Jennifer Thornton

From: "Johnson, Sandra L. (JSC-IS)[TES]" <Sandra.L.Johnson@nasa.gov>
To: <jfthornton0206@msn.com>
Cc: "Wright, Rebecca A. (JSC-IS)[TES]" <Rebecca.A.Wright@nasa.gov>
Sent: Thursday, January 22, 2009 3:30 PM
Attach: ThorntonWE_3-3-04a.doc; Thornton topics 2-04.doc
Subject: JSC Oral History Project transcript

Ms. Thornton,
I've attached Dr. Thornton's transcript of our oral history session and also the topics that I had hoped to cover during the interview. Like we discussed at the workshop, if he is more comfortable writing "from scratch," then please tell him that's okay with us too. He shouldn't waste his time trying to correct the transcript if he's not happy with it. He could possibly use the topics as a guideline and write a narrative, or if he'd simply like to write answers to the questions, that would work also. Just let me know what you think (and what he thinks!) and we'll work with you on getting it documented – which is the most important part of this process. He has a unique perspective from his time with NASA and it would be a shame not to document his experiences.

Thanks you so much,
Sandra

Sandra Johnson
Production Coordinator
NASA JSC History Office
Tessada & Associates, Inc.
JIMMS Contract
17047 El Camino Real, Ste. 217
Houston, TX 77058
281.486.0678

William E. Thornton
Suggested Topics
March 2004

PRE-NASA

Please explain your work with the Air Force Manned Orbiting Laboratory (MOL). How did you become involved with MOL?

What was the objective of the exercise programs you worked on in conjunction with the MOL program?

ASTRONAUT CORPS

What influenced your decision to apply as a civilian to NASA?

Describe the scientist-astronaut application/interview process.

How did your background and previous experiences in science prepare you for your career with NASA?

What was your relationship with the first group of scientist-astronauts chosen in 1965?

How did the previous pilot-astronauts react to your group's selection?

What were your first duties and responsibilities when you came to NASA? Please share with us the details of the astronaut training program.

What were some of your duties after you completed flight training?

SMEAT (26 JULY 1972-20 SEPTEMBER 1972) AND SKYLAB

How did you become involved in the Skylab Medical Experiment Altitude Test (SMEAT)?

Explain your work with the Lower Body Negative Pressure (LBNP) device.

Explain your work with the Skylab Program.

As a doctor, what do you feel were the greatest contributions of Skylab?

Tell us about your duties as CapCom and as a member of the support crew for the Skylab Program.

SPACELAB

How were you selected as a payload specialist candidate for Spacelab 1?

Please describe your role in the Life Sciences Spacelab Mission Development III.

PRE-SHUTTLE PROGRAM WORK
What were your duties with NASA after you returned from leave in 1977 and before your mission support roles in the early shuttle program?

LIFE SCIENCES AND SAS INVESTIGATIONS
What was your role with Mission Support on the early shuttle missions?

Explain your work with the Space Adaptation Syndrome (SAS).

Describe your role as a principal investigator for several of the early shuttle flights.

Describe some of the studies you conducted and the information you gained from these investigations.

STS-8 (30 AUGUST 1983-5 SEPTEMBER 1983)
When and how did you learn that you were selected for your first shuttle flight?

Describe the training regimen you and the rest of the crew completed in preparation for the flight. How much time did you spend training on specific payloads or tasks?

Describe the mission experiments and your general duties in working with them.

STS 51-B/SPACELAB 3 (29 APRIL 1985-6 MAY 1985)
How did training for this mission differ from training for your earlier mission?

During the mission, what experiments were your responsibilities?

Please explain the collaboration of ESA and NASA on the mission.

How had the Spacelab program evolved since you became involved in 1977?

GENERAL
You hold many patents. How did your work and inventions help to shape the shuttle program?

What do you consider the most challenging aspect of your career working with the space program? What do you consider your most significant accomplishment?

What led to your decision to retire from NASA?

NASA JOHNSON SPACE CENTER ORAL HISTORY PROJECT
ORAL HISTORY TRANSCRIPT

WILLIAM E. THORNTON
INTERVIEWED BY SANDRA JOHNSON
BOERNE, TEXAS – 3 MARCH 2004

JOHNSON: Today is March 3rd, 2004. This oral history with Dr. Bill Thornton is being conducted for the Johnson Space Center Oral History Project in Boerne, Texas. Sandra Johnson is the interviewer and is assisted by Jennifer Ross-Nazzal and Rebecca Wright.

I want to thank you again for allowing us to come and visit you today, and I want to start today by asking you about how you first became interested in aerospace in your early years.

THORNTON: It began very early. It began, really, with my father and mother, Will and Rosa Thornton. They came up in a much earlier age and in both cases had to raise siblings, which they did an outstanding job of. Rosa delayed marriage until she had her siblings safely launched, so I came along fairly late in their life.

My father was a small landowner, and about the time I was born, the Great Depression really settled in. He lost his savings, for example, in an overextended bank. This was hard-cash savings, not speculation. But we came from a background of total self-sufficiency; you depended upon yourself. Yes, we had a bit of land. I grew up with a barnyard, crops that were being grown within the small town adjacent to us, gardening and such. As it turns out, this early experience, especially with animals, served me very well indeed on one of the missions.

It was at this point in time that my interest in space was aroused, because my father was a superb naturalist. He spent great amounts of time tramping the woods, anything of interest in the

area, and especially nights, storytelling, and some of the basic elements of natural science, such as evolution and such, I just knew from the very beginning.

