must have been 20 desks, some with engineers working. On the opposite end of the room was the glassed-in office for John [P.] Mayer, branch chief and his assistant and Carl [R.] Huss. They had me sit down. John started to talk to me about how—this would have been 13 years earlier—Chuck Yeager broke the sound barrier. At that time, they were in Langley's Flight Research Division when the sound barrier was broken at Edwards Air Force Base[California]. He told of how they didn't really know the test successfully broke the speed of sound until the next day when they processed all the tracking data. I said to myself, "Oh, wow, how did I get here in this place, with these people? And what do they want me to do?"

They told me to go over to this other smaller room off to the side. It was to meet the guys that are in what was called the Control Center Simulation Group. Except for Harold [G.] Miller they were in meetings away from their desks. So, just walked in and introduced myself to Hal. The next few days were settling into my desk and getting familiar with the four other guys. There was Harold Miller, Dick [Richard A.] Hoover, Glynn [S.] Lunney, and me. Stan [Stanley] Faber was in the supervisor's office. He was the group leader. They were starting the next phase

of Project Mercury which I began to learn about. They had put the group together to run the simulations in the Mercury Control Center [MCC]. They had been planning the simulation systems themselves, Mercury Procedures Trainer [MPT], and the telemetry system that sent data to the MCC from the MPT. I was added to the group, and it was a while before they let me go down to the Cape [Canaveral, Florida].

They were already starting to run simulations, the very very first ones. Frankly, it was boring because there was nothing to do at Langley at this point, at least until I became familiar with the system and that required being at the Cape with hands on the simulation system and the MCC. The Mercury Control Center was pretty much complete except for the communications units. They weren't working yet. They had a shuttle (a Convair 440) that went back and forth twice a week, and when they were gone down to the Cape, I was back there by myself in that little room, trying to figure out my role mostly by imagination. They had shown me an organization chart of the consoles and positions and their responsibilities in the Control Center. Most helpful was the Mercury capsule systems handbook which had diagrams of its several systems. Of course, it was the very object of our attention through the Mercury Project, so it was no small thing and something which would become my key source for selecting problems to be presented during simulation exercises.

ROSS-NAZZAL: What sort of tasks were you working on while they were down at the cape?

KOOS: I don't know. I can't remember I did much work except learn. There wasn't very much I could do yet. I didn't know much of anything yet. Looked through the little package that described the organization and job description of the console positions of the MCC. It described

who was to do what in the MCC, trying to understand it a little bit. As best I could without seeing the MCC.

The first unmanned Mercury-Redstone flew when they had the problem where it launched the escape tower. The capsule—as we called it at the time—and Redstone stayed on the ground fully loaded with fuel. I don't know if you read all these stories. The flight control team came back to Langley, talked about how they would stabilize and defuel that rocket sitting there with all this oxygen and kerosene so that they could get to the spacecraft and retrieve it.

The first time I went to the Cape was a little bit later. I was on the shuttle plane over at Langley Field, and we were sitting there ready to go. Somebody came in and said, "Mr. Koos, will you step out please?" They took me off the plane. I don't remember who it was. I think it might have been [Walter C.] Williams. He thought I hadn't been there long enough to go down to the Cape. The next day Chris Kraft, who hadn't gone with the team, came to me in the otherwise vacant office. He came in and said, "Well, we're going to put you on a commercial plane down to the Cape tonight. Don't tell anybody I told you this." That was the kind of take action guy Chris Kraft was. He didn't ponder very much at all in making a decision. Furthermore he definitely understood no one was going to learn anything about the MCC and the whole operation without being involved. It wasn't like an academic library.

I went to Patrick Field for a plane to Newark and then flew down to Orlando. I'd never been anywhere like those places. Found my way from Orlando over to the KoKo Motel at Cocoa Beach, walked into the hotel room where they were going through a countdown preparing for the next day's simulation. That document was the countdown for the launch. During the exercises we would read the countdown so the flight control team would be familiar with the operation. That's how I got started. We went through the countdown as it was a script in the Control Center

so everybody'd get used to some of the calls they would respond to in the countdown and when they would occur and it gave people in the MCC information about the capsule systems status.

