ORAL HISTORY TRANSCRIPT

DR. JOSEPH P. KERWIN
INTERVIEWED BY KEVIN M. RUSNAK
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RUSNAK: Today is May 12, 2000. This oral history with Joe Kerwin is being conducted at the Johnson Space Center in Houston, Texas, for the JSC Oral History Project. The interviewer is Kevin Rusnak.

I'd like to thank you for joining us today. It's a pleasure to have you here.

KERWIN: It's nice to be with you, Kevin.

RUSNAK: I'd like to start with some of your background. Tell us about where you grew up, maybe what some of your interests were that might have led you into the field you went into.

KERWIN: Okay. Born February 19, 1932, in Oak Park, Illinois, a suburb of Chicago. I was accused by my big brothers and sisters—I'm the seventh child in the family—of having either caused or perpetuated the Depression by my birth, but I don't think that's true. I am a Depression baby, however. Although I was too young to serve in World War II, I had two older brothers who did serve in that war. I feel more and more out of it as I get older, because there are so many people now who don't remember the events that were absolutely central to the lives of us who were growing up in high school and in grade school during that war.

I read science fiction a lot when I was a kid. Of course, there was no such thing as the space program, and I'm talking the forties through the early fifties. The first V-2 rockets, I guess, appeared in the mid-forties, but there was no talk about sending people into space. It

was all fantasy fiction. Again, my nasty big brothers used to say, “Oh, little Joey wants to go to the Moon. Look, he’s reading K. E. Van Volker, Robert [A.] Heinlein again.”

I went to Holy Cross College in Worcester, Massachusetts, as a Bachelor of Arts in philosophy, with a pre-med minor. Liked the pre-med minor, so I went on to medical school at Northwestern [University, Evanston, Illinois]. We’re in the mid-fifties now. I graduated from Northwestern in 1957, so I was an intern at the District of Columbia General Hospital in Washington, D.C., when Sputnik went off. I had no feeling of connection to Sputnik or the space effort at that time. I was merely a civilian guy going through an internship.

But there was an interesting thing in the fifties called the "doctors draft," the Barry [phonetic] Plan, that was the way the military got their supply of physicians. They gave you exemptions from the draft as long as you were enrolled in a legitimate medical educational program, including internship and including residency, and as soon as you finished it, your name went in the hopper. If it got pulled out, you were up for a two years' service.

My name went in the hopper during my internship and was pulled out by the Navy, so I got this letter about January of 1958, I guess, saying, “Hello there. You have been drafted and assigned to the Navy," blah, blah, blah. And I was in Washington, so I got in my car and went up to 14th and I, I think it is, to the Bureau of Medicine and Surgery and presented my letter, and said, “What duties have you got available?”

One of the several duties that they offered to me was the last seat in the flight surgeon school that July, just after getting out of internship. “Cost you an extra six months,” it said, “but you learn how to be a flight surgeon and you get a little flying time while you’re at it, about twenty hours of time under instruction and just for the experience, and if you pass the physical and the check, you may get to solo in the T-34.” So I said, “Great.”

I bought my uniforms and went down to Pensacola, went through the aviation medicine, and was assigned to the U.S. Marines at Cherry Point, North Carolina, 1959. We are at the beginning of the NASA program now, the height of the Cold War, a time when it

was a very acceptable and patriotic thing to be in the military. I enjoyed my tour with the Marines just immensely, and they were very good to their Navy doctor. They allowed me to start and taxi their fighter aircraft around. [Laughter] A little bit unconventional, but the Marines were like that. They said, "Yes, let's teach the doc how to taxi. Just don't take off." So I did that.

The bug really bit me, and I applied for a program that the Navy had had for several years already, in which they trained a small number of flight surgeons to be naval aviators. This had gotten started back in the late thirties, when a number of Navy flight surgeons in aviation medicine was very new in the thirties, said, "We can understand this pilot business better if you'd train us to be pilots." Half a dozen of them applied for that. Flight training was pretty inexpensive and it didn't take too long in the thirties, so they trained these guys up to be pilots.

Then World War II happened, and at the end of the war, the Navy noticed that those people had done a wonderful job through the war as flight surgeons and were in senior command positions in the Medical Corps. They said, "This is a good program. We'll continue it."

About once a year or once every two years, they accept an application from a doc—and they're still doing it—to be a pilot, get the full flight training, fly the high-performance aircraft and understand the environment better, so that they can apply that experience to certifying and treating pilots. So I applied for that and was accepted, and in 1961 entered flight training in the Navy and transferred from the naval reserve to the regular Navy in order to do that.

I went through flight training. I was assigned to an air wing at Cecil Field, Florida, and met a couple of friends among my pilot patients, if you will, one of whom was Jim [James A.] Lovell and the other was Alan [L.] Bean. One at a time, both these guys came to

me and said, "Joe, I'm going to apply to be an astronaut. Would you help me fill out my medical forms?" So I did, and they were both accepted, obviously.

Suddenly now I had a connection, a personal connection, however tenuous, to what was going on in Houston. In 1964, I was sitting in front of the television with my wife, I think it was David Brinkley, the old Huntley-Brinkley show, announced, "NASA has announced that it will hire scientist-astronauts to go to the Moon."

My wife looked at me and said, "You'd like to do that, wouldn't you?"

I said, "I'm not a scientist. I'm just a doc." But I thought about it, and applied through the Navy. Since there weren't many physicians who could pass the physical and had 2,000 hours of time in single-engine jet aircraft, that turned out to be enough, and I was accepted into the astronaut program in 1965.

RUSNAK: What did you think about the inclusion of scientist-astronauts at the time?

KERWIN: Well, I thought it was wonderful, but, of course, the whole thing was so new that I had no idea what they were really going to do with us, and they didn't either. But it turned out, in retrospect, that the determining factor there was the announcement of the Apollo Program, that they were going to land humans on the Moon, and that there were scientific programs to be carried out on the Moon. Immediately, the scientific community, represented, I think, by the National Academy of Sciences, strongly recommended to NASA that some of the people who go to the Moon and participate in these scientific missions should have genuine scientific backgrounds and not be test pilots.

NASA thought about that for a while, thinking, "This is a highly technical, highly risky, test-piloting program. We're not sure we can afford to carry scientists who aren't pilots along," but they finally agreed that they would hire some scientists, train them to be

pilots, so that they could do the piloting jobs as well, at least in an assistant mode, and carried on like that. It was a hybrid, transitional sort of decision.

I know that when we showed up at NASA in 1965, and I was a member of a group of six people, only two of whom were already trained pilots, the other four were not, and they were immediately sent off to the Air Force to get that "second-class" kind of pilot training that the Navy doesn't give you.

The two of us joined the astronaut program, but they didn't start us into formal training, because two people doesn't make a class. They decided to wait for the next pilot class to come along. So I went to my first Monday morning pilots' meeting in Building 4, up on the third floor in the conference room, and Deke [Donald K. Slayton] and Alan [B. Shepard, Jr.] were at the front of the room. The guys are sitting there, and I'm in the back, and they introduced me.

Then Shepard says, "Headquarters has okayed the selection of another group of astronauts next year."

And Dick [Richard F.] Gordon [Jr.] said, "Are they going to be pilots?"

Shepard said, "Well, I certainly hope so." [Laughter] So I sort of realized that I was here, but I didn't have a distinct role yet.

As it turned out, one of the six resigned very shortly after coming into the program. The rest of the five of us were a mixed bag of specialties, and the only one who eventually went to the Moon on the Apollo Program was Jack [Harrison H.] Schmitt, which was perfectly appropriate because he was the geologist. As the physician in the group, it became pretty clear to me, of course, I would raise my hand whenever there was a new crew to be assigned, and they'd say, "Sit down, Kerwin," but it was very clear that something to do with medical research on long-duration space flight was probably where I was going to fit. It wasn't until the Skylab Program, even before it was called that, began to come in in 1966 and '67, that I felt like I had a role and a mission to shoot for.

RUSNAK: Since you were, as you pointed out, one of the few in your class that was a naval aviator at that time, did you find your reception among the astronaut corps was different than with the other members of your class?

KERWIN: Well, it's hard to compare. You'd have to ask the other guys what their stories were. I think Jack was well accepted, even though he was a geologist. I think Owen [K.] Garriott and Ed [Edward G.] Gibson were pretty well accepted, even though they were physicists and engineers, whereas [F.] Curt Michel, who was a paper-and-pencil astronomer was not so well accepted, but I think that was the degree to which we merged and subordinated our scientific interests to those of the program.

For example, I remember going to Captain Shepard very early in my time there, when I didn't have a lot to do, was waiting around for the next class to show up so we could train. I said, "Captain Shepard (I didn't call him Al at that time), do you think I should keep my hand in medicine by going to the clinic a day or two a week?" He looked at me with his steely eyes and said he didn't think that would be a very good idea, that I had plenty of other stuff to do. [Laughter] And you sort of get your priorities in order that way, and realize that clinical medicine is not going to be your job in this program, that keeping on top of medical research and medical issues in space flight was very important, and he encouraged me to do that, but they also encouraged me to train as an astronaut. I was going to sit in that cockpit, and they had to be able to rely on me.

It turned out that medicine, since there were so many medical issues involved in flying into space, was a very easy profession to reconcile with the duties of an astronaut. All of the astronauts, in addition to just training, had technical jobs that they had to do. One of them would concentrate on boosters. One of them would concentrate on space suits, one on orbital navigation—Buzz [Edwin E.] Aldrin [Jr.] comes to mind—life support systems, so on

and so forth. It's easy if you're a doc to find that the life support systems and the space suits and the cabin atmosphere and a lot of other things are things your background helps you to understand. So I had the medical background. I had to pick up the engineering informally, enough to understand what the trades were.

It was easy to work as an astronaut with a medical background. I think that's still true today. I think that's why we see a fair number of docs picked up as mission specialists. It's a little harder for an astronomer to use his or her background in the program, and I think that's why people like Dr. Michel didn't make it as well, is that reconciliation job was hard to do.

RUSNAK: Tell us about some of the technical assignments you did, work with space suits or environmental control systems.

KERWIN: I worked with both of them. My very first one was environmental control systems, just picking up on what the atmosphere problems, and why we were using 100 percent oxygen, and looking at some of the long-duration tests that were going on even in the early sixties, in the mid-sixties. Out at Douglas [Aircraft Company] they had a ninety-day study where they shut people up in a can.

My mentor in that area was Bill [William A.] Anders, since has had a wonderful career as CEO of a big aerospace company. Bill was a very organized guy. He said, "You've got to reduce these things to their simplest terms, keep notes on three-by-five file cards, and organize your thinking, and you'll be fine." Okay. So I picked that duty up from him for a while when he went off to train for his Gemini backup mission, which he complained—I think he was assigned to backup crew either Gemini XI or Gemini XII, and he said, "Kerwin, it's like learning every nut and bolt in the *Santa Maria*. It's useless

knowledge. We're going to the Moon, and I'm stuck with this Gemini backup role." So I did that under his tutelage.