Let me say another effect, though, occurred. When I was a year old, I had bilateral lobar pneumonia, which had an appalling death rate at that time. I was placed in a very early pediatric hospital and survived. I was constantly reminded of the role that the doctors and nurses had played in my survival, and I have no doubt that this affected many of my later decisions.

It was a totally different world. It was a structured world in which there was individual responsibility that was taught from the time I was carried into the Sunday school room, before I could walk, and then it continued. The schools did things that they would be sued for today. They actually taught ethics, and with a strong moral background such of that time. So I came along at that.

I was a slow, but became, by the sixth grade, the best student. But my father died at eleven and I went to work. I'm afraid I used that as an excuse to become—I certainly slipped in ranking in schoolwork, etc., etc. I worked at whatever would make a few pennies, whether it was first delivering papers. I was a big kid. Hard manual labor. By the time of World War II, I had become a full-time theater projectionist for two years, while I was in high school. I didn't have a relief operator. I won't go into the details of that. It was during this period that I learned electronics. This was self-taught from out-of-date encyclopedias; experimentation, primarily.

After leaving the theater, I supported myself then until I went into the Air Force. I supported myself and helped my mother, who also had worked hard during this period, with electronics repair, primarily radio and then TV.

I went into State College the first year, State, which is an engineering school, because I was accepted at the university, but there was no space. This was just after World War II, and one

of the major things that I did, because I honestly felt there was going to be another war, I had no choice but to join the Air ROTC [United States Air Force Reserve Officer Training Corps] when I was at State, but I had the option at University of North Carolina [Chapel Hill, North Carolina], but I continued in it. I did physics, was really my great interest. That ROTC cost me a year, but I guess it was worth it.

I really had no social life. I won't go into the details, but I had to work from week to week to get eating money for the next week. However, I indulged myself by, of all the crazy things, going out for the football team, which University of North Carolina had the—as a matter of fact, they had the number one team in the nation at that time, and they were a bunch of really college pros. I had never had a football uniform on, but I went out as a meatball and sat there, the only amateur athlete on the whole team. I had no scholarship or anything else, just persistence. They were kind enough to give me a letter my last year. I was a meatball, where you sit there and put on the other team's uniform in scrimmage for four days. I got run over by some pretty good people and every now and then I've run over a good person or two.

So, come graduation, the Korean War was on, straight into the Air Force. Now, I haven't mentioned, my great interest up until this time were airplanes. Even as a child I couldn't, and still can't, hear an airplane going over without looking up to see what it is and so forth. I did the usual model-building. As a child, I can remember walking three miles there and back just to see a Piper Cub take off from a hay field. This sort of thing. All the usual interests. Science was my other great interest.

So, when I got into the Air Force, in many ways it was a great opportunity. I was on and off flying status, depending on various projects that I was assigned to. I was not a pilot, but I

flew every opportunity, flew everything from World War II B-17s to B-47s, the latest jet at that time.

I was immediately called out from indoctrination, and in the Air Force's way of doing things, they needed scientists, and of all things, I was assigned to a bacteriological warfare project, which munitions were being picked up in [Fort] Dietrich, Maryland; flown down to Eglin [Air Force Base, Florida] for operational—this was operational testing; flown cross country; dropped in Utah. And of all things, there were, I think, two of us that, once we were told what it was, said, "Yeah, we'd do it." We "volunteered." We were given jump chutes, parachutes, without a scrap of training. We were assigned a bunch of APs, Air Policemen, that were similarly equipped with parachutes. I don't know how many of us would have jumped if we had had to, but if anything happened to the plane carrying the munition, we were to go down, secure the thing, protect the populace, while the plane that we were in carried trucks and other decontamination gear. We were given instructions in how to decontaminate things and such as that.

The significance of this, it totally reawakened in me a deep interest in medicine, particularly the bacteriology and so forth. I had read and thrilled to [unclear] and all of the other great medical stories of the day.

Well, this project ran out and I was assigned as an officer in charge of the Photo Optic Section. Eglin Air Force Base, where I was, was the operational testing ground for new aircraft. They worked out the tactics and such as that. For example, on the beaches of England, there were still the V-1 ski ramps left over from World War II, where they had bombed them, and [General James H.] Doolittle practiced for his Tokyo [Japan] raid there. It was this sort of tradition.

So we had a bunch of new aircraft. Now, remember, this was cold war. However, it was on the fringe of heating up. We were at odds with the Communist world, who now had nuclear weapons, they now had intercontinental bombers. There were no intercontinental missiles at that time, but our protection depended on air defense interceptors that would go up—they were all weather interceptors. The first group that had their own radar, computer systems such that theoretically they were vectored to the incoming aircraft. Some twenty miles out, they'd pick it up on their radar. The last two or three miles, the pilot would fly whatever the display told him to do. The rockets would be launched automatically and the bombers destroyed.

That was great in theory; however, the hit rate from that, it only took one rocket to bring a bomber down, but they had forgotten something in the development. They had nothing to shoot against, because all they had was World War II tow targets, which were just totally unsuitable. If you didn't get a hit, you didn't know where you missed. These planes could not be set up on the ground. They had to be corrected for firing errors by actually knowing where the rockets went, and there was no such thing.

In my, I suppose, arrogance, I jumped into that, developed a scoring system, which then allowed the use—and I did the first development and testing of small high-speed targets that could be towed behind aircraft. This was not done without a certain amount of stürm und drang. I was making waves, shall we say. The operational people that flew the aircraft and so forth, they were all for it. They obtained a nice decoration. Not many second lieutenants get a Legion of Merit, which is the second highest noncombat decoration. So they gave me that.