That was the beginning, one of the first few simulations of many that we were to run. There had to be some sort of rehearsal and what better way than to use the MCC itself. I think they put MCC together with the Mercury Procedures Trainer because the MCC never had control over a satellite. I think maybe the Air Force Discoverer Program, where they ejected satellite cameras and caught them on a net by airplane. I thought my gosh, especially with someone orbiting in a space capsule. You had to have monitoring of their health, of the systems, of everything in the vehicle. That's why we were there, to help facilitate preparation by practicing.

ROSS-NAZZAL: How did you become acquainted the Mercury capsule? In order to simulate you really have to understand the vehicle, the spacecraft itself. How did you, a mathematician and econ major, become acquainted with this complex spacecraft?

KOOS: Yes, I guess I can go back a little bit. When I was alone in the room up there, they did hand me, I think I still have one here at home. It's a handbook with colored schematics of the vehicle systems that McDonnell put together. That was the very first one. In later programs, Gemini, Apollo, Gene [Eugene F.] Kranz used the flight control guys to prepare that kind of book rather than have the contractor do it, because it was an excellent way for the flight control team to learn the spacecraft systems.

It developed a real good process for training, it was one of the ways. But yes, I did have a chance to look at that, go through it, and study it a little bit. It wasn't like I went down there completely dumb. We referred to it in planning the simulations through the Mercury Project. At

first, I didn't do a whole lot. I was mostly just learning. Is that what you wanted to know about the Mercury procedures, the room where we were?

ROSS-NAZZAL: What was that room like? What did it contain? I know the Control Center—there wasn't a lot to it. When you look at Mission Control today, it's a lot more complex than it was back then. Very I guess simple is the word.

KOOS: Yes. The capsule part of it was in one end of the room, and off to the side was the analog computer. Everything was analog then. Wasn't anything digital. The capsule had what they call an 8-Ball to show the attitude reference responding to the crewmember's use of the control stick. The control-stick, with the analog computer responding were the only computers that could do all the fast computations necessary for attitude control and vehicle dynamics.

In front of the MPT there was a console called the telemetry console with an equipment rack. Electrical signals were taken off the simulator into a commutator, which assembled the signals together for transmittal to the MCC. Each of the parameters was a measurement of some aspect of the capsule systems that indicated capsule status. There were 88 measurements such as cabin pressure and temperature that were transmitted by cable under the floor over to the telemetry room and distributed to control room consoles for the flight control team.

The only commands were the abort command for use if something occurred during launch and retrofire, which was for effecting reentry, The simulations were closed loop while the exercise simulated the part of the flight when the capsule (the MPT) was only within communications of the MCC. When the simulated flight was over the stations located around the

world, it had to be by voice with instructions to the crew. That's basically what the setup was. Closed loop meant that any action taken by the flight control team as they would in a real flight.

Around the world there were all these sites. I there were 9 remote sites with flight control teams. They went around the world from Bermuda to the Atlantic ship to the Canary Islands to Kano, Nigeria, to Zanzibar over to Australia, Woomera on the west side, Muchea on the east side of Australia. There was a big gap around the Pacific because there was no coverage there. There was an Indian Ocean ship.

That was okay for [Alan B.] Shepard's flight, but when flights started going into orbit, we had to put telemetry tapes together to give all these sites so they would be part of the whole operation, send in the data, give reports, and talk to a simulated astronaut. Astronauts were out there, part of the each remote-site flight control team.

The launch, the closed-loop aspect of it, worked really well because as we introduced a problem, we called them faults, people in the MCC and the astronaut crew would take corrective action as they would in real flight. Consequences of their action would most always be true. There were some cases when the simulation didn't respond correctly. I remember when we ran something, and we did this every now and then, a problem of some sort with the cabin pressure or suit pressure. If it happened during launch, it always started lively discussion. I remember that. I don't remember the circumstances of the sims.

ROSS-NAZZAL: Do you remember how you came up with these ideas for problems, malfunctions?

KOOS: Go back a little bit. Jack Cohen left about the time I came there. He left for IBM, I think. He was there from what's the aircraft company that folded or laid a lot of people. Among them, Tec [Tecwyn] Roberts, John [D.] Hodge, a number of them. He must have gone to Australia because we connected by e-mail long after Mercury. He must have followed things because he was impressed by what we had accomplished. Jack was the leader of the Control Center Simulation Group as they planned and implemented the system.

ROSS-NAZZAL: The AVRO-Arrow guys.