Then Ken [Thomas K.] Mattingly got a backup assignment in Apollo, and they turned over the space suit technical assignment to me, and that was just wonderful. I got to try on the new suits. There are a number of suits still hanging on the racks over there that have Kerwin's name and were fitted to me, just because that was my assignment, was to check those things out. I remember participating in the Source Evaluation Board for the Apollo suits and reading the proposals and seeing the prototypes from Hamilton Standard and their research, and the outfit in Massachusetts.

RUSNAK: David Clark [Company, Worcester, Massachusetts].

KERWIN: David Clark. They were in there. I didn't have any particular influence on the decision, but it was a great learning experience.

Then going through the Apollo suit, all the compromises between thermal meteorite protection and mobility, the transition from the old rotating helmet to the new bubble helmet, which was a wonderful invention, and trying to participate in making that bubble helmet, which was made of polycarbonite, lexan, and was the first such application of polycarbonite, which was a fairly new material. It was strong enough, it was resilient enough, had all the properties of that kind that made it safe to use as a helmet on the Moon, but it was soft and scratchable, and its optical properties were not good.

They went through hell, the engineers did, trying to blow those bubble helmets in a controlled way that made them suitable to look through, free from distortions and spots and all of that. They finally managed. It was a company called Airlock, Incorporated, again in the New England area, that finally figured out how to blow those helmets. We went through

quite a selection process. They probably had to blow ten of them for every two or three that we approved. So it was great fun working the suits.

At about that time—I'm changing the subject, is that all right?

RUSNAK: That's fine.

KERWIN: I was asked by Al one day—in fact, Curt Michel and I were asked to get a T-38 and go out to the Douglas plant and have a look at an S-IVB stage that was in production out there, because the Marshall Space Flight Center [Huntsville, Alabama] had this crazy idea they wanted to use the inside of an S-IVB fuel tank as a space station prototype or a laboratory or something. So Al said, "Get out there and have a look, and come back and tell us what you think."

So Curt and I went out there. We were pleasantly received and taken to the production line where this big old S-IVB, third stage of the Saturn V, and second stage of the S-IB with the first, I guess, restartable engine in the line, was coming through. They said, "Well, this is it." On the end of it, the dome had a big hatch with seventy-two bolts in it. We said, "How's the crew going to get in there?"

He said, "Well, we'll give you a wrench, and you can undo the seventy-two bolts."

"Oh, okay." We went on in, in our stocking feet and our white coats and all, because this was a flight stage. [Sniffs] And there's this chemical smell from the material they used to cure the sides. It was a fiberglass lay-up with some kind of protective coating over it, and it smelled funny. "How are we going to get rid of that smell?" we said.

"Oh, it will leach out given time."

There was nothing else in there except some helium spheres to pressurize the tank, a propellant utilization probe, essentially a fuel gauge, running down the middle of it and wired

to the side. Lots of sharp edges. And that was it. We said, "What are we going to do in here?"

"Well, we haven't figured that out yet. Maybe you could put on your suits and sort of fly around and check out the EVAs [extravehicular activity] in here. It's a nice big area."

"Are you going to pressurize it?"

"Well, we haven't decided, but we think we probably ought to pressurize it with oxygen." Okay. Very, very primitive stage of the whole thing.

So we went back. I wrote a memo to Al saying that they had a long way to go. Curt wrote another one saying he didn't see any evidence of any scientific value in this whole operation, which, from his point of view, was certainly true. But the Marshall people were serious, and they very rapidly converged on a configuration whereby this thing could be utilized for at least long-duration habitability experiments, and possibly for much more.

It was a very rapidly developing program, Skylab. In fact, it wasn't much more than a year later, maybe a year and a half after that, mid- to late 1967, when I found myself in Huntsville one evening with a handful of other astronauts, led at that time by Al Bean. He was the senior guy in this group. We were outlining in chalk on the floor of the mockup building at Huntsville the layout for the crew quarters of the Apollo Applications Program, which was going to be Skylab. "Now, we've put the sleep compartments over here, now they're too big. Make them smaller. Here's where the waste-management thing has to go," blah, blah. It was fun. We felt like we were in on the ground floor of a program.

At that time, Skylab was a wet workshop, because it didn't have a Saturn V booster assigned to it. The Skylab was to be launched as the second stage of the S-IB, which meant it had to be a working stage. So, filled with liquid hydrogen in an engine on the back, burnt into orbit, then you open vents, let the hydrogen leach out for a couple days, close the vents, backfill with oxygen to a third of an atmosphere, and then undo the seventy-two bolts, through an adapter section, of course, and let the crew come on in and do their thing. The

program manager was going nuts trying to figure out how much outfitting he could do in a stage that was going to be used and filled with liquid hydrogen. They couldn't find any wiring, for example, that would withstand the temperatures. It was proving to be a very difficult thing.

It was a big breakthrough for the program when they were finally assigned a Saturn V, I think at the expense of Apollo 18, 19, and 20. When those three flights were removed from the Apollo Program manifest, three Saturn Vs came available. To the best of my knowledge, we used the one to launch the workshop and the other two are sitting out here as displays at JSC and Huntsville. That was a big day when we went from the wet workshop to the dry workshop. Instantly we had what space programs up to that time had never had: weight margin and volume. We had all the weight and the volume in the world. They didn't have to cut corners. We could load all the consumables for three flights on. We could put experiments of all kinds up there, medical, solar physics, Earth resources, without worrying too much about the weight margins. So it became an easy program.

RUSNAK: How workable did you think the wet workshop concept was?

KERWIN: Well, we were prepared to go do it. It just wasn't going to have much scientific value. We never got deep enough into it for me to make a detailed comparison at this time, but I think there would have been a great paucity of in-flight medical experiments and in-flight solar physics experiments that would have impoverished the return from the program a great deal. It still would have accomplished the fundamental goal of, if you will, certifying a human being for ninety days. That I think we could have done.

RUSNAK: That makes sense. How long after they went to the dry workshop did you find out that you were actually going to be one of the people to go up on this?

KERWIN: You know, I don't remember exactly when that dry workshop date happened. It was either '68 or '69, somewhere in there. Of course, we were all weaving in and out of the program as a technical assignment and going to other assignments.

I had a fun assignment in there as a member of the crew of two hangar queens. The first one was called Spacecraft 008. It was the altitude chamber test command module for the Block I Program. It was to precede Apollo 1, the flight that [Virgil I. "Gus"] Grissom, [Edward H.] White [II] and [Roger B.] Chaffee were to have. We had three astronauts assigned to spend a week in Chamber A in Building 32, which was brand new at that time, testing that spacecraft out, and we did. Had a good time doing it. We utilized equipment and a procedure which was the same equipment and the same procedure that killed the crew of Apollo 1, so we considered ourselves, in retrospect, very fortunate that we didn't have a spark.

So after that, back into Skylab for a while, and then out again to command my first mission, which was the second hangar queen, which was called the 2-TV1, Block II, Test Vehicle 1, spacecraft Number 98, the first Apollo Block II post-fire spacecraft off the assembly line. Vance [D.] Brand and Joe [H.] Engle were my crewmates, so we had a good crew. We went out to California, out to the Rockwell plant for two or three weeks, to bring the thing through the test program out there at the plant, before delivery to the Manned Spacecraft Center. I nearly said JSC; it wasn't yet. And then it went into the chamber and we went into it. We spent another week there, testing out the new launch procedures that avoided the use of 100 percent oxygen. Of course, we had all the new fireproof materials, insulation equipment, and so on, in the vehicle. So we felt like we were breaking some ground and doing some necessary testing to enable the Wally [Walter M.] Shirra [Jr.] flight of Apollo 7. So that was good. And then back into Skylab again.

As I recall, it was early 1970. It was, because [Charles C.] Pete Conrad had just come off his Apollo 12 flight, which was November '69, so this had to be around January or February of 1970 when Slayton came into a pilot's meeting on a Monday morning, he had a sheet of paper in his hand, he said, "The following people are now formally assigned to crew training and mission development for the Skylab program." He read the names of fifteen people. "Conrad, Kerwin, [Paul J.] Weitz, [R. Walter] Cunningham, Brand." God, I forget the exact routine now. He didn't say who was prime, who was backup, who was what mission or anything else. All he said was that Conrad was going to be Sky King. He was in charge, and he would tell us all what he wanted us to do.

We had no idea what that list meant. There was a lot of speculation going on about who was going to be on what mission. There were fifteen of us, which meant there were three prime crews but only two backup crews, so somebody was going to have double duty as a backup crew, it looked like, unless the first prime was going to be the last backup. Deke didn't say. Deke was not a man of many words. He didn't say more than he thought was necessary at the time.

It turned out, again in retrospect, that the way he had read that list was first prime, first backup, second prime, second backup, third prime, just in order. But it took a couple of years before the specific crew assignments were made, probably in '72 that we actually knew for sure that we were going to go with Pete on the first flight.

RUSNAK: You mentioned you were going back and forth between Skylab and some of these other duties. One of the other things you did was serve as a CAPCOM [capsule communicator] on Apollo 13, which we've just had the thirtieth anniversary of.

KERWIN: Yes.

RUSNAK: I believe you were on console during some of the more interesting points of the mission, so if you could tell us some about your experience there.

KERWIN: Once again, I was, for no particular reason that I could figure out, assigned as the lead CAPCOM on that job. What that meant was that you got to do the schedule. So my other guys were Vance Brand and Jack [R.] Lousma, were the other two CAPCOMs on Apollo 13.

We split up the duty differently than the different teams of flight controllers, because we had training responsibilities to consider and we wanted to specialize in different areas. I did not know much about lunar modules, but I knew a lot about suits and I was a good command module person, having spent these two seven-day periods running command modules. I was also the boss, so I did the launch, the lunar surface EVA, and reentry, were my key things. I seems to me that Vance Brand did translunar injection, TLI, and had those key command module burns, and I think Jack had the lunar module descent activities and specialized in the LM [lunar module]. I'll go back and look at this now, and I could be wrong in my memory, because, of course, it all came unraveled after the mission started. But we trained in our different areas, and assigned ourselves to different teams during the mission and participated in all the sims [simulations] and did our thing.

The launch was pretty uneventful. The center engine on the second stage shut down prematurely. I remember that very clearly because I saw that light come on and just turned and looked at the booster guy, Frank [L.] Van Rensselaer, to see how long it would be before he would tell us something to tell the crew. He told us to tell the crew that it was a go, just about the time the crew called down and said, "We've had a center engine out, Houston. Over." So that worked out fine. Everything else appeared to be nominal.

I remember going home and having dinner and going to bed early, because I had the 6 o'clock a.m. duty the next morning as CAPCOM. I was walking into the bedroom from the

television, when in the background I heard something about "They seem to have a problem on Apollo 13." I went on to bed. Got a call about midnight from Vance, who was on console. He said, “Joe, the lunar mission is over.” He meant the lunar landing. “We’ve had some kind of explosion in the service module. We’re still trying to figure it out. It’s a bad situation. I wanted you to know about it before you came over for your shift.” Well, of course, that was the end of sleep for me.