But there was also a pattern set up, which has continued throughout my life. The people that have to do things, I got along very well with. The people that sit back and control them and talk about doing things, don't do so well with.

I got my first patents there. At that time, I had just automatically assumed that once I got free of them, I would go to flight school. But I made the decision, based on my experience with the BW [bacteriological warfare] warfare, what was going on, that, "Hey, maybe you can do more for the world in medicine." I had some rather exalted views of medicine at that day.

So I went back to the University of North Carolina with the intent not of doing medicine formally, but simply bringing electronics into medicine, because, believe you me, medicine was a different world. The most sophisticated electronics they had were a little bit of nuclear stuff, counters and things, a few instruments in the lab for the electrocardiogram, which I spent so much time with. You lay very still, didn't dare move for messing up the record, and you got two or three feet of one channel of the EKG [electrocardiogram]. It was switched from channel to channel. That's what it was when I got there.

Well, I went to the University of North Carolina, and something else life-shaking for me happened. I had had virtually no social contacts or anything else in my whole life, and, lo and behold, I meet Jennifer. So, two things happened. It soon became obvious that if I were going to do any good in medicine, I was going to have to also learn medicine as well as electronics. I also was determined to marry Jennifer. So there was no way that I was going to either let my wife support me, as I'm sure she would love to have attempted to do, or try to work my way through medical school, so I went into industry.

By this time, the Air Force—this work that I had done previously—large contracts had been let and one thing and another, and I went to a small startup company in Los Angeles [California], and went head-to-head competition with the largest electronics outfit in the world at the time, military electronics, Hughes Aircraft [Company]. To make a long story short, I still knew more about my systems than anybody else. We had a big flying contest at Yuma, Arizona.

I won that going away, without any difficulty. It became quite successful. The system, actually, was sold to the entire free world.

Unfortunately, I was very monetarily naïve, but, nevertheless, it was so successful that before I left, I had continued my contacts and was beginning to do the sorts of things that NASA is now so proud of, but I was doing them long before NASA was sending telemetry back from space. I was sending telemetry from patients, etc., etc., around the hospital, etc., doing studies particularly in EKG.

The importance of that and what I was interested in, I knew that patients, even though I was by no means a doctor, I knew very well that patients react very differently when they're up and around in their life than lying flat on an EKG table, and this, of course, proved to be the case. I talked the company into letting me—I had previously been chief of and I started their Electronics Section—I then talked them into a spinoff to build medical equipment, one of the very first outfits to build medical equipment, and started that company off, which went on.

I was using telemetry as one way of freeing the patient up. I was also working on a recorder that the patient could carry around, but another physicist, called [Dr. Norman J.] Jeff Holter, had come up with a much more efficient little recorder that is the well-known Holter recorder that monitors patients' EKG. Anyway, I convinced them to take that on, produce it, and the company became a major player, and was only recently sold. It became a major player in medical electronics.

But I managed some way to marry Jennifer, after multiple trips to England and a great deal of stürm und drang. So we went back to the University of North Carolina Medical School, with a brand-new baby boy.

I was, at best, a mediocre student. Looking back, I was a less than mediocre student in physics, and I could weep on what I missed there. But in medical school, I figured as long as I kept half the class below me, they couldn't flunk me. So that was the extent of my ambitions there. However, I did medical development in those years that was years and years ahead, and unfortunately, virtually none of the professors that could have taken advantage of it had the insight.

For example, between my second and third year of medical school, I did the first automatic analyzer for EKGs. No longer were you dealing with a strip of paper two or three feet long; you were now dealing with records from hundreds of people, twenty-four hours long, and there's no way to manually analyze such data, which has subsequently been well proven in courts and everything else. I did the first of that, which went on to make tens of millions of dollars for the outfit that, unfortunately, I was still legally bound to.

There were a number of other—I spent my time, frankly, that should have been spent doing conventional things, in medicine. I also spent about an equal amount of time on doing a lot of the early work in telemetry, such as monitoring, particularly.

Finally, we come to space. Somehow I ended up in a medical symposium on space in San Antonio [Texas], and this relit all the fires under me again. It just seemed too good a thing to miss. So I had to make a decision. I had finished medical school, was on the staff of the university, so the big decision was whether to go with NASA or the Air Force, because at that time—this was in the earliest days of the program—there was no assurance that NASA was going to be the big player in space.

The military, which I knew and knew how to work with, had a program called the Dyna-Soar Program. To make a long story short, I made arrangements such that I would do an

internship. I wanted an internship. I was still interested in clinical medicine. I'd do an internship at Wilford Hall, the Air Force Hospital here in San Antonio, and then I'd made arrangements with the Director of the School of Aerospace Medicine that I would be assigned to some space medicine project, if I went into the Air Force.

So we put the kids, two small children, in the back seat of the car and came to Texas; San Antonio. Did the internship. Strangely enough, went to the top, except once again, I managed to have trouble with theory versus practice. I won't take the time to go into the one trouble spot that I had, but if you look back at that record, you will see an outstanding record as an intern and physician.

However, at the end of that, on the way out to San Antonio, the Dyna-Soar Program had been cancelled. Well, having been in the Air Force, this didn't bother me a bit, because programs are cancelled all the time, new ones are generated. So they generated a new program called the Manned Orbiting Lab [MOL] Program. This was to be a physically manned surveillance program, going up for longer periods of time. It was basically a Gemini capsule to come back in with two people aboard.

But in those days, they were beginning to just get the first indications that space did things to the human body. There had been the so-called space motion sickness of the second Russian cosmonaut. The Mercury people were beginning to come back, had orthostatic hypertension, unexplained weight losses, transient weight losses, a variety of other things that indicated there were medical problems in the program.