KOOS: Jack Cohen, he asked me, "Would you like to run the telemetry console?" I said, "Well, sure." By then I knew enough about what the telemetry system was and the simulation console that went with it. I'd learned what the simulation system was. I couldn't fix it with a screwdriver, but I knew how to use it. I understood what we were doing with it. I knew how to go back to that handbook that McDonnell wrote, and I'd just go through it—if this valve or that valve would fail what would happen. Or if that electrical converter didn't work what would happen and so forth. That's how we really developed what problems we would insert.

I was saying that when you get to the orbital flights, we had to build all these tapes for the remote sites to be played during their time when the spacecraft would be within communication. We would get all the calibration and everything for telemetry set up from the data that we had. Technicians at the Cape would make copies for each remote site to be played during the simulations. I'm sure going into a lot of detail.

ROSS-NAZZAL: That's okay. There's nothing wrong with that. As long as you're okay with that.

KOOS: That's just where my mind is going.

ROSS-NAZZAL: Did you get a chance to go out to the remote sites yourself?

KOOS: No, I didn't. You asked about Shepard's flight. You asked me what I did for those. Simulation really didn't have much responsibility during the flight because we were busy with the simulations. I think maybe Faber and Dick Hoover and Lunney were understudies at that time, they were taking a position in the MCC.

A lot of people would move up and then somebody else would take their place. They were building the organization that way. I was asked to be the escape tower observer in case there was an abort. I could observe what happened. Of course, it happened to be that the rocket was behind a cloud that day. Wouldn't have done any good anyway. That's what I did then, because I was young and inexperienced. Although it was eight months or so when I started working there. Being a complete newbie, they couldn't trust me. Ha!

ROSS-NAZZAL: What did you think when that rocket went off and you knew that the Space Task Group had been successful?

KOOS: It was a relief. I tell you what. Something like that you'd expect they'd be pretty nervous, I guess. Building those tapes became my big job because we went into a more orbits. I

would go down to the Cape with a couple Philco tech rep guys, and we'd record problems on tape. The procedures trainer would just get it running through the flight plan, and we would have someone in it as astronaut. Some of the McDonnell guys that were maintaining the trainer knew how to fly it so they helped a lot. They did some of the astronaut tasks and tried to follow the flight plan. We record problems in like that to be sent to the remote sites.

That period, 1961, a few weeks before Shepard flew, Yuri Gagarin had just flown. We saw that, and we knew we were in a race for sure. We knew that we had to catch up. The week before Shepard flew, we had a full-up Mercury capsule on an Atlas without crew. It was the first test flight to prove the network of sites was ready. It got about 40 seconds off the pad, blew up like all those that I had seen on video on television.

I remember around that time we went over from Cocoa Beach to Cocoa for dinner at the Luby's cafeteria together: Tec Roberts, Carl Huss, and Harold Miller and myself. Harold said as we were driving over the causeway, "Maybe they just put a voice tape recorder, made it look like there was an astronaut onboard to fake it." Wise old Tec Roberts said, "Now Harold, you know we're trying to do the same thing. Why do you think that they aren't doing it?" Harold was about as young as I was, right out of school about a year from a technical school in Tennessee. Gagarin flew. A couple weeks later MA [Mercury-Atlas]-3 blew up. That weekend we went to the bars a little bit and got some attitude adjustment.

Then Shepard had his flight the very next week. So, the next day we worked in the MCC sim room getting ready for simulations with Al Shepard. Before we went back to Langley, a group of politicians from Washington came down and toured the MCC, Vice President [Lyndon B.] Johnson and Senator [Robert S.] Kerr; everybody was shown around the MCC. Johnson and Kerr were huge guys.

It was a couple weeks later that [President John F.] Kennedy made his speech about our going to the Moon. For me it just came totally out of the blue. There may have been some people in NASA doing some early planning, but people around me didn't seem to know about it. Everyone reacted with, "What? We haven't got anybody to orbit yet and here we are going to plan to go to the Moon." That was probably the universal reaction of everybody.

We were going to have our first simulation of John [H.] Glenn's flight in June, so I had to make some tapes for that. I did record them, of course at the MCC. I came back to Langley and immediately drove home to Iowa and Beverly and I were married on the 17th.