Like everybody else, I was over there early, standing behind Vance and just trying to soak up what was going on as we defaulted to a different schedule and made ourselves up a different watch schedule pretty much now connected to the different teams that were working. And again, since I was the reentry CAPCOM, I retained that designation, and Vance and Jack did their things, making sure they were on the console for the main—

Lousma became a very important CAPCOM there because he was the best, the most experienced in lunar module operations, and he knew lunar module systems the best. So we struggled through. I became part of the team that was making up the protocol and the checklist for waking up the command module about three hours prior to reaching entry interface.

The real work there was being done by the backup crew, especially by Ken Mattingly, over in the simulator. To cycle back to a few days before the flight, you will already have heard the German Measles episode. I was shocked by the decision that they made on that. The doctor. I said, “German Measles is a mild illness in adults. A little fever, a little malaise, and then it’s over with. You think that will slow Mattingly down, even if he gets it? No way. And it’s very important that this crew which has trained together on this mission stay together.” I happened to express that opinion in a meeting at which Dr. [Christopher C.] Kraft [Jr.], the center director, was present. The way I phrased it was, “I don’t agree with Dr. [Charles A.] Berry’s decision.” Kraft turned his beady eyes on me and said, “I just want to

know, Dr. Kerwin, that that wasn't Dr. Berry's decision. That was my blankety-blank decision." [Laughter] I was put in my place.

Of course, it worked out great. If you believe in fate, you have to look and say that there was nobody better suited than Ken Mattingly on the ground to go into the simulator and figure out how to save the mission, and, in particular, how to turn the command module off completely and then power it up in a careful, regulated way that minimized the use of power, but had the systems up in time to get ready for entry interface. Very difficult job, and he was just wonderful at it. His experience and his workaholic nature both assured that he had the detailed knowledge and he knew how to use it, go in and take over. So it was really nice. There was, I think, some opinion around that maybe Ken should be the entry CAPCOM, and Ken wouldn't have any of it. He said, "I'll sit here with Joe, and together we'll make sure that things happen."

So my memory of Apollo 13, a couple of them. One is just long hours of sitting there at the CAPCOM console with my headset on and white noise in the headset, and listening and listening and listening for the crew to call through the white noise. What they had done, they would power down the high gain antenna on the spacecraft to save power, and so you didn't get a good voice connection, but just good enough to hear them. If they called, then you'd command the high gain antenna on and get better com and go ahead and do your thing. So I spent hours just listening in case the crew had a problem during off times.

Then I remember at the very end—let's see what the sequence was. They transferred to the command module. They did the command module activation. It worked perfectly. They jettisoned the service module. Saw the terrible damage and had time to snap a couple of pictures, and now it's Jack [John L.] Swigert's big moment. He has to align the platform on the command module before jettisoning the lunar module. He did that by looking through the telescope, finding two stars, and marking on the stars so that the star angle difference could be measured precisely, thereby verifying that these two stars were the ones he thought

they were. Those two locations would tell the platform what its attitude was. Very, very critical to an accurate reentry.

He's having a terrible time doing it because the lunar module is sitting on the front of the command module and reflecting light into the telescope, obscuring the star background. He's having trouble identifying the stars, for that reason. He tried, didn't work. Try it again, didn't work. We are racketing [phonetic] toward the atmosphere at 36,000 miles an hour and I'm sweating bullets, and I'm looking up at [Eugene F.] Kranz, who was standing right over here, and Kranz is going [demonstrates]. In other words, "Give them another few minutes. Give them another few minutes. We've got another few minutes." And finally from the spacecraft comes, "Five balls." Meaning the star angle difference is 0.0000. He has correctly identified the stars. The platform is aligned. From there on out, it was just routine, or seemed like it. That was, to me, the most dramatic moment as a CAPCOM.

RUSNAK: As someone who had previously worked on the environmental control system, what did you think of the fix they came up with to scrub the carbon dioxide out of the air?

KERWIN: It thought it was great. Of course, it was our friends Dick [Richard S.] Johnston and his people in the Crew Systems Division who came up with that fix. I was privileged to be the CAPCOM who read it up to Jack Swigert. First they brought all the pieces over, and we sat there, right on the floor, in front of the CAPCOM console, spilling out into the aisle. They said, "First you do this, and this is the piece of cardboard he uses from the checklist, and this is the tape. This is the square canister, and this is the round hole," and blah, blah. I understood it thoroughly, and then I'd call up Jack.

I could just hear the skepticism in Swigert's voice. [Laughter] "I'm going to get all this stuff and then what?" This sort of thing. But he was patient, and he went and collected all the equipment needed and be sure he had it, and then we talked him through. It was sort

of like third grade, scissors and paper sort of thing. Those guys weren't quite sure we knew what we were talking about, but they connected it up, and, hell, it wasn't ten minutes before the CO_2 level started coming down. So that was a nice thing.

RUSNAK: It's good that you were able to help by passing this along to them in a methodical fashion that they can put that together.

At one point during the mission, Jim Lovell had said that he thought this was going to be the last lunar mission for some time. What did you think the impact of this accident was going to be on NASA, and what did you think of the investigation and recovery from it?

KERWIN: Well, of course, during the mission, you blot all that out of your mind. You get extremely focused, just as Kranz would say failure is not an option. Let's focus on what we have to do now to get this crew back. So our only thoughts were, "What's the oxygen margin? What's the water margin? What's the power margin? How are the systems holding up? You mean you found a way to charge the command module batteries? That's wonderful!" Just day at a time, hour at a time. "Why does the trajectory keep"—was it steepening or shallowing? I'm trying to remember. On the way back, they had them on the perfect trajectory to the entry corridor. I think it shallowed out a little bit.

RUSNAK: That's right.

KERWIN: They made a couple of mid-course corrections. It turned out, after the mission, somebody said it was the lunar module water boiler that was causing this very slight delta-V that would cause it to shallow out. Trying to figure out mysteries like that and stay focused, and hoping the crew was okay. Watching as they dealt with Fred [W.] Haise's [Jr.] kidney infection and all of that afterward.

Only then did you think a little bit about the investigation. I wasn't involved in that in any substantive way, so it seemed to me that they rather rapidly and fortunately discovered the anomaly in the handling of that oxygen tank and the anomalous way in which it had been emptied, I believe, after a test, as I recall, and were able therefore to pinpoint the cause and write it off with confidence, inspect the histories and the hardware in the subsequent service modules and say, "We're go." So it didn't seem to take that long, actually.

RUSNAK: No, it didn't.

KERWIN: I'm trying to remember what the dates were. April 1970 was Apollo 13. And when did we fly 14?

RUSNAK: It was January '71.

KERWIN: January of '71. I mean, that's really short. Look at how long it took us after the Challenger accident to get back to flying.

RUSNAK: In this case you had Al Shepard finally getting his ride on 14.

KERWIN: Al finally getting his ride, yes. Isn't that good?

RUSNAK: After being put out for his inner ear problem.

KERWIN: His Meniere's Syndrome. Yes, it was good to see both Al and eventually Deke get that ride. They tell me that Deke always used to submit two crew recommendations, one

with him on it and the other one without him on it. Finally, they accepted one with him on it. It was very nice.

RUSNAK: Do you have a professional opinion on either of their medical problems?

KERWIN: No, I think Al's was handled pretty well. I think they were both handled pretty well, but Al's in particular, a significant period of time went by, the symptoms had subsided, there was no residual damage to the vestibular system, and he was certified for flight in a relatively routine fashion.

Deke's problem was more difficult because it was arrhythmia, and those things do tend to recur, and if they recur, they're usually not harmful. You could have made the argument back in 1962, I guess it was, and some of the doctors did make the argument, that this atrial fibrillation was intermittent, would not have interfered in a short mission, and it was just that overwhelming conservatism that said, "We know it probably doesn't matter, but if you can find another crew member who hadn't got that problem, it's just one less thing to worry about." It's too bad, because Deke was a splendid crew member and a good leader and would have been a good commander on an Apollo mission. It was not to be. I think he quit smoking at some point early on in there, and had had a stretch now of several years without fibrillation recurring, and that's what made them feel that they were safe in sending him up. And they were right, he didn't have a problem in flight.

RUSNAK: Did you have any involvement with any of the flights after 13?

KERWIN: Not in the Apollo sequence, no. I went from there right to full-time training for Skylab.

RUSNAK: Now, after having been an astronaut for several years, you finally get your seat on a flight. Take us through the training regimen that you went through to prepare for your specific mission.

KERWIN: We figured out after that we might have trained more than any space flight crew up to that time, and that was due to a couple of factors. One was the large number of different science disciplines that was on this mission as compared to the Apollo missions. And two, was simply the long preparation time.

—Skylab in 1966, so I worked it for seven years on and off, partly training, partly participating in decisions as to the configuration of the spacecraft and the experiment package. So we helped to design the experiments as well as just training for it. I don't want to give you the impression that I participated in the design of the ATM [Apollo Telescope Mount] experiments, the solar physics stuff. I wasn't smart enough to do that. I think Owen [Garriott] and Ed [Gibson] did to some extent, in the joint observing program world. I concentrated on the medical experiments, and we had a lot to say about some of them, and it wasn't all favorable, either.

Example. The M-131 vestibular function experiment, designed by a genius, also a really sweet man, Dr. Ashton Graybeal [phonetic] of the U.S. Navy Medical Research Institute in Pensacola, had done an enormous amount of research on vestibular adaptation to unusual environments, and he designed this experiment which had several different modules in it. And the module we all hated was the motion sickness susceptibility test. He had devised this wonderful test where you sit in the chair, and the chair rotates at a rate that's been determined with pre-flight testing. While it's rotating, you move your head forward and sideways and back, in and out of the plane of rotation in such a way that it's very provocative. He tried to titrate the rotation rate so that it was somewhere around fifty head movements before you barfed, or maybe seventy-five. He wanted to bring us right up to the

point of barfing but not quite, as his endpoint, and then to compare susceptibility in flight to susceptibility on the ground.

The reason for all this was we'd had a number of documented or suspected cases of space motion sickness, a motion sickness a lot like seasickness, but occurring in the first twenty-four hours of space flight. So we knew that he was up to something legitimate, but it wasn't very pleasant. So the first thing we did was to get him to back off from what he called malaise three to malaise two, so that we could quit reliably before we threw up. He agreed readily, and we tested that a little bit, and we backed off and did that.

The second thing we insisted on was that since there was always a chance that you'd go too far, and you'd get somebody throwing up and motion sick and really miserable up there, that you'd exempt the commander, Pete Conrad on our flight, from that part of Graybeal's test, so that we'd always have one guy who was in good shape to take us home if we started losing pressure or had an emergency. And he agreed to that. Graybeal was nothing if not easy to get along with. He was a peach. So we in that sense helped to re-jigger the experiment to make it what we thought was more operationally compatible.