I will mention one individual here who was selected to run that medical program, and we moved over to the School of Aerospace Medicine, into the Headquarters Division, Aerospace Medical Division, and he was then in charge of cardiology, and that was Colonel Jack Ord

[phonetic], who was one of the best I have ever known. He went on subsequently to finally as the Surgeon General of the Air Force when he retired.

He had laid out a research program, but there were things that you couldn't do—medical research in space, because the tools either weren't available or didn't work there. For example, one of the most fundamental things that you need is simply body mass. How much do you weigh on Earth? Well, we knew they were coming back with a sharp loss that was recovered, etc., etc. This, with the orthostasis, the tendency to faint early after the flight and so forth, this made this a very high-priority item. NASA had spent large sums of money, and so had the Air Force, trying to develop a workable mass-measuring device.

Once again, in my arrogance, I went on and dug in. It took me a year. I must admit it took me a whole year, but I did develop a workable mass-measuring device for the human body, which was tough to do. That was a tough one. Then also smaller devices such that you now had a means of weighing, if you will, in weightlessness, what was going on in the human body.

I also did a number of other medical items that were needed. I automated EKG, EEG [electroencephalogram]. I did the very first multispectral densitometer, which is now routinely used in many areas, on the finger for oxygen saturation, this and that and the other. I did the first one of that class of instruments.

NASA needed, just as we did, the same sort of tools. I'll never forget one of the senior and rather famous engineers, directors of NASA when I brought the mass-measuring device, because they had been struggling for years with the problem. I brought it in, and I'm a great believer in putting your cards on the table, so I put it in the big conference room and I hauled it out, threw the mass-measuring device on the—well, I brought it in a nice little polished case to begin with, and this guy looked at it and says, "I wonder what he's got in there. I suppose it's a

mass-measuring device." Well, it was. I brought it out, put it on the table, demonstrated it, let them play with it and this, that, and the other.

So I suddenly was of considerable interest to NASA, because they had built large programs around, but there was a lacuna there; there was a black hole. No way to implement a simple thing such as that.

So I first became a principal investigator for both human and nonhuman mass measurements. About this time, the beginnings of Skylab were beginning to be tossed around. I won't go into the details here, the way that program evolved. The Apollo Program was under way at that time, but, nevertheless, Apollo Applications, which was what the first Skylab efforts were called, was being planned.

Anyway, by this time, the contractors had spent all of the Air Force's appropriations for the MOL Program, hadn't produced anything. This is a recurring problem. They hadn't produced anything, and so the program was cancelled. NASA had had two successful programs by this time, so it was obvious that I was on the wrong horse. So, I used any and every contact that I had, and finally, just before I left the Air Force—I was planning to leave the Air Force sooner or later—my recollection—the record shows that I had contacted other people at NASA, but my recollection is, the really important contact, I just called up [Donald K.] Deke Slayton, who was good enough to take my call, and told him my situation and such.

At this time there had been one group of scientist astronauts, the first group [Joseph P.] Joe Kerwin and so forth were in. And he said, "No, don't give up yet, Bill. We're going to put up a new selection of scientist astronauts." And said, "Go ahead and make application." He told me what I had to do. There were two ways to get into it. The Air Force was going to be allowed a certain number of candidates, the Navy and various and sundry groups, or as a civilian. He

advised me at the time, he said, "You ought to come in as a civilian." So I made arrangements to leave the Air Force, resigned from the Air Force at that time, which was just as well, because they weren't about to let me. They had their own choices and their own notions about who they wanted to put up as candidates.

Anyway, to make a long story short, I resigned, went back to work for a period with the company that I had previously started, which was now a large successful company. Went back to work with them for this period, suffered through all the thousand ups and downs that obsessed people that apply for astronaut status go through. I went through that. Parked Jennifer and the boys—for once, they got a fairly good deal—parked them in one of the hotels in Santa Monica [California] next to the beach and such as that, and we sweated through that.

Finally, I was notified that I had been selected, and you can imagine—no, you probably can't, unless you've lived through something, something that you've put years into, that you think is going to be everything that you wanted to do, and I meant what I said when I said I would not trade places with the President of the United States. I felt that way.

Well, the first little glimmerings of the fact that the Moon may have two faces came whenever they sent me a letter saying I'd been accepted and the price that I had been accepted at, crikey, and my wages. Shoot. There was no way I could live on what they were going to give me. There were two of us that were put in this category. Whether it was by accident or not, I don't know. Doctors weren't universally loved in the astronaut thing, but the two doctors who arguably—certainly, I was paying more money in income tax at that particular time than NASA was offering to pay me. Anyway, that was the first little cloud to appear.

The second cloud that appeared is when we arrived. Been lots of changes, program had been cut back. Deke, in his own inimitable fashion, was right, "We don't need you. We don't

want you. Right now we'd love to take resignations from any or all of you." Not the first time. Deke was a straightforward person.

So anyway, the eleven of us who were going to go out and change space and the world and so forth, all crowded into one room. Now, at that time we had to jump through the hoops for this selection. We had to jump through the hoops that National Academy of Sciences had set up for us to meet requirements, etc., etc., scientific requirements, which included going back and taking graduate record exams and things such as this all over again. That was part of the selection. The astronauts, conversely, came down and said that we also had to meet their requirements, insofar as possible, which was to go to flight school. So, finally, I had the possibility of doing what I had passed up and had wanted to do so badly many years before. Little did I know, though.