The only other thing to say about Mercury was I eventually became a Sim Sup [simulation supervisor] down there, and you asked something about the name. I don't know how that became the position title. I just don't remember that. It was already done before I got there, I think. This is going to get boring, if we do this a lot.

ROSS-NAZZAL: Are there any fun stories from that time? You were a bachelor down at the Cape. Were there any antics going on that you recall? We often hear about the flight controllers and the things that they would do to one another. Were there things that you would do in simulation, or were you a serious group?

KOOS: Oh, I think generally pretty serious. Boy, there was a lot of joking around back in the hotels and the bars. Harold, Carl Huss, and I shared a room every time we went down there and stayed at the Polaris Hotel, which I'm not sure is even there anymore. It was a nice little quiet place; the bar wasn't really busy with a lot of people. There was a beach there. When I

mentioned MA-3 that exploded and then the attitude adjustment, we did that in earnest. Harold Miller and I visited a quiet bar called the Ivanhoe.

Paul [L.] Havenstein was the assistant flight director. Gene Kranz was his understudy. Yes, STG was young and there were only about 600 of us, but it started with 30 who had been working on manned spaceflight before [President Dwight D.] Eisenhower formed NASA. When I realized that, I understood how fortunate I was.

The Polaris was just a two-bed hotel room. We had a rollaway bed for one of us. Harold and I got to flip a coin who got the rollaway bed. Carl's hobby was airplanes, little plastic model airplanes. He would sit around when we had time. He would be painting them. I don't know, I guess we were a bunch of clean-cut guys, mostly tired from the long days and early hours.

ROSS-NAZZAL: What were your days like when you were at the Cape? What would you be spending your days on?

KOOS: After MA-3 blew up, MA-4 was the first time we were exercising the network. The first time we held a simulation with the whole network using our recorded tapes. For MA-3, which didn't make it off the launch pad, the remote sites only had some test tapes. They didn't make any sense representing flight activities that were programmed by a sequencer. I hadn't been there long enough to really understand what all this was about. I remember clearly, the flight control teams at the remote sites were frustrated with trying to make sense of the data. I remember Arnie [Arnold D.] Aldrich was very vocal about it and justifiably so. We tried to make more sense out of them but it actually became a mess doing it from the MCC with not

knowing what was recorded. It didn't work well, but it was good enough to show that the network was ready to support the flight, MA-4 which would also be unmanned anyway.

We worked on it feverously that week. We'd get up at 2:00 in the morning and then simulate the countdown and run through an exercise, which took couple hours for a single orbit. Then try to do better the next time. The rest of the time we tried to figure out how to manipulate the recorded data to be more real. We were working like 20, 22 hours a day for a few days in a row. That got kind of tiresome. Then it blew up, which deepened our disappointment.

ROSS-NAZZAL: Why did you have to get up at 2:00 a.m.?

KOOS: The real countdown started then. We did everything just like it was supposed to be.

ROSS-NAZZAL: I see.

KOOS: We'd get back sometime still early in the morning, after we'd run the exercise. I think we only ran one simulation a day. The eventual challenge as Mercury progressed was to provide simulation for a 24-hour flight, which was to be [L.] Gordon Cooper's.

During each flight the sim guys would listen to the back-room loops, and during John Glenn's flight, MA-6, there was a problem with the heatshield, which turned out to be just a misaligned microswitch. I remember George [C.] Guthrie at Corpus Christi giving them the instructions to not jettison the heatshield. The revolution before that, there was all this conversation in the back room. McDonnell was on it. I'm sure Kraft was. I don't know who else, but Max [Maxime A.] Faget was there too, and he said, "Just don't jettison. It'll be okay."

That goes back to the experience those guys had. During World War II, Faget was working on reentry heating. So he was certainly aware of the problem of reentry heating. In fact, John Mayer and Carl Huss and some of the other ones, Kraft was one, I think probably Chuck [Charles W.] Mathews, were working in flight research. Mercury was quite a few years after the war, but they were working on Project Mercury before Eisenhower created NASA in 1958. They were starting to already put together that big thick—maybe you saw it—book of equations for about everything associated with spaceflight, all in handwritten equations. I still have a copy.

ROSS-NAZZAL: I may have seen it, but the equations probably didn't make any sense to me. I will admit that readily.