They got all their data, and to our amazement, in flight, by the time we had gone through all of our adventures on the first few days of the mission and gotten to the point of doing Ash's experiment, we found that you couldn't make yourself motion sick. Once you had adapted, you were bullet-proof. We eventually, all three of us, spun the chair up to the maximum rotation it was capable of which was 30 rpm, just about like a long-playing record, and make the maximum number of head movements you were allowed to make, which was 150. You know, your neck would be pretty tired. No malaise, no sweating, none of those pre-vomiting symptoms at all. A little nystagmus, that was it. We had discovered a new phenomenon, or Ash had discovered it with us as subjects. We felt, in retrospect, a little sheepish about our great conservatism and our fear of this experiment, which was totally unjustified by events. But anyway, there it was.

The other one that we argued a lot about was the metabolic balance experiment. We just knew this one was going to make our life miserable. It was an experiment to measure complete intake and output of everything we ate, everything we drank, everything we urinated, everything we defecated, and they wanted to do everything we perspired, but he couldn't figure out how to collect the sweat properly, so they had to skip that one. He wanted every molecule of sodium in and out. This was Dr. Don Weedan [phonetic]. He was doing a very meticulous job. He had done intake and output experiments in medical labs, and he knew how to do it, but the thing he wanted to do was to put us all on the same standard diet, pre-flight, in-flight, and post-flight. Everybody gets 2,400 calories; everybody gets 800 milligrams of calcium, right on down the line, protein, carbohydrate, everything, exactly measured.

We said, "This isn't going to work." We had Jack Lousma, who was a great big 6'1" or 2" Marine, who routinely eats 3,200 or 3,500 calories a day, and is trim and fit. And we had Al Bean on the other extreme, who's about a 1,900 calorie-a-day person, and he's trim and fit. You're not going to feed them both 2,400 calories a day for what amounts to three months and get away with it. In fact, Weedan was convinced this was the standard way to do intake and output, and damn it, that's the way he was going to do it.

We were rescued by a crew called the SMEAT crew. I don't know if anybody's brought that acronym up to you before, SMEAT, S-M-E-A-T, Skylab Medical Experiments Altitude Test. This was a test run in one of the altitude chambers in Building 7, with a crew of three astronauts, for fifty-six days, which was the longest duration then contemplated for a Skylab mission, using the medical experiment hardware and the same diet as was planned for the mission. It had Bo [Karol J.] Bobko, Bob [Robert L.] Crippen, and, bless his heart, Bill [William E.] Thornton. Bill Thornton was built like and exercised a lot like Jack Lousma, and he was in there on 2,400 calories a day. He was losing weight like mad, and was very

seriously irritated about all this. He said, “The only thing that kept me from killing that guy was the two inches of steel between us.” [Laughter]

As a result of that fiasco, the scales fell from everybody’s eyes, and we got Deke Slayton behind us and the program manager, and said, “You’ve got to feed these people what they need. Feed them what they need, and they’ll go along with the regimen and the careful measurement of input and output and all that stuff.” And we would. We just wanted enough to eat. So we changed the routine, and we went through a one-week period of eating all our meals at the laboratory in one of the buildings around the center, being fed carefully measured portions, and if we didn’t eat it all, they took it back and measured it. They got to know what everybody’s dietary intake was, and tailored our meals to that dietary intake.

That wasn’t quite the end of it, because there was another hypothesis floating around. It was a theory, everybody knew it was true, that when you went weightless, since the large muscles of the body were not being used, it was a lot like being at bed rest. And if you’re at bed rest, your basal metabolic rate goes down, your resting heart rate goes down, your caloric expenditure goes down, and you don’t eat as much. So we even took our average daily caloric intake from the little seven-day test and subtracted 300 calories from it, then tailored everything from that. So instead of getting what we were getting, what we ate normally on the ground, we got what he thought we would normally eat in space based on this theory, which turned out to be totally false. [Laughter] And it wasn’t his fault. I believed the theory, too. I thought, “Yes, that’s probably about right.” Turned out not to be true.

He started us on this diet three weeks before the flight, to get a three-week baseline period. This is good science. And for eighteen days after the flight. That’s actually three six-day periods. We had a six-day diet cycle. I don’t remember why. Of course, that diet was identical to the in-flight diet. The food even came from the same lots. So the result there was that pre-flight and post-flight, we were 300 calories down from our normal diet. He wouldn’t give us anything extra to eat except lemon drops. Empty calories. "You can

have some empty calories, but I don't want you taking any minerals, I don't want you taking any protein. All that has to be steady."

You can imagine we had some arguments with Don and, to a lesser extent, on some of the other experiments in all the habitability stuff. The crew was very active in this whole experiment called long-duration flying in space. What should the bathroom be like? How about the restraints and mobility aids, the kind of foot restraints? All of that stuff. We were co-experimenters, if you will, in all that. Sometimes maybe we overdid our conservatism a little, but we got a darn good spacecraft out of it.

I remember about three weeks before launch, Chris Kraft calling us up to his office. He tells this story differently than I remember it, but that's typical. My recollection of it is that Chris sat us down and said basically, "Now, listen guys. You've had a lot of disagreements with the medical investigators over this whole training period. It's time to put that all behind you now and go do the stuff."

Pete said, "Chris, we already decided to do that. We're happy with what we've got. We're going to give it our best shot," which we went and did.

Chris remembers the same conversation of being more of a lecture than it really was. "You guys, you've got to knock it off now."

So it was that interesting relationship. We weren't just guinea pigs; we were also co-investigators, informally, on all the experimental work that went on. Had a wonderful time doing it.

RUSNAK: Obviously your special interest is in the medical experiments. How much training did you spend on other things like the Earth observation and the Apollo Telescope Mount?

KERWIN: I spent an enormous amount of time on the Apollo Telescope Mount, because we didn't have an Owen Garriott or an Ed Gibson as the scientist astronaut on my flight, so I had

to be the lead guy for the ATM as well as the medical experiments. That meant, by the nature of things, that I spent very little time on the Earth observations experiments. I had one particular camera, the S-190 five-inch camera that I was responsible for, but that was pretty simple stuff. All of the time-lining and major decisions were made by Pete and Paul on that.

We all did a lot of training on ATM. I did more than them because I had the malfunction procedures to learn in the computer. We spent—I've got the training hours around somewhere on a piece of paper, but thousands of hours of total training time, counting everything. It was good. In the command module, obviously Pete was the commander and he did the flying. I was the navigator and did the telescope and sextant stuff and the computer stuff. Paul was the systems expert for the electrical power system, the life support system, and all of the systems hardware and systems malfunctions. And we'll all backed each other up, kind of in that order. So we all had all of that training to do. In the Skylab, again, Paul was the systems expert. I was ATM and medical, and Pete was earth resources and overall command.

Pete was—I need to put in this plug for my late commander. I could not have had a finer commander to work with. He was moderately demanding, but very open. He wanted you to tell him when he screwed up, and he would tell you when he screwed up. He had this wonderful communication relationship with the mission control team, as well. There were no secrets, so there never was any tension built up. We did a little drinking together, we played baseball together from time to time. We simulated a lot, and he gave you responsibility and said, "Tell me what you're doing and go do it." So it was a real treat flying a mission which otherwise might have had its tense moments, with a crew that got along so well and was so well led.

RUSNAK: I was planning on asking you about Pete, since he did pass away last year.

KERWIN: An amazing thing. I thought he'd outlive me. He had a lot of energy and was in excellent physical health and so on and so forth. I was just amazed to find that I can't call him on the phone anymore. It's too bad. But we did good.

I've told this story often, I might as well tell it on tape. Pete told us this story several times during training and during the flight, about his initial run through the selection process with the Mercury 7 astronauts. He was one of the finalists. They went out to the Lovelace Clinic at Albuquerque, New Mexico, for their final physical examinations. Pete had a run-in with at least one of the docs. I believe it was the surgeon who did the procto-sigmoidoscopy, and Pete felt that he'd been unnecessarily rough and told him so. They got into a bit of a discussion on this at the bar that evening, okay. [Laughter] In the event Pete was rejected, and the basis for his rejection was a psychiatric evaluation that he was psychiatrically unsuited for long-duration space missions. So here's Conrad, he's gone to the Moon, he's up here in Skylab with us on the first-ever long-duration Space Station mission, and he's saying, "I'll show that son of a gun. Who's psychologically unsuited for what?" [Laughter]

So he was very motivated to do a great job on Skylab. Just the kind of commander you want. He exercised more than we did, and kept us all up to a very high level. Even coming home. He said, "Guys, we're going to walk out of this spacecraft. There's going to be none of this carrying us out on stretchers stuff. There's no time to do it like right away. When that hatch opens, I'm outta here, and I want you guys to follow me." He had it all planned out.

It could have been different, if we'd had a different kind of character, because we had some initial problems. We had a problem with the exercise bike, and this was a key piece of equipment not only to measure our aerobic fitness and our muscular strength, but to keep us fit. It was used about every fourth day in the full experiment mode, where we carefully went through a graduated exercise cycle, fully instrumented and measuring oxygen consumption

and CO_2 production and a very careful appraisal, but we found, when we first tried to ride the bike, that we couldn't ride it to the high levels.

On the ground, knowing that we were going to be weightless, and nobody had ever ridden a bike in weightlessness before, Story Musgrave helped us design a very elaborate harness to wear. It had a harness that strapped around here, and it had shoulder straps with separate adjustments, and it had four bungies that went to the ground, and really kept you in one position. It was okay on the ground. You were sitting on the seat anyway. You got up there and found that you don't sit on a bicycle seat in weightlessness. The bicycle seat might as well not be there at all. It's a useless piece of hardware. And when you start to peddle, you ride up into this harness, and it's so tight that it cuts off the circulation in your thighs, and your leg muscles get oxygen-starved. They start to hurt, and you just have to quit before you have reached the aerobic levels that are your goal.

Pete was trying really, really hard to reach that peak level in spite of the pain and discomfort, and he started throwing premature ventricular contractions. He would throw an occasional odd PVC in his electrocardiogram. That's not that disturbing a thing by itself, but here we are in space, and the docs were all very worried about the twenty-eight day duration. I'll go back. Remind me to tell you about the monkey that preceded all that. So the harder we tried, the more concerned the guys on the ground got.

It was probably about the eighth day in the mission when two things happened simultaneously. One, mission control and the doctors decided to restrain our exercise and say, "From now on, you can't use the bicycle to exercise unless you are fully instrumented and over a state-side pass so we can watch your heart rate and your rhythm." They were just getting ready to radio that up, when we were getting ready to radio them down that we had solved the exercise problem. We now knew how to ride the bike and we could get to our max levels without any problem.

What we had done was to take Story Musgrave's harness, carefully fold it up and shove it in the trash airlock. [Laughter] Instead, we put a couple towels on the overhead, so our head wouldn't bump it too hard, and just found a posture with no restraint that eliminated the circulation problem, and we were off. So this resulted in Conrad and Chris Kraft having a private conference, and ironing out the issue. Pete said, "Call off the doctors. We have solved the problem. This is ridiculous."

And Chris said, "Okay. Whatever you say."