So we jokingly said, "Okay. They won't let us be half astronauts." [Laughs] So we were the complete astronauts, the scientist astronauts. We called ourselves, after Deke's invitation, we called ourselves the Excess Eleven. At first, we had some good parties, and we had a couple of good parties at our little place, and there was a lot of that.

It didn't take long for cracks, though, to appear. I think I saw on your list of interests this business of science versus engineers. It wasn't science versus engineers; it was science versus the then-establishment, because remember what we were coming into. We were coming into a tradition. We were being thrust into arguably the most select group of people on Earth, and for good reason. I mean, hey, they were the best in the world at what they were doing. They did incredible things. They were supported by an incredible engineering organization. Yes, it was less than perfect and so forth. Good grief, they had the contract. Here we were coming in—the

field contract was almost over. This was the exclusive right to their stories, etc., etc. But we took away even a little bit of that; that was shared with us.

But most importantly, there was all the—hey, there were, as you well know, members that could get on the phone to the White House, members of the astronaut corps, etc., etc. And here is this bunch of nerds coming aboard, including a couple of doctors, who had caused considerable grief not least of all to Deke. Here we were being thrust into something like that. So, yes, we bloody well were going to flight school.

Now, flight school. It was a six months' delay because the Air Force was so backed up with training Iraqi and Iranian students, pilots. Hey, that's the way it was. Governments are more fickle than—I'll be careful here. Governments are fickle. [Laughs] So at that time, the Scientist Astronaut Program was put on hold for six months while the Air Force was training, and continued to train—when we arrived, a lot of our classmates—that was another story why Iraqis and Iranians that did not love the United States.

Okay. Flight school at this point, I am going to pull a curtain down, because there is enough emotional content left that someday, probably with a minister at one elbow and a rabbi at another elbow, to maybe try to keep me honest, keep the emotions out, I'm not going to talk about things that happened in flight school. It cost another year and a whole lot more of my life. It was an easy way to get rid of scientists. It was a very easy way, and they did; they got rid of several of the Excess Eleven.

Let's just say that I came out of flight school—I am going to say this, I could fly the T-38. I could do things with the T-38 ultimately that not everybody could. I flew the thing safely. I didn't bother with even keeping co-pilot time. Whenever I was pulled from the bird, I had something under 3,000 hours of front-seat time. I was frequently grounded for flying too much.

But anyway, that was one of the things that kept me in the program, was that airplane, and I could fly it. If it means anything to anybody, I could and did do instrument approaches under the hood on needle and ball, which not everybody that was flying them at NASA could do. On a good day, I could land the thing, fly the thing on instruments all the way down to touchdown. And even a year after I was pulled out of the T-38, I can remember landing it—I hadn't been in the plane for a year, and the first time I had my hands on it, I landed I it from the backseat, and I remember the pilot saying, "Tell us when we're on the ground." Because, I could fly it. Okay, enough about that. As you can see, that's very emotional.

Okay. Skylab. I was PI [principal investigator] on the mass-measuring thing, but that was just a small part. First of all, we come to SMEAT [Skylab Medical Experiment Altitude Test]. What was SMEAT? SMEAT was the Skylab Medical Equipment—basically, evaluation test. At this time it was very obvious that a lot of the equipment that was essential to Skylab—and that was, by the way, there were going to be three Skylabs. Two of them are still parked on the ground someplace; they flew only one. That's what we were brought in to man, but it had been cut back by this time to the one program. It remains the high point certainly of medical and probably scientific investigation and the space program. I can speak with authority as being the high point of medical investigations in space.

But it was a shambles, because it was our first attempt at long-duration flight in which people were going to be put up for long periods of time. Some of the Russians were having to be carried off after twenty-odd days, we heard, in terrible condition, and various and sundry other things.

So it was a combination of evaluation for the first time of such things. It was a massive and, at that time, unheard of costly program to look at the calcium, bone loss, studies pre- and

post-flight, and then in-flight studies. All of the fluid intake, output was measured, all of the food intake, fecal output was measured. There were two of my small mass-measuring devices to fill those squares. Although the human body mass-measuring device wasn't in that, they were an essential part of that study.

Urine collection. That was probably the most onerous problem. The fecal collection problem wasn't as bad. But they floundered around and floundered around with that. And exercise. Well, the powers-that-be unfortunately didn't understand exercise; still don't. So they had selected the bicycle as the only tool that was needed. They weren't even going to measure strength loss before and after, which is absolutely essential to understanding the calcium losses.

Nevertheless, the equipment that they had nobody trusted, for good measures, so they grabbed [Robert L.] Bob Crippen, [Karol J.] Bo Bobko, and myself. And by this time, I'm afraid there had already developed some considerable tension, which had been there from the very beginning, between Life Sciences and the Astronaut Office. The Astronaut Office still had enough power to protect itself, although it was rapidly losing that power. The astronauts basically, if something didn't look right, and the chances were that if safety or some other thing were involved, somebody either looked hard at it, changed it, or it didn't get done.

Well, there were a number of things that didn't look right, so they did the SMEAT test to prove this. One of the things of great concern to me, they had decided you needed much, much less food—these were the world's authorities—that you needed much, much less food in space because you weren't expending all that energy out jogging around tracks and this and that and the other, and they cut it back to a ridiculous amount, which, to me, was so obvious. They cut it down to 2,000 calories, and, hey, I was a big, active fellow at that time, with a fat percentage of certainly less than 10 percent body fat percentage, which was pretty low for those days. So I had

no reserves to fall back on, and a 2,000-a-day calorie diet was just ridiculous. So there was that question.