KOOS: My last Mercury flight, they called it Sigma 7, Wally [Walter M.] Schirra was the astronaut. You asked what they said about us. They'd moved us upstairs, above a wind tunnel across the alleyway, and Stan Faber was up there with me. Wally Schirra came in to talk with him about the flight. Stan introduced me to him and what I was doing. He said, "Oh, *stimulation*." I kind of emphasized that. But it was meant to be complimentary. He had the team idea of the whole operation, which was why he used, I'm pretty sure, he used the Sigma, the sum, to recognize the team approach.

I did Wally Schirra's flight, and then we moved to Houston. It was '62 or '63. Then we did somebody else's flight from Houston. I don't remember who was next. Was it [M. Scott] Carpenter? I've forgotten.

We did one more flight I was the Sim Sup for. That was pretty good, had two runs in one day, and we did reentry simulations, launch sims, and shortened orbit sims, because we had to do a simulation that would shorten the flight. Boy, I'm really getting way off.

ROSS-NAZZAL: No, these are useful stories. How did simulation change over the Mercury Project?

KOOS: I think they did run a full 24-hour-length flight like Cooper flew. I think Gordon Ferguson was Sim Sup for that. Wally Schirra was six orbits. Gus [Virgil I.] Grissom was on a Redstone suborbital flight. I think Gus Grissom was followed by John Glenn and Scott Carpenter plus a couple unmanned flights and two with chimps. The challenge sim has always had is adapting to the ever changing the nature of spaceflight. That's beside the point, I guess.

That last one, there were two. We needed two runs. One of the tech rep guys said, "There's one of the telemetry parameters which is a voltage reference." Hal [Harold B.] Stenfors suggested we change the reference so that readings of all the parameters would be incorrect. All the parameters were on a reference scale of 0 to 3 volts. If a parameter was normally 80 degrees was 3 volts, then they'd read 80 degrees to the flight control team. He suggested on our simulation changing that from 3 volts to 2 volts. The 80-degree temperature would be about 50 degrees. I said, "Oh yes, that sounds like a good idea." Simple to do, and they might have a little trouble figuring it out. The truth is when we ran it, they never did figure it out. They never did know what their data was really saying to them for the whole simulation, and they had the tools to figure it out.

Then the next sim somebody, I'm not sure who, wanted to run it with a sick astronaut. They tried to instruct the astronaut, simulated by a technician at the remote site. We had written scripts to use as the scripted "simulated astronaut" to reenter and told him when, but he didn't follow our script. Things went to Hell in a hand basket quickly. It got so bad we just said, "Well, we're going to have to terminate this."

ROSS-NAZZAL: Oh no.

KOOS: It went from the sublime to the ridiculous. That's what I told the flight control team as we terminated the sim. I was the Sim Sup for that one. That was the first time at it.

ROSS-NAZZAL: How would you describe simulations during Mercury? Were they pretty formal events or were they kind of casual, easygoing? Did you type up the scripts, or were they handwritten? Can you capture those details?

KOOS: We wrote some things down. I don't remember exactly, but we began to use scripts in Mercury. Maybe it got to the point where we were so busy that we didn't get a chance to write everything down. When we came down to Houston, when we started simulations there, I think we got a little bit more formal.

Fact is I wasn't in simulation at the time when they finished all those flights. Let's see. They finished simulation—I guess that was after the program was over for Apollo—they were all in file drawers. They were all sent up to some government archive in Dallas, I guess the

government has them. I mentioned that to this John Tylko that I told you about. He said, "They're not organized. I understand it's difficult to find anything."

ROSS-NAZZAL: Oh no.

KOOS: Or it would take a lot of work.

ROSS-NAZZAL: That's too bad.

KOOS: For people like yourself.

ROSS-NAZZAL: That makes it difficult to learn those lessons learned. Were there any lessons that you learned during Mercury that helped you as you started thinking about this new program that you were going to be working on, Gemini?

KOOS: Yes, Harold Miller and I talked about a lot. It frustrates us when you're playing tapes for all the remote sites, and somebody takes an action that doesn't fit the scripted crew. The simulation comes apart when the data is recorded and fixed. That tended to be that way. It happened often enough. Chris Kraft understood that. We talked a lot about, "Boy, we need to get a simulation system." By then Hal Miller and I were thinking, "Will we have computers to use in the Houston Control Center? Yes, we ought to do a simulation so that we can be closed loop."