So off we went, but there was a little potential crisis there if they had backed us off from exercising. They were already concerned about all the hardware problems that Skylab was having at that time. We might have come down in worse shape than we did, and it might have hampered the follow-on crews. They might have cut them back to twenty-eight days, God knows. But Pete was a good leader and led us through that problem and into the sunshine of successful performance.

I will go back and tell you about the monkey. It's 1969, and the Skylab Program has gotten the dry workshop, and we're well in the preparation process, the crews haven't been selected yet, when NASA launches an unmanned but monkeyed satellite called Bio Satellite. The purpose was to serve as sort of pathfinder for Skylab by flying a monkey for thirty days, and bringing it back and measuring what its physiological changes and decrements were. This was part of that not-too-popular-with-astronauts 1960s' mind-set that if a monkey can do it, then it's okay for you.

So off they went with the monkey. About day five of the mission, the monkey stopped doing the little game that gave it banana pellets. They still could give it a banana pellet that was eating. About day six, it stopped drinking, and its body temperature started to come down, and it became lethargic, and the heart rate decreased. They said, "What is going on up there?" They brought it down—I think I'm right—about day eight they de-orbited the thing and landed it and parachuted it in the Pacific Ocean near Hawaii, and they successfully

picked it up and they brought it to the Trippler Army Hospital, and it died some twelve hours after splashdown and had lost 25 percent of its body weight. Its heart rate was down to sixty, which for a monkey was terrible, and was in really bad shape.

So the response of the wonderful scientists on the Bio Satellite Program was to march to Washington and give congressional testimony before a subcommittee saying that they had to call off the Skylab Program, because we were going to kill an astronaut with this absurd plan to fly for thirty days, until they had thoroughly wrung it out with the monkeys and found out what to do.

We were sitting back there in Houston saying, “Now look. They put this monkey up there. It was in a cold spacecraft. It was restrained in such a way that it could only move its hands and feet. It was given an inadequate amount of food and water." Just like Dr. Weedan was planning to do with us, right, except he wouldn’t restrict the water. They restricted water. They had a measured amount of water. They thought they knew what was good for this guy, but he was in a cold, dry spacecraft and was probably urinating more than normal, as you do when you go into weightlessness.

For one reason or another, it was the constraints on the monkey’s ability to cope with the environment, added to the fact that this particular monkey is a very fragile subject in experiments of that kind. They had a handful of monkeys, from memory about five, on the ground as baseline monkeys. They had picked the one to fly from this group of half a dozen baseline monkeys, and two of them died during the mission from random causes. You know, this is a fragile system. So we were only slightly worried by this.

Dr. Berry, God bless him, Dr. Berry and I have had our run-ins over the years, but he stood up there and told the Congress and anybody else who cared to listen that the conditions were not comparable, and he had no qualms about sending guys up for twenty-eight days on Skylab. So off we went.

But all this was in the background, plus the fact that the Russians had had a Salyut mission up for something like twenty-two or twenty-three days a year or so before we flew, establishing the then-record, and had lost that crew during reentry. It was later discovered that it was a hatch problem, and that they'd asphyxiated. The climate at mission control was one of tension. What is this about long-duration space flight that we haven't managed it yet? They were very solicitous over the exercise problem, which turned out to be a mere blip, just a matter of learning how to do something in weightlessness.

RUSNAK: You mentioned that during that, Pete Conrad had called for a private conference. That was one of the issues before going up, was what sort of private communications can the crew have.

KERWIN: Oh, yes.

RUSNAK: Where did you come down on that?

KERWIN: We were working our way through these problems for the first time. We thought it was ridiculous that we couldn't have unmonitored private conversations with our family, but we couldn't. The press was dead set against that, they wanted all that. "This is a public mission. It's been paid for with government funds. We want to know every intimate detail, what goes on. What if they tell their wife that there's a real serious problem on the spacecraft, but they won't tell it on the normal air-to-ground to mission control? Why, the whole program could fail." You know, the standard kind of argument that the press uses when they want to stick their noses in. The counterargument being, "Well, if you make it all public, then they won't tell anybody. How will you be worse off?"

So our crew decided before the flight that if we couldn't have a private family conference, we wouldn't have any family conferences, and that our wives were all Navy wives, and they were used to their husbands going off on cruises and not being around for periods of time, and they could tough it out and so could we. So we didn't have any. I believe the subsequent crews softened that approach. They were going to be up there longer, and most of them weren't Navy guys anyhow. [Laughter]

So it was during the missions that compromise was finally worked out, where they would have their private conversations, these conversations would be listened into by one person who would make sure that nothing catastrophic to the welfare of the United States of America had been said, but would not reveal the actual transcript of these conferences to the public. That suited everybody, and that's how we did it.

We also had scheduled private medical conferences with our flight surgeon, and again, the flight surgeon was required, he was obligated, to tell any material that could affect the safe conduct of the flight to the flight director. And that was okay with us. It's just that we wanted an opportunity to informally discuss things with Chuck Ross without having them get blown out of proportion and made into a big deal when they weren't. You trust your flight surgeon, and you know he understands what you're talking about, so we had some nice conversations with Chuck during the flight.

And on top of that, the crew commander did have the authority to call a private conference with either the flight director or the center director if he wanted to. Pete did that once, on the exercise issue, to my recollection.

RUSNAK: That ended up working out all right, and you managed to find a compromise that was workable for both you and the ground.

The Marshall Space Flight Center obviously had a key role in Skylab. How much time did you spend there, and how were the relations between Huntsville and Manned Spacecraft Center?

KERWIN: I know that there were some friction in the relationship between Marshall and the Manned Spacecraft Center, but we really never saw any of that at our level. Pete may have seen some of it, but I sure didn't. I remember the Marshall guys coming down to brief the Manned Spacecraft Center guys in 1966 on their plans, and the guys from Houston saying essentially, "That sounds nice, but can't we put it off for a while? We're trying to go to the Moon here." And the Marshall guy saying, "This is going to go with you or without you." I know there was this competition, and I've read about it since, for more authority and more to do with human space flight. [Wernher] Von Braun had a feeling that he could do that, too.

Skylab is probably as deep in human space flight as the folks at Huntsville got, but thanks to strong Headquarters leadership and essentially good will on both sides, the strong leaders, [Robert R.] Gilruth at JSC and von Braun at Marshall, and the guys running the program at Headquarters, Bill [William C.] Schneider was the program manager, great guy, they worked out an acceptable set of responsibilities and authorities, and we carried them out without any difficulty.

We spent a lot of time in Huntsville. For one thing, aside from the developmental work, we did all our EVA training in the big water tank down at Huntsville. We spent some time in between the launch of Skylab and our launch down at Huntsville, trying out the Marshall sail solution to the loss of the heat shield. They ran a good ship down there. They always welcomed us. We stayed at a particular motel which was seven dollars with black and white television and eight bucks with color. [Laughter] This was the good old days, right?

We were very used to the T-38 directorate from Ellington [Field, Houston, Texas] up to the Redstone Army Airport. And, incidentally, began to formulate the rules for flying after diving for astronauts. After you'd been submerged in the water tank at forty feet of water, how long did you have to go before you flew back to JSC in a T-38 without getting the bends? Dealt with problems like that. At the working level, we had a great relationship and made a lot of good friends.

RUSNAK: Let's talk about the launch at the orbital workshop then.

KERWIN: Here we go. May 14, 1973, we are watching the Skylab go off from the roof of the MSOB [Manned Spacecraft Operations Building]. Looked great, it was a nice day. We went back downstairs and got some headsets on and followed the progress. We missed the part about the G-spike during launch, and the thing arrived in orbit and everything seemed to be okay until they started to deploy the various parts of it, at which point—let's see what the sequence was. I don't remember when in the sequence the ATM was erected. I know you know this. I'll try and draw a mental picture. In the Skylab stack was the same booster as the one that went to the Moon, but up in front of the command module where the lunar module had been stored for the missions to the Moon, the solar physics module, called the ATM, Apollo telescope module, was stored instead, and surrounded by four pieces of fairing, just as the LM was.

After orbital insertion, those four pieces were jettisoned, exposing the ATM. The ATM was then ratcheted out ninety degrees with electric motors, and locked into place at right angles to the long axis of the Skylab, and then its solar panels were unfolded. I don't remember whether that happened first or not, but it happened normally. There was no problem with that.

Down on the workshop, the main solar panels that accounted for about 60 percent of the available power, maybe 65 percent, were inside big solar panel covers that were folded down flush with the sides of the workshop. Over the top of, in addition to the third stage, made specially for Skylab, which was a heat shield/micrometeorite shield, a stout aluminum shield that was carefully folded in over the workshop, the process was, first you deploy the solar panel covers out away, and the solar panels themselves come out, and then you pop that heat shield out about six inches on spring-loaded standoffs from the surface of the S-IVB. It acts like a thermos bottle, as an insulating device, reflecting sunshine and keeping the inside of the workshop at normal cool temperatures, and it provide an additional micrometeorite shield.

But something went awry during launch with the heat shield. The kind of rough stories you hear afterwards. Well, the designers of the heat shield didn't talk to the aerodynamicists and they didn't properly protect the heat shield from the supersonic windstream. When the vehicle went supersonic, we got some windstream under the leading edge of the heat shield, and it just ripped right off the spacecraft. When it ripped around to one of the solar panels, it carried it off with it at the shoulder, so we lost one panel. When it got to the other panel, thank the Lord, it ripped around it instead and preserved that panel, but riveted it almost completely shut. A piece of aluminum with a rivet at one end literally wrapped it to this solar panel cover and held it down.

So they got into orbit, commanded the solar panel covers to open. They got no response from one and they got a little trickle of power from the solar panel on the other side. The thing had opened, as it turned on, about a foot and then jammed. Then the temperatures inside began to climb.

It wasn't too long before the ground put together the story that the heat shield had come off. They had apparently lost one solar panel. They apparently had not lost the other one. They had some Air Force satellite reconnaissance photographs that gave them blurry

pictures that sort of verified that. They were able to put together a pretty accurate guess as to what had happened.

Meanwhile, it became apparent that afternoon that we weren't going anywhere the next day. This was not ready for a crew and might never be. So our first duty was to our families, who were having the pre-flight cocktail party at Patrick Air Force Base [Florida]. We called them up and said, "You can keep having your party, but we're not launching tomorrow. You can go on home."

In fact, the next morning, we got in our T-38s and flew back to Houston and joined the team that was going to try and figure out this problem and what to do about it. It was a great team. I look on Apollo 13 as the supreme test and mission for the mission control team. The Skylab problem was the supreme test for the engineering team. Both the contractors and the civil servants joined together as one, and they figured out what the problem was, and they developed three different solutions to the problem, in terms of what can we bring up that the crew can deploy over the warm side of Skylab to cool it down so that we can get on with the mission, (A). And, (B), how can we get that solar panel unstuck?

We had different teams working both of them. Marshall developed a sail that required a space walk to install it. JSC had two ideas. One was this umbrella thing that was stored in a box originally designed for an experiment. You pushed it with push rods, out an airlock on the sunny side, and when it was fully deployed, springs made it sort of fall open. It was made of fishing poles and springs and the thinnest nylon they could find. Jack [A.] Kinzler invented it. It worked. It was the first thing we used, and it worked. We had a third solution that was never used, that was a sail to be deployed from the side hatch of the command module, flying around the Skylab. Whose idea was that? Max [Maxime A.] Faget's idea. We launched with it, but we never used it.