Anyway, we put all the equipment into the atmospheric test, because, remember, we were still using a very hazardous atmosphere at that time. It was a low-pressure, oxygen-rich atmosphere, so fire—remembering both the Apollo and a fire when I was at the School of Aerospace Medicine—in some atmospheres were very real concerns at that time. So they locked us up. We were put on the same collection protocol. We had our own little nicely-colored cases to carry around collected feces and urine in, and we were put on the Skylab diet of canned foods and so forth, and we were supposedly put on that thirty days before and for thirty days afterwards and with all the collections involved. We were still flying, of course, before SMEAT started. Bo particularly hated carrying around that—for a person with "the right stuff" to be carrying around this little box with unmentionables in it, into conference rooms and so forth, was not Bo's favorite thing. [Laughs]

Anyway, of course, like many things in those days, it kept being delayed. So we were on the diet, and the moment I went on the diet I began to lose weight. We were supposed to make up the differences with lemondrops and sugar, make up the caloric differences; the basic nutrients were supposed to be there. Anyway, I ate more sugar cookies and lemondrops, and I still can't face a lemondrop, which I used to love. The weight loss became obvious before we went in. Once we got inside the chamber, it continued, and this, believe you me, this caused a major bone of contention.

Other things that caused equal amounts of contention were—and I was the person that had—one person only had to use the fecal-urine collection system, and we were in this relatively

small chamber, now, locked up for—I think we ended up in there what, fifty-eight days Jen, something like that.

JENNIFER THORNTON: Fifty-six days.

THORNTON: Fifty-six days to simulate the second mission. The food came in through lockers, and the waste material went out through an airlock, but otherwise, we were there. I remember just before we went in, one of the French newsmen said, "What wine are you taking in?"

"We can't take any wine in. NASA's director is a Mormon, so we're not allowed to take wine in."

"Incredible," he said. He said, "Well, how often are you allowed conjugal visits?"

"We aren't allowed any."

He didn't believe it, and he looked back at me. "You're not allowed any?" And I can still see him. He slammed his fist on the table and he said, "But that's barbaric." [Laughs]

Barbaric or not, we were locked up in that thing for fifty-six days, and it was series of medical equipment catastrophes, particularly the urine collection. That thing had six major malfunctions. A bag of urine, which had not refrigerated, had been sitting there, burst into the chamber, which was fairly small. We didn't have a lot of cleanup material. We used our castoff underwear. There really wasn't anything to clean with, except a few small wipes. We cleaned that up, and I cut my hands and everything else trying to clean up that equipment and everything and start over again.

Well, it finally became obvious that the thing wasn't going to work on Skylab. Fortunately—and this shows what NASA can do with the right people—another astronaut was

given responsibility for ramrodding a new program through, and they totally redesigned that system in a matter of months, which worked.

Okay. Other problems that came up, there were multiple problems that I won't go through, in the equipment, except there was one that I attained notoriety, which I still hear about, and that was the sole exercise device that they had put aboard, was the bicycle. From my paperboy days I could ride a bicycle pretty well. They had rated it at a maximum of 300 watts, and when I went in there, yes, I could jump on it and hold 300 watts for forty-five minutes. So I did that, and the bicycle came to a screeching halt. It just wasn't designed, in spite of the specifications and all, the NASA specs and this and that and the other, it had been built by Marshall [Space Flight Center, Huntsville, Alabama]. So there went our exercise and so forth. They hauled it out, put it back in, refurbished it, but this time they put a thirty-minute restraint on it.

By this time, I'd gotten pretty weak because I was just constantly losing weight. So they put a thirty-minute restraint on it, being ridden at the maximum design. So I got on it, and I can still see Bob Crippen's face when it ground and screeched to a halt twenty-nine minutes and thirty seconds later. This may seem like a trivial thing, but if you're going to have equipment in space, the only item that you have, now, for a countermeasure, that's the sort of thing. Okay. That brought me a lot of notoriety.

We came out and, now—look, tell me how badly I've gotten off track. Let's call a hold at this point before we go on further.

JOHNSON: Do you want to take a break?

THORNTON: Yes

[pause]

JOHNSON: The design of the urine-collection device before SMEAT, and the input that you had on that before the program actually started.

THORNTON: Well, unfortunately, I wasn't allowed to make much input. To me, it was very obvious that it was clumsy, unworkable scheme that they had come up with. As a matter of fact, I went so far as to design a physical system that ultimately the principle was used, not my design, but a relatively simple centrifugal separation and measurement system. I designed and demonstrated such a thing.

You see, one of the disasters was that the manufacturers were allowed to use simulated urine. Urine's messy stuff. I'll be the first to admit it. But they were allowed to simulate the testing, and so actual urine wasn't used until I used it for the first time in SMEAT, and that's when things fell apart with the—they used a so-called hydrophilic-hydrophobic membrane to separate things, and I won't go into the technical details, but, to me, there were obvious reasons why it wouldn't work before. But it took the SMEAT test to demonstrate it and then go ahead and use a very, very simplified but very, very expensive means of making the collection, which, as I say, [Richard H.] Dick Truly was the office person that spearheaded that program and got it ready.

Okay. We are ready, I guess, then to proceed with the launch of Skylab I, and I still remember the day. Apparently nice launch. As soon as it was on its way, I ran back to the field

and grabbed a T-38. [Charles] Pete Conrad [Jr.] wanted something over on the west coast of Florida that he wanted to take with him. I ran over and picked it up in the 38 and came back, and as soon as I got out of the 38, why, it was obvious there were major problems. I'm sure you will have plenty of descriptions of how unexpected—air pressures hadn't been allowed for and it partially lifted off one of the wings, did major damage and tore off, such that they had a laboratory that was now much too hot to live in. Most of the major sources of power were down and such.