The idea was that you'd have a simulator on-site and interface it with the Control Center. You'd have coverage for the whole flight or as long as you wanted. You'd just simulate the loss of signal when you're not in coverage. That was an aspect of closed loop. The other aspect is the flight controller sees the results of what he's done. The quality of simulation must be good. That means there's a lot of data to be generated with a capability to respond to commands. The other flights, Gemini and Apollo, had a lot more data than the 88 parameters on Mercury. That was one of the first things that we started worrying about. It takes big, fast computers. Then when we went to Houston that's what I did for Gemini, I worked with the people who were working on the simulator to work the interface out with the Mission Control Center in Houston.

Harold, I think, came up with the name: Simulation, Control, and Training System, SCATS. It's also a training system, but it's also a test system in the sense that the front end of the Mission Control, the data went into it in the same format it would in flight. It would just be distributed and reacted upon as flight data. Those spacecraft added the uplink which didn't exist before. There were two things: the results of whatever flight controller action he took or recommend, he'd experience; he would see the results. People asked us, "Well, do you grade the flight controllers?" We did not, but it provided an opening for their supervisors to provide an evaluation. That was Gemini and Apollo.

ROSS-NAZZAL: I did want to go back and ask you. For someone who's reading this, would you explain in detail what you mean by closed loop?

KOOS: Oh, okay. Closed loop means that if flight controller sees a simulated problem with the system he's monitoring and then takes action as the result of something that in our case would be

a simulated problem. He would act, give verbal recommendations for the astronaut or through a data uplink to the spacecraft, and then the simulated spacecraft would respond. Then he would get the results, good or bad. If he did the wrong thing, he would get the wrong results. That's what closed loop meant. It was kind of a self-learning in that respect. Although we didn't involve them in knowing in advance anything we were going to do. We were really independent on the problems that we included. Does that explain it to you?

ROSS-NAZZAL: Yes. You mentioned the 88 parameters. Would you elaborate more on that? What does that mean? There were only 88 items that you could simulate or that there would be problems with?

KOOS: Cabin temperature, suit temperature, oxygen pressure, cabin pressure, suit pressure, each of those is a parameter or a piece of data that tells you about the health and performance of the spacecraft. When I said 88, those are the primary ones used in operation during Mercury. The Apollo and Gemini spacecraft, the number went to hundreds for each. There are also vehicle dynamics parameters that were also included, that were much different and more complex to simulate. There were also EKG [electrocardiogram] and respiration for health monitoring in Mercury that were analog. Those parameters were—oh gosh. I'm getting myself in deeper technical stuff.

ROSS-NAZZAL: If I'm asking something too complicated it's okay.

KOOS: The commutator—that I referenced earlier was used in Mercury—was what took all these signals and put them into serial form for transmission to the MCC. Then the ground system unraveled it all and distributed the data to the appropriate consoles. Hope that helps. The advance of computers and digital communications has certainly accelerated what the space programs use to monitor the spacecraft and receive scientific information. Now we use big computers as phones to communicate around the world in a flash.

ROSS-NAZZAL: How closely were you working with the medical team on some of these issues in terms of monitoring the astronauts during simulations?

KOOS: For the tapes we sent to the remote sites on MA-7, Schirra's flight, we each took turns being wired to record our EKG. We learned from an Air Force doctor how to increase our heart rate to give the flight doctors at the sites something to report. Medics around the world all reported different individual's hearts. I remember Chris Kraft saying, "Well, just like a doctor, nobody's going to agree to anything." Or something like that. When we moved to Houston—new people were taking over for Mercury's last flight and the new Gemini sims. They went up to the medical center in Houston, and they got a bunch of recordings of heart attacks, all anonymous of course. Then they played tape recordings at the remote sites in one of the sims. Of course not all heart attacks are the same. They used several. The medics all around the world reported what they saw wasn't the same individual and when reports arrived at the MCC it caused much confusion. That was one sim people talked about a lot.

ROSS-NAZZAL: Kind of stands out in your memory. You mentioned moving to Houston. What did you think about moving to Texas when you heard Houston had been the site that they had selected?