It was great to see the interaction. We went down to Huntsville, we the prime crew, and we did the underwater testing of the sail in the water and blessed it. Said, "Yes, we can

do that. It's feasible." It was kind of a weird ten days. The press was trying to get all over us and Deke was trying to keep us from the press. In going to Huntsville, we broke our quarantine just a little bit. Nobody got sick, so it didn't matter. We'd stayed on our diet pretty well.

The guys at JSC did their thing. The launch opportunities for the crew were at five-day intervals, based on the orbital geometry of when the thing came back over the Cape. In five days, it was clear that we weren't ready yet. These things hadn't been designed and tested. But by ten days, we were ready, and not only were we ready, but it was getting to be now or never time, because meanwhile, the mission control team had been trying to find the appropriate attitude for Skylab, cocked far enough away from the sun to avoid over-temperaturing everything. They were losing batteries and control relay modules, and the catsup was getting contaminated. [Laughter] The vitamins were leaching out of the food, for crying out loud.

But if they got too far away, the remaining solar panels, the ones on the ATM, were producing such a small amount of power that, again, the batteries were beginning to run down. So they played this attitude-control game for ten days, and hosed out a lot of the precious propellant on the workshop which was nitrogen gas and could not be replenished. I think we had used 60 percent of it or so by the time we arrived, after ten days. That's scary, because this was a one-year mission. But they did the job and held it long enough.

On launch day, now May 25th, we showed up at the launch pad and there was practically nobody there. This was the least well-attended Apollo launch in history, because everybody had to go home and put the kids back in school, you know. So it was a very peaceful morning. We arrived at the command module and looked inside, and it was a sea of brown rope under the seats, and under the brown ropes were all these different umbrellas and parasols and sails and rope, and also the equipment that we had selected to try and free up the solar panel, which was a pretty eclectic collection of aluminum poles that could be connected

together, and a Southwestern Bell Telephone Company tree-lopper, with brown ropes to open and close the jaws, and all that stuff. They handed us the checklist and said, "This is how to operate that stuff." [Laughter] Some of it we'd seen, some of it we hadn't.

They checked the wind very carefully on our launch day, because the space under the couches on the command module were supposed to be kept open, so that if you had a launch abort very early in the launch, and landed on the beach instead of in the water, it was a very hard landing. The couches were built to stroke, to prevent over-stressing the crew. Our couches weren't going to stroke. There was too much stuff under there, so they had to make sure that in case of an early abort, we'd land in the water instead of on the land. We said that was okay. We didn't care. And off we went.

That was a great engineering triumph. I don't know if the paperwork ever got done on this stuff, but it was quickly, carefully, collegially done. Everything we tried up there turned out to work. We had a very exciting first day, kind of a long first day. It was an eight hour or so rendezvous. Good rendezvous, nothing in particular to talk about.

I took my Scopdex [phonetic] tablet prophylactically against space motion sickness shortly after orbital insertion, about the time we took our helmets and gloves off, because I had been moderately susceptible to seasickness, and I thought, "I am not going to get sick on this mission and screw it all up." I popped my pill and thought no more about it. It was such a tense mission, I think our levels of adrenaline were already very high and stayed high that entire first day. Pete, of course, was an experienced crew member who hadn't had the problem before. Paul and I were both rookies. We did not get motion sick. We didn't even get close to getting motion sick. I didn't even think about it after I took my pill.

So I spent the eight hours before rendezvous removing brown rope and blankets, and identifying equipment, and sort of sorting it out for the way it should be when we got there. Pete steered us up to the spacecraft and we did a fly-around, Pete flying around and describing what he saw while Paul Weitz—we did have a TV camera—and Paul would hold

the TV camera out the right side command module window and send some TV data back to the ground. This was extremely useful. It confirmed exactly what was going on, showed the solar panel cover, showed the one strap of aluminum that was holding it up and where it was, and allowed them to design the EVA that we were going to do two weeks later.

We then soft-docked. I won't describe that in detail, but it's a partially docking. Sat there for an hour or so discussing with the ground—we had lunch at that point—what we were going to do. We decided that it was worth trying an EVA to open the side hatch of the command module and use one of the tools we had, which was sort of a shepherd's crook on a five-foot pole, to try and pry that solar panel up. We didn't know how much force it was stuck down with.

So we tried it. We got our helmets and gloves back on, checked the suits out, and opened the side hatch. Paul Weitz had the shepherd's crook, I had Paul by the legs, and Pete, of course, was flying the spacecraft.

He'd fly it up within a couple of feet of the solar panel, and Paul would put his shepherd's crook out there and get it hooked under the free edge. He'd pull back, and the two spacecraft would come together, and there would be jet firings everywhere. [Laughter] Conrad would say, "Oh my God." We never collided or anything, but it was fairly sporting. Tried that two or three times, and it was obvious that it was stuck too hard and this was not going to work, unfortunately. So we subsided, closed the hatch, re-pressurized. Pete got himself a little ear block, I think, on that occasion, but he didn't say anything about it until the next day.

We said, "Okay, that's not going to work. Let's go back and dock and just proceed with activation, and we'll go to Plan B." That's where we went back to dock and the docking wenches didn't work. Oh my God. They had worked the first time, for the soft docking. This time they didn't work. So here we are up there, now we'd been up for, I don't know, eighteen hours or something already, and it's getting late. He tries it soft and he tries it hard.

We tried all the backup means in the book. We finally got to the last backup, which required another EVA. It required that we de-pressurize the spacecraft again, because we now have to go up into the tunnel hatch, remove that hatch, get up into the docking probe itself, and cut a couple of wires.

We had looked at this procedure once on the ground. I'll never forget it or the guy who did it. We were over in Building 5, in the mockups, going through some of the arcane maintenance procedures. He says, "You guys have never looked at this backup docking procedure. Let me show you where things are." So he showed us where the wires were, and he showed us where the jumper cable went in down in the right-hand equipment bay.

We said, "Okay. Now we're up here, we're going to actually do this." So back on go the helmet and gloves, down comes the hatch. This time I am up there, because I'm in the middle seat and it's most convenient for me. I cut the wires and put the hatch back on. What it does is, this bypasses a relay that requires the capture latches to be mated before the main latches can activate. So we've solved that, and now he has to dock once more and keep, with the hand controller, keep the RCS [reaction control system] jets forcing the probe to collapse against the docking ring, and hopefully, when it collapses fully, the main latches will now latch on their own.

So we go in, he's got it knocked, he's right in the middle. He's one, two, three, four—they said to give it ten seconds—five, six, seven, rat-rat-rat-rat-rat. There's machine-gun noise, which is all twelve of those docking latches. We said, "Thank God. We don't have to go home tomorrow." Because you know, they were saying, "Stand off a couple of miles. We'll have another look in the morning, but we might have to bring you home." The whole mission would have been a disgraceful failure.

But we were docked. We were hard-docked, and from that point on, Houston was as happy as we were. They said, "Grab a bite to eat, go to sleep in the command module. We'll start activation tomorrow morning." So we were off. By that time, you know, we'd had a

long day, a very exciting day, two EVAs on day one. You're not allowed to do an EVA until day four on the Shuttle, because you might get sick. And a good night's sleep, a really good night's sleep the first day in space. I think that's what kept this crew from having any motion sickness problems, even in the great big old workshop, where they sort of expected it. Didn't have anything.

RUSNAK: It's an amazing day of twenty-two hours or whatever it ended up being.

KERWIN: It was a pretty neat full day. It wasn't the best day we had up there. It was maybe the most exciting one. The best day was day fourteen, I think it was, when we did the EVA and got that solar panel. That was a good one.

RUSNAK: So you get up the next morning. What tasks do you have to look forward to then?

KERWIN: Checking pressure in the Skylab. Opening the hatches that are on the command module side and on the Skylab side. Getting into the multiple docking adapter, checking things out there, and then a very careful procedure for sampling the air in the workshop through the hatch. They were afraid that this excess temperature had leached out some potentially damaging chemicals from the walls of the workshop, and they had carefully and quickly got together some dreger [phonetic] tubes. They're glass tubes with reagent in them, through which you suck a certain amount of air and it'll measure for a specific reagent. We sampled that air through the relief valve in the workshop hatch, found that there were no measurable levels of—I can't remember what the chemical was anymore. So then opened that hatch and Weitz, as the system expert, went down first, and then Conrad followed, and then I was the last one to go down. The other main job that day was to get that parasol pushed out through the sunny-side airlock and deployed.

The temperature, of course, was still between 125 and 130 down there in the workshop, so it was really hot. You had to go down and work for fifteen or twenty minutes, and then come back to the docking adapter, which was cool, in the sixties, and relax and had a drink.

So they did that, got the thing set up. My job at that point was to go back into the command module, where out the right side window I could just barely see down the long axis of the workshop, and I could see the corners of this thing coming out, and, in fact, took some movies of it. Said, "Yes, yes, it's out. Okay, it's flattening out now." See it bounce around a little bit and settle down. So getting that out was the big job.

And then the job for the next three days or so was activation, bringing all the systems up and taking all the launch pins and other things out, just methodically checking it. It took longer than we thought, because getting used to moving your body and doing those tasks in weightlessness takes a couple of repetitions to do. No real problems, just slow. Then we started in doing medical experiments.

We couldn't do much by way of earth resources experiments, because we were seriously underpowered. Power was still a big problem. They were very, very careful with us, making sure that we didn't turn on too many lights at one time. We were not allowed to use the food or drink heaters down in the galley. We ate our food at room temperature. That was okay. There were certain experiment combinations that had to be prohibited.

We could do some Apollo Telescope Mount work, and we started in doing that, but doing the Earth camera passes required that you take the whole spacecraft out of its sun-pointing attitude. The normal attitude for Skylab was with the sunny side pointing at the sun all the time. Solar inertial. To do proper earth resources, you go into what they called a Z-local vertical, where the bottom side of the spacecraft is now rotating at the same rate you're going around the world, so it's pointed at the ground and you can pick out ground targets. We weren't allowed to use the word "targets," said to be too militaristic. But this is what we

were doing, picking up ground features and photographing them with special films and multispectral cameras and all that stuff. Well, if you go out of the solar inertial attitude, you begin to lose power. The batteries drop off the line. It's a disaster. We tried it once, and it took us the rest of the day to recover. We didn't try it again until after we had freed up the solar panel.

So the first two weeks, we were still in the dark. We still hadn't solved all the problems, so there was still tension. We were doing the exercise thing. We had a half-day off around day eight or nine, and we gave the ground a little television show. Weitz had a taped copy of "Thus spake Zarathustra." It was the theme for *2001*, Strauss. We played that real loud, and we set up the TV camera, and we came down into the workshop for the docking the day after and we did our acrobatics thing. See, we had learned how to do it in the first week, and the ground thought that was neat. So it relaxed everybody.