That was a demonstration of what the old guard—and I do say this deliberately—what the old guard NASA, the people that were used to responding, there was enough of engineering and such left there that they just pitched in, once they figured out what was wrong, made things on a last-minute schedule.

For example, I stood by literally at the end of the runway at Ellington [Field, Houston, Texas] the night before launch of the crew, when they finally put together the parasol, which was to be slipped out the airlock and would expand and cover, protect the Skylab where the insulation had been torn away, protect that from the sun's rays, keep the temperature down. Just like a big umbrella being shoved out through that. That took incredible engineering and such.

There was one last piece, and as soon as it came off and was checked, they ran it out to me, threw it in the T-38, and I streaked down to the Cape [Canaveral, Florida] with it, in the wee hours of the morning, and I can remember thinking, "Hey, my kid would enjoy this," because there were red lights and sirens rushing out to the launch pad and all of this. All I wanted was to go to bed, but anyway, I hand-carried the thing and turned it over, and they launched. And that crew did an incredible job, that first crew, of clearing away debris, going into that lab, getting it set up. I mean, they demonstrated the right part of "the right stuff."

So we finally then began to get back online. All the collections started, the daily mass measurements being made, and I will leave it to other people to talk about the fantastic values to science for Skylab. Skylab was a better space station than Russia had for many years. That's one of the sad things about it. That turned out to be, after the shakedowns, turned out to be an incredible vehicle. And the science that came back—and I will restrict myself to medical science, because I can speak with assurance and knowledge of the contributions that were made there. I was CapComing [Capsule Communicator] during the scientific portions and so forth.

Yes, there were still problems. For example, early on there were problems with the restraint system, which had been misdesigned, on Skylab to hold the subject to the bicycle. There were some transparent things that happened between CapCom and crew and so forth that we had anticipated and such as that, that I won't go into the details of here, but anyway, I can still hear Pete Conrad, who had been ordered not to ride the bicycle until they got fixes, he was determined to get on with the program. I can still hear him as we went LOS [loss of signal] and Pete was obviously on the bicycle and said, "We'll see ya," or something to that effect in his own way. Astronauts still walked tall in those days.

Okay. So we settled down into a routine there. Things worked. Huge, unprecedented amounts of data began to flow back. However, some things became obvious that all of the carefully planned objectives were going to leave a lot of stuff uncovered. Even the crew was talking about it. We had talked about "bird legs" in space for a long, long time, the early astronauts had. They talked about the full faces, the stuffy nose that comes from the fluid shift, when the fluid shifts from the lower to the upper body. So I talked Flight [Director] into letting us get a few unscheduled just full-face pictures, just taking pictures of their faces, semi-quantitative pictures. And we did that without running it through the system, and I can

remember being called up by one of the astronauts about four o'clock in the morning, the next one on the shift, "What are you doing this stuff for?" And if he could have, he would have chewed me out.

I tell this to show, up until this time, everything had been planned on the ground. It was executed. You were graded not on results obtained, but how well you kept to that schedule and not making any mistakes. The switches, that you threw the switch at the right time, etc., etc. Are you with me?

JOHNSON: Yes.

THORNTON: They were acting simply as robots, and as far as changing any of that sort of thing, that was unheard of.

Well, the crew landed, and it became pretty obvious to all and sundry that we needed to change some things if we were going to keep people up there. One of the big things was the inadequacy of the exercise. Very obvious. I had tried to get a more adequate exercise device that I had designed for the MOL Program on board, and I don't know whether Deke wouldn't let me or whether he couldn't swing it, but in any event, he said no, and we cut a deal—they weren't even going to measure strength change before and after. Oh, yes, they were going to do calcium scans, but the driver for the calcium changes they weren't even going to look at. We won't talk about this further, but, nevertheless, he allowed me, for the first time, to make measurements before and after the strength.

Well, you didn't really have to make strength measurements when you saw the crew come out to know something different had happened. They had lost roughly just under one

percent of peak strength in the lower legs and somewhat less in the upper body, when the crew came out. Their food, their weight, for the first time we could see what was going on and we saw two things—a big transient weight loss in the first five days of flight, but then we could see the same thing that had happened to me on SMEAT, and that was a constant loss of weight on the diet that began pre-flight and continued until they came off the diet. So there was a food question. Fortunately, there was excess food aboard, but there wasn't time to do anything about the exercise.

I was CapCom, and now I was free and I went into overdrive. Ran down to Sears & Roebuck's [Department Store] looking for anything off the shelf that might help. It was pretty obvious to me I wasn't going to be able to do anything about the legs. Nobody else could offer anything, and, as a matter of fact, there was considerable resistance because they had planned on using the bicycle and adding things might confuse the results, and this sort of nonsense.

We were interested in operations in how to keep people in adequate condition in space on long flights so that when they returned to Earth—there were no problems in space, but when you're space-adapted, adapted to weightlessness, if you're fully adapted, you're not going to walk around on Earth and so forth. And that was our goal. Our goal and the Astronaut Office was very different, from the medical scientists' goal. If they had carried them off in stretchers and required months of rehabilitation, hey, that's a doctor's dream. As one of the astronauts said, "No doctor ever made any money from a well patient," and that's the way it was. Whereas the astronauts didn't like that much, and we could still look out for ourselves.