KOOS: As soon as I got to Langley, we started hearing, we're going to move. Space Task Group was just moved on one side of the Langley Research Center for conducting man in spaceflight, separated administratively from Langley. It wasn't a full center, yet. It was a group organized for that specific task. Langley was called by Johnson Space Center people the "mother" center. We heard we might move to Goddard [Space Flight Center, Greenbelt, Maryland]. We were rumored to move up to Goddard, go down to the Cape, or go to Oklahoma City or Tampa. There might have been other ones. That's what we followed but not so much so not to lose focus on work.

I remember talking about it, and one guy who was a Philco tech rep said, "Don't you know? We're going to go to Houston. Haven't you read the *Congressional Record*?" That carried on for quite a while. Then suddenly it was decided, I think it was after Kennedy said we were going to the Moon, maybe not. Maybe I'm wrong about that. I said, "Well, okay." There wasn't anything to react about or talk about right away.

Beverly and I had a three-floor apartment, and the couple upstairs worked for Exxon in Aruba, I think. We told him about it, and he said, "Oh my. You know, that's the same climate as Calcutta, India." I said, "Oh my, it's hot and dry there."

Going to Houston, we got all our stuff packed up, and we bought some furniture and got that all trucked to move. We drove back here to Iowa to see the folks. On the way we stopped at a hotel in Ohio; we had to have heat in the hotel. We drove down to Houston with a car with no

air-conditioning, and it was 102 degrees for two weeks. That was bad. But I suppose you really have it bad now.

ROSS-NAZZAL: Oh yes. It's been 108 lately.

KOOS: I saw this bumper sticker that says, "Impeach Earl Warren," put there by the John Birch Society which was active at the time. I mentioned it to Glynn Lunney and he said halfway in jest, "Do you think they want us here?" Otherwise, it was just a big place. We were at the Stahl-Meyers building when we came there. Kranz was the branch chief of the flight team. Tec Roberts still worked a little bit with Mission Control. He was a flight dynamics officer. Glynn Lunney had been the backup flight dynamics officer at the Bermuda site. People were moving into new positions as they gained experience. Dick Hoover and Stan Faber moved on to other parts of what now was to be called officially, the Manned Spacecraft Center.

Thinking about Tec Roberts, reminds me of a guy, Craig Scott from Wales who said, "The home that Tec Roberts grew up in has a big sign for him recognizing his birthplace." It says something about the Tec Roberts home and that Tec was the first flight dynamics officer in NASA's man-in-space program which is, I thought kind of neat.

ROSS-NAZZAL: That's wonderful. Nice to see history being preserved. I wonder if this might be a good place for us to stop and pick up on Thursday. We could start talking more about coming onto the center, once the center was finally built. Working on Gemini and Apollo.

KOOS: Okay.

ROSS-NAZZAL: Unless there's something else that we didn't touch on.

KOOS: Something in Apollo that doesn't have to do with simulation, I guess. After Apollo, let me see. Got Skylab. Then after Skylab there's some things I could talk about there, I guess. I don't have very good memories of Skylab. That shift they set up for us was terrible. You probably heard about that.

ROSS-NAZZAL: I did. I heard about the sleep shifting that they had to do.

KOOS: I don't know how. So many days on, a couple days off. Then you'd rotate. You rotated backwards somehow or other. Then it would shorten your days off is what the effect of it was. It was just tiring and not good for home life.

ROSS-NAZZAL: I bet. Shift work is kind of like that, right? Having to do a day shift and the night shift.

KOOS: If you're not on a shift consistently, yes, it's hard.

ROSS-NAZZAL: Yes, that's difficult.

KOOS: Training aircraft is one of the things I worked on. I won't go into it here. I can wait till Thursday.

ROSS-NAZZAL: That would be great. Once Apollo ended it was hard to find a lot of detail.

KOOS: Disappears.

ROSS-NAZZAL: Yes. It was kind of strange. I don't know why that was the case, but that would be great.

KOOS: We did a downsizing. We took some other jobs just to keep us around, a lot of us. That brought us into the Shuttle Training Aircraft and then was there some stories about that. Jimmy [James E.] Bodmer, the Spacelab Instrument Pointing System. That group were nice people.

ROSS-NAZZAL: I want to thank you for spending some of your morning with me. I look forward to hearing more on Thursday.

KOOS: That's fine.

ROSS-NAZZAL: Have a nice day. I'll see you on Thursday.

KOOS: Yes. Thank you.

ROSS-NAZZAL: Okay, thank you. Bye-bye.

KOOS: Bye.

[End of interview]