But we were still a troubled mission until we got to the point of, I think it was about June 10th, when we got ready to go out the door. Rusty [Russell L.] Schweickart had led the backup crew, again in the Marshall water tank, knowing what the problem was, to devise an EVA where we could go out, work our way around to that side of the workshop. There were no handholds, no footholds, no visual aids, no lights, because there was never any planned maintenance on Skylab. Too dangerous. There was, fortunately, planned EVA. It was to retrieve film and exchange film in the ATM. So we had the suits, we had the umbilicals, and we brought up some tools that we thought we'd need.

They planned an EVA that had us erect a twenty-five-foot pole, put the cable cutter on the end of it, and the jaws, which are about three inches long, had to close around that aluminum scrap that we'd seen, and bite halfway into it but not all the way. That was step one.

Now we had a handrail. Pete could go along the handrail while I stabilized the near end of it, with another rope attached to his sleeve. When he got as far out as he could, taking

care to avoid sharp edges, please, he would hook that rope into the solar panel cover as far down as possible, so as to give it some leverage from the hinge. Because what we had to do was not only cut the scrap, but then break up that hinge which had frozen, and start the thing up. He was to go down, put the rope on, then I would tie the other end of the rope up to a handy stanchion, as close to the surface as possible, and then the two of us would get under the rope and stand up and hope for the best. That was the Rusty Schweickart solution. We said, "Well, okay, Rusty, we'll give it a go."

*And out we went with all the equipment. I even had a dental saw from the medical kit taped to the chest of my suit, just in case, if all else failed, we thought maybe we could go down there with the dental saw and try to get that thing off. Didn't have to use it. Did have a couple extra tethers, six-foot equipment tethers, with hooks on both ends. This proved to be crucial to the mission. Because we went out there. Getting around to the area was no problem. Erecting the twenty-five-foot-long pole with the ropes and all that was no problem.

But getting those jaws—and we were a good twenty feet away and couldn't get any closer to the aluminum strap—getting the jaws onto the strap at a twenty-foot distance with a pole with no foot restraints just was proving impossible. I had the pole in my hand and I would move it toward the jaws, trying to gauge whether I was exactly far enough there, and as I did that, my body would start turning. Newton's third law. Conrad was trying to grab my legs with one arm and a strut with another arm, but that's not a stable enough platform. We went nuts for one whole day-side pass and failed, just didn't do it.

It comes night-side, we're sitting around thinking about it. We found an eyebolt, a circular bolt which just looks like the end of a Yale lock, on the surface of the workshop near one of the antennas, right in a line. Don't know what it's there for, but what if we strapped myself to that eyebolt? So we got the spare tether, and there's a hook on the front of the suit. Hooked it through there, ran it through the eye bolt, back up through the suit, tightened it up, and now I have a three-point suspension. Now I can stand. I'll place my feet on the surface

of the workshop and almost straighten my knees all the way out, and suddenly I'm as stable as a rock. It was like standing in your garden at home. It was wonderful. Man, two minutes later, the job was done.

The rest of it unfolded, as I said. We crawled under the rope that Pete had laid out. That was probably the most dangerous part of the spacewalk, was Pete going down there amid all that debris, but he got away with it. We stood up, and suddenly it released on us. We both went ass over teakettle into outer space. But our EVA system was an umbilical, a nice stout umbilical with an eighth-inch steel cable in the middle of it, so we didn't have any worries about that. We went out to the end of our umbilicals, and then hand-over-handed ourselves back till we got something to hang onto. Turned around, and the prettiest sight I've ever seen in my life was that solar panel cover fully deployed, ninety degrees, and you could see the panels starting to come out as they warmed up in the sun. And we knew we had done the job. So that was great.

We finished the EVA. It was rather a short EVA. We actually went down to the sun end of the ATM, to sort of have a pre-look at the film-retrieval route and see whether that was all okay. I will mention that I was allowed to do that, because I had trained for it. You go up to the sunny end of the ATM. It's the middle of the day now, so this thing is pointed at the sun, and the Earth is now below you. You get up and stand in foot restraints up there, and you are king of the hill. I mean, here you are, standing up, looking down, and here's the world spread out, horizon to horizon. There's nothing like looking at the world through the helmet of a space suit. It's much better than the hatch. You just feel like you're in the middle of this big Cinerama movie. That was a heck of an experience. Described the color and condition of the parasol, and took a general look around and then went back in. It was over in less than three hours, but that was the best day of the flight.

RUSNAK: Quite a remarkable three hours.

KERWIN: Quite a neat day. You find, also, that getting out there, working around in a suit, gives you more exercise than you normally get in space, and that feels really good. Space is too sedentary. Normal activities, even in the big old Skylab, were pretty sedentary and left you feeling kind of sludgy and feeling like you really would like to go out and jog or do something. Only one day of the mission did I get to do that.

RUSNAK: So how realistic was your training for EVA compared to the actual experience?

KERWIN: It was excellent. Again, another gold star for the people at Marshall. Good mockups. This is a truism by now; it's harder to do it under water than it is to do it in space, because no matter how well they weight you out, you're not really weightless. If your body is turned upside down, yes, the suit is neutrally buoyant, but you're jammed up against the shoulders and the blood is rushing to your head. If you can do it under those circumstances, you're going to find that it's a piece of cake in zero-G. The suit worked perfectly, and the tools worked as advertised, and the EVA trail was great up to the ATM, to do what we had. Everybody gets 100 percent.

There were a lot of gold stars issued on Skylab, overall. The habitability provisions were excellent. The food and water and waste management, and crew and equipment restraints, all of that stuff, a lot of thought was given to it. A lot of stuff that's considered standard on Shuttle today was invented by these engineers who did Skylab. And it was a palatial living experience compared to either Shuttle, and I think even International Space Station. We had tons of volume. We had a good atmosphere, had a quiet spacecraft. It was a very pleasant place to live and work.

RUSNAK: If you had the solar panel out, the station's much closer to full power, so you could actually do—

KERWIN: Close enough to do 100 percent of the job, yes. It turned out that the missing solar panel gave you essentially a margin, so we didn't have the margin, but we had enough we could turn the lights on, we could heat up the food, we could do the earth resources passes, and so the rest of the mission was just catch-up, just working through the days, doing as much as we could. Houston thought we were wonderful, so they didn't get on our backs if we goofed, which we did a couple times.

We fell into a routine. It's amazing how quickly you fall into a routine. About eight days after the EVA, we were sitting around at the dinner table, and somebody says, "God, it's been day twenty-two forever up here, hasn't it?" [Laughter] Because we were doing the medical experiments and we're doing the ATM experiments, and things have just fallen into a routine, and we're getting sort of ready to come home.

So the phone rings, so to speak, and Houston calls, and they said, "Guys, we've been thinking about extending you for a week. Just in case we have to truncate the final part of the Skylab mission, would you guys be willing to stay up for thirty-five days?"

We looked at each other like that, and Pete said, "Absolutely, Houston. No sweat. No problem. We can handle it." Which we could, of course. For some reason, they talked that over and decided that, no, it wasn't necessary. Things were looking fine, and they did not ask us to stay up extra.

So we finished our routine, got to the day before reentry, which was basically deactivation day, powering down, taking a lot of close-out photos, getting rid of all the trash, getting ready for a short night, because we'd been on a twenty-four-hour day, getting up at 6 a.m. Houston time, no matter where you were around the world, and going to bed, at least saying goodbye to Houston at 10 p.m. Houston time, and now we were faced with having to

get up at what amounted to two in the morning in order to get ourselves in phase for the reentry.

Not a big deal, but we nearly had a disaster. The trash on Skylab was all stored in the oxygen tank. Remember now that this is a third-stage booster. We are living in the large hydrogen tank. Underneath the hydrogen tank between it and where the engine used to be is a spherical tank, which was the LOX [liquid oxygen] tank. Instead of using it with an engine on the other end, they just put an open grating, so it was constantly exposed to vacuum, but physical stuff couldn't get out. They put a trash airlock in between the hydrogen tank and the oxygen tank, so that you could open a top hatch, put a bag of trash in there, close the top hatch, seal it, then open a bottom hatch and with a plunger, push whatever it was out into the oxygen tank and it stayed there forever. That's how we disposed of our trash without littering orbit.

It worked fine, until the very last day when some large object, we were disposing of some large object that was just small enough to fit in there but it had edges on it. Weitz put it in there, and he closed the top hatch. He opened the bottom hatch, and he went to plunge it with the plunger, and it wouldn't plunge. It wouldn't go through. It was stuck. It was stuck halfway through the bottom hatch, and it looked very much as if we had just destroyed the trash provisions on Skylab, because you couldn't open the top hatch, you were exposed to vacuum. The bottom hatch was open and it wouldn't close. God. The crews went over to the trainer to try and figure, Weitz is jiggering this thing, and we're saying, "Are we going home tomorrow or not? Are we going home tomorrow or not? What are we going to do?" Somehow, somehow, three hours later, he jiggered something and it went on through. We closed it and said, "Yay! We're going home after all." And that was that. It was routine.

So, day twenty-eight, we get up early in the morning, finish the deactivation, get in the command module, and depart. Do a fly-around, take some nice pictures, it looks beautiful. We're rehearsing the reentry stuff. People have not been up there twenty-eight

days before, and we weren't quite sure what kind of shape we were going to be in. So we did a two-stage de-orbit from Skylab. Skylab was at 235 nautical miles, and they decided to do a service module burn to lower us to about 120 miles, and then another burn to do the final de-orbit. It was a service propulsion system burn. Even on a fairly lightweight, empty service module, it's only about a 1-G. We're taking it in the couches lying sideways.

So he lights up the service module, service propulsion engine, and two of us grayed out. Damnedest thing I ever saw. Your visual field contracts like it does when you're pulling Gs in an airplane. That's all. It just grayed out and then went back, but we said, "Are we that sensitive to gravity after twenty-eight days in space? This is very strange." I remember Pete and I going through the switchology, making sure that if one of us stayed conscious, he wanted to be absolutely certain to hit that entry switch to auto so the valves would close and all of that stuff. We were a little bit concerned about reentry at that time, being something that we might not tolerate. Of course, we didn't share our concerns with Houston.

Around we go, and it's time for reentry and the second service module burn. It's not a problem. We come into the atmosphere in a very gradual buildup of G-forces to about four and a half Gs, and nobody had the slightest bit of problem. So I still can't explain that little gray-out that we had on the first burn. I guess you might say it was just sort of settling the blood back where it belonged, you know.

Normal, routine landing. We landed so close to the carrier, they almost had to move to avoid our landing on the flight deck. This was the first mission at which the command module would be picked up by a shipboard crane, and actually settled down onto a place on the flight deck, and then we would get out. All the previous missions, they had sent a chopper out with rafts, and you got on a raft and then up into the chopper. They figured they would go easy on us, since we'd been up there for a month.

We're all ready to go, and I'm thinking, "You know, we're going to be dehydrated. We've lost a lot of fluid. I think I'll chug-a-lug a strawberry drink after we touch down." That was the wrong thing to do. I should have chug-a-lugged the damn strawberry drink with breakfast that morning instead, but I had it on the gently bobbing command module, and I got seasick and didn't feel very good.

So, but anyway, they opened the hatch, we all got out and went down into the sick bay, where we were supposed to go, and threw up. [Laughter] Worried Dr. Berry a little bit, but it was just that I got seasick from drinking strawberry drink.

RUSNAK: Aboard ship, what type of debriefing did you go through in the wrap-up from your Skylab mission?

KERWIN: Unless I got very detailed, there wasn't much to tell about that. You brief the ongoing crew about where things are, what the hard and easy things were to do. Told them to exercise more and that sort of thing. They were raring to go.

We had one little interesting episode. The third day, they helicoptered us from the *Coral Sea* back to San Clemente, California, where Richard Nixon was having a conference with the premiere of Russia, Mr. [Leonid] Brezhnev. He wanted to introduce the Skylab crew just down from our successful mission to Mr. Brezhnev, so off we went on the chopper and down. We were wearing these masks. You're supposed to wear the masks to prevent yourself from getting infected, because you're still part of a medical experiment. It's going to be another eighteen days before you're off the diet and they stop collecting everything you put out. If you got a disease, that might interfere with the experiment.

We're out of the chopper, and we're walking toward this little stand where we could see the President and Brezhnev there, and Conrad says, "I don't like this. This is insulting to the President of the United States. Let's take these damn things off and put them in our

pockets." So we did. [Laughter] Dr. Berry probably had a heart attack, but they didn't give us any diseases, and we didn't give them any diseases, and we had this brief conversation with these two guys.

Pete angled an invitation from Brezhnev for us to come to Russia. Sure enough, the following year, we got this invitation to join a group, with our wives, and had a very interesting tour of Russia at the peak of the Cold War. That's another story. It has nothing to do with the space program.

Going on from there, I guess I didn't contribute much of anything to the rest of the Skylab program. Starting to get ready for Shuttle. Starting to redefine the crew positions because we're now going to bring in non-career astronauts, call them payload specialists. There was a lot of activity on what to call them, how to train them, how to integrate them, how to define and divide the tasks between career scientists, like we felt we were, and non-career scientists, like the new ones were going to be. Of course, there's so much water over the dam since those early efforts, the Shuttle has pretty well ironed out all those problems, until we get into a new set of problems with Space Station and with international crews. That will all be very interesting.

So I was involved with preparing for Shuttle. In charge of the space and life sciences directorate during the early Shuttle years. But I can't think of anything spectacular to tell you about those years. Everything went pretty well routinely, waiting for Space Station. Waiting for the follow-on to Skylab, at least from my perspective, that was the big thing. We were very happy when [President Ronald W.] Reagan announced in 1984 the permanent presence in space, authorizing NASA to begin the process of developing a space station.

I think we have not performed in the most stellar fashion in the last sixteen and a half years. We should be there by now. I'm not blaming anything on the current administration or leadership, because I think our problems started right back in '84, when in an effort to gain a constituency for a space station, a new major project for NASA, NASA went out and beat

the bushes and made promises to every constituency they could think of to get a lot of people to sign up and say, "We'll use a space station." And they got a set of missions that couldn't possibly be accomplished within the budget.

They tried to design, for $8 billion, a space station that was all things to all people. Some of those earlier design concepts have to be seen to be believed. They had external hangars for maintaining interplanetary spacecraft, and all kinds of astronomy and planetary micrometeorite collection, and huge numbers of modules and acres of solar panels, and you just couldn't do it.

They never quite got the thing under control in terms of budget and schedule. I think they would have done, except for the Challenger accident. Early 1986, boom. Here comes the Challenger accident, and it just turns NASA upside down. Never before that had anybody thought that NASA was less than the best-managed federal agency ever. Immediately after, we found that we were the worst federal agency ever. You know, the atmosphere just turned around completely.

In its terrible and ultimately successfully efforts to get out from under the Challenger accident and get back to flight, the Space Station program was an orphan. It was not well managed or surveilled in those days. There was change of leadership at Headquarters, and I think some decisions were made about Space Station that weren't properly looked at. Some other decisions were made about Space Station management as a result of the Challenger accident that were inappropriate and have since been reversed. We ended up with a Freedom Program that had an ungainly management structure, an unnecessary layer of management at the Headquarters level, which has since gone away, and a configuration that was very difficult to build.

I also think that by January 1993, the program, in spite of the management problems, had learned how to manage. They were making real progress toward critical design review, and the impression I had was, "Yes, we're over budget. We're behind schedule. But we

have learned how to do this thing, and we're going to be successful." And in comes a new administration and decides that the only way to save the Space Station is to give half of it away to the Russians. I think that was a diplomatic move, not an engineering move, and the amount of pain that it will cause us is yet to be determined.

We're working away manfully to try and make that thing work. I am working away manfully to try and make it work. I hope it will work. In retrospect, it's sort of crying over spilt milk. Perhaps one could say that we should have started on a little more modest scale with the permanent space station, more on the scale of Skylab, as a matter of fact. More the way the Russians did with Mir. Put a core module up and build on it as your capability and your needs expand. This, in fact, is what we may end up doing with the International Space Station, in spite of the grandiose look of it in viewgraphs today.

I think the permanent presence is important. I think it is a valid way-station to planetary exploration and will be a very useful national laboratory in weightlessness. It certainly has taken us a long time to get there.

RUSNAK: It has. Do you think there are any lessons that ISS could learn or could have learned from the Skylab Program?

KERWIN: Well, it's learned a lot that are by now so deeply ingrained into it that it would be almost hard to point them out, but the habitability, the diet and exercise, the workday structure, a lot of those things.

As a matter of fact, one thing I find that's good about this long gap between Skylab and Space Station is that it's kept me usefully employed for twenty-five years. [Laughter] People still come and ask for data. "How did you guys do that? How did you manage this? Give us a little seminar, get some people together, and tell us about managing science on the Skylab. How did you manage to do that so efficiently? What did you do wrong, that we

shouldn't repeat?" We had a lot of things that we did wrong that should not be done that way again.

So I figure that once the International Space Station has been in operation for about two years, Skylab will be as interesting as Columbus' voyage. [Laughter] All those lessons will have been learned over again and new ones will be being learned. But now we're still popular, so it's kind of fun.

RUSNAK: It's good to know that your mission back then is still proving valuable today.

KERWIN: Yes. It was a good mission, a beautiful medical data set. Still, I think, the best, most complete medical data set on nine people that exists for weightlessness. Again, I can't wait for Space Station to do a much, much better job of that and to refine the exercise prescriptions and the diet prescriptions and the other countermeasures that will allow us to go for six months and a year safely, overcome physical, psychological, and environmental problems, and go to Mars.

RUSNAK: We can only hope that that comes sooner rather than later.

KERWIN: That's right. Amen.

RUSNAK: What's your role in the International Space Station today?

KERWIN: Well, I manage a contractor now, a fairly small contractor called Wylie Laboratories, which is the support contractor to the medical effort at the Johnson Space Center. So my people are extra hands and feet for the research laboratories, the medical operations and training, the medical equipment development, building the crew healthcare

system and the exercise hardware for Space Station. So I'm now a supporter, a contractor, rather than a manager at NASA, but still on the team, still helping the Space Station to get on with it.

RUSNAK: Great. I have just a few sweeping questions, I guess, for you to kind of reflect back on. What do you think of the role of life sciences and medical experiments, these types of things, in NASA from the time you joined through Skylab and Shuttle and now International Space Station? How do you think that's changed over time?

KERWIN: In a number of ways. That could be another long reminiscence, but briefly to snapshot, the initial astronauts were selected in total ignorance, not stupidity but ignorance, about what the environment was like or what it was going to take. So they did every difficult, nasty test they could think of, just to try and screen those people down to seven who could stand hot, cold, acceleration, disorientation, etc. When the astronauts, much to their amazement and everybody else's, discovered that they were national heroes and they hadn't even flown yet, they fired the psychologists and sort of set the medical folks back into, "You're nice and supporting and we realize that we have to have you around, but don't get too ambitious."

A battle ground, if you will, for this over all the years has been what's the role of exercise in space flight? The crew has always considered it just that, it's exercise. It's an operational thing, something we do to keep fit, and we don't need the doctors to tell us what to do or how to do it. That was the attitude through Apollo, and even into Skylab. We agreed it was very important to measure all the exercise, but we didn't want a prescription. We didn't want them to tell us exactly what exercise to do. We said, "You don't know what exercise is necessary. Let us go up there and do our thing and measure the results. From that will come, is it necessary? If so, how much? If so, what kind?"

We're still stuck between Skylab and Space Station because we don't have any good long-duration experience with good data since Skylab. The Russians have some good experience, but they don't have the organized data. So we're right at the same point we were in 1974. We know it's important. We know there's going to have to be a prescription. You can't anymore just leave it to the crew's discretion, but we don't know what the prescription was. So let's go work on that. That's, if you will, an encroachment of the doctors and physiologists back into what has been an astronaut purview up to now. I think, in that sense, there's a better relationship, perhaps, between the docs and the crew than there was early in the program, although ours wasn't bad.

In another sense, the world has changed almost beyond recognition in the area of informed consent for experiments. There were no informed consent forms before Skylab. I've described to you how we fought and scratched on the details of medical experiments trying to make them what we thought operationally suitable as well as useful, but there was never any question that it was part of the job to go do that stuff. We never signed any consent forms.

About two years ago, somebody from JSC asked me whether I thought I could possibly get signed agreements from the Skylab astronauts for the free use of their medical data for research purposes. I said, yes, I figure I could probably do that. We had an astronaut get-together shortly after that. In thirty minutes, I got nine guys to sign on the dotted line. "Hell, I thought it was already in the public domain."

The attitude is quite different and a little bit more divisive, I think, today, in that crew members feel that it's their right, and they're told that it's their right, that participation in any experiment is voluntary. They have to sign informed consent, approve the protocol, and if the protocol is changed, they can change their minds. In that sense, there's a lot more bureaucratic hassle, if you will, that stands between you and the result. Again, good will will work it out, but it's more complicated than it used to be.

RUSNAK: If you look back on your career as a whole, what do you think the most significant contribution you made was?

KERWIN: I don't think it was anything in management; I think it was just conducting that Skylab mission properly. Carrying out the good work that was planned by the teams on the ground.

RUSNAK: On a related note, what do you think the greatest challenge for you was?

KERWIN: Getting that solar panel up. [Laughter]

RUSNAK: That was certainly an achievement in of itself, because if that wasn't running, then who knows what would have happened to the other missions going up there, as well .

KERWIN: Exactly. That bailed out the program.

RUSNAK: I wanted to give you a chance to make any final remarks before we run out of time today.

KERWIN: I can't think of anything either wise or funny to say, so we might as well just knock it off. I enjoyed it.

RUSNAK: It's been a pleasure for me, and I'd like to thank you again for joining us.

KERWIN: Thank you, sir.

[End of interview]