So the first countermeasures, then, other than to the cardiorespiratory—the bicycle is fine for maintaining cardiorespiratory fitness. Doesn't do a thing in the world, to speak of, for the strength of bone and muscle, and it was obvious to me then what was happening, why we were

seeing these big transient shifts, because the moment they got into space, I saw on the mass-measurement studies, all of them, over the first four or five days of flight, had about a five percent loss of body weight, and obviously that was fluid. Then there was superimposed a long lower loss.

So I got some simple expanders from Sears & Roebuck and put fireproof handles on them. Also, Life Sciences had been playing with another sort of strength exercise device. I took that—it couldn't possibly have flown, the shape it was in. It was full of flammable materials, so we re-engineered that and got that aboard, and convinced the people they should feed the astronauts a bit better. So we launched off.

The real breakthrough came, as far as I was concerned, for medical investigations, which continue to this day, came with the next flight. I was still CapComing. The next flight, they managed to get ahead of things. They had a bit of time on their hands and they said, "What can we do?" Well, this was a dream come true for me. I started what became then the DTOs, the detailed test objectives. Oh, they had been present. This is something that does not take all of the approval, the chains and so forth. It deals with an immediate problem. So I immediately jumped in with a list of measurements. Nobody else, apparently, had much ideas of things they wanted to change over in Life Sciences, but goodness knows, I wanted to see what was going on.

We were getting hints that the body didn't like certain positions up there. For example, we got a lot of complaints about people that had to bend over, do any kind of bending task. They didn't like the chairs. They told us that they'd thrown the chairs away. Various and sundry purely operational things such as that. So I put a bunch of photographic, simple stuff; it had to be simple photography and things like this. But, listen, that flight just began to bring back—and don't misunderstand me. The studies that had been previously designed were flawlessly

executed. They gathered the calcium-balance studies, for example. They still set the new standards. But in addition, we were able to load real-time studies now to respond to what was coming back, rather than waiting for years before we had another opportunity.

Okay. Flight came back. They still had some problems with their lower bodies. It was obvious from the strength measurements. They still continued to lose lower-body strength at a tremendous rate. The simple upper-body countermeasures I had put aboard worked quite well. There was virtually no upper-body losses. They came back, complaints about inadequate food, etc. So that, once again, was ratcheted up.

Then, finally, the real payoff , as far as I was concerned in Life Sciences studies, came in the last one, because in the meantime, I had worked night and day to get some sort of lower-body exercise, locomotor exercise, which was the problem. Here on Earth, you exert tremendous forces. I mean, these are the biggest muscles in the body. Up there, you don't use them, so you're going to lose muscle. Consequently, with no force on the bones, I don't care what you do, you're going to lose calcium and bone strength, so, to me, that was a major one.

The other big one was fluid shift. So I took a modified standard method of measuring lower-leg volumes and upper-leg volumes, and it was a very tedious procedure in which you made repeated measurements at certain levels of the arms and legs. By this time, the DTO had become an accepted thing, so put on a whole bunch of anthropometric measurements, including height, stature, and put on what they came to call "Thornton's Revenge." It was a terrible, it was a terrible exercise device, but I only had three and a half pounds. They would give me three and a half pounds. They had bungees and the harness that hadn't worked for the bicycle, so I put on basically a sheet of Teflon with some modifications of the bungees so that it applied body weight. Actually, I cheated a little bit and loaded them a bit more heavily than their 1-G

[gravity] body weight. Then they would lead forward and their feet would slip on this—you see the same sort of Teflon exercise things, only people are slipping back and forth on it. Now, you sat there and it was like climbing a slippery hill. It was a terrible device, but, nevertheless, they used that and a lot of other stuff.

Now, I'm being very egocentric here. There were all kinds of results that came out of that crew. Oh, they did an outstanding job. There were some unfortunate startup transients on that, but I have nothing but accolades for that crew and what that crew did for space science. Not just life science, but for space science, because other people were beginning to send up, by this time, some additional real-time changes that were plugged in. So they brought a real, for me, treasure trove back, which, for the first time, enabled the unraveling of what went on as the human body adapted to weightlessness.

Two of the major areas we could see, for the first time, the mass, the urine collections, the ad hoc measuring of limb girth enabled me to calculate the limb volumes. And to my utter amazement, by the day of first measurement, for which I got roundly chewed out for, because it was a tedious measurement and screwed up their schedule. [Alan B.] Al Shepard [Jr.] met me at the door of mission control and began to chew me about putting that dumb thing on. Anyway, they persisted and got the data, and the data showed that they had lost literally—and these weren't big fellows—they had lost literally liters of fluid had shifted out of the lower body—that's where the bird legs of space came from—up to the upper body, and that's where the puffy face is. Are you with me?

Then over the next four or five days, the sensors in the upper body sensed the fluid overload and got rid of it, probably through lack of thirst. There was no brisk diuresis or

anything such as that, in spite of what some people say; that was not remarkable. So for the first time, we had a handle, much of it the data coming from the ad hoc studies.

Other studies, I can remember one amusing thing about the anthropometric studies that I did. We found big shifts there, for example, it was as if in weightlessness, the contents of the abdomen are not applying force to the stomach wall, so the stomach wall now acts like a girdle, and they lost up to four inches in girth, for example. Oh, yes, it was as if they wore a girdle up there.

And the one that everybody—as a matter of fact, ABC just recently—I cooperated with them on a little thing they did on height. Height keeps being rediscovered, the height increase. Hey, we go through this, the spinal column is literally spring-loaded and it's elastic and plastic, so it expands whenever you take the load off. You are a little taller in the morning than you were when you went to sleep at night. Also, if you lie down, you're a little taller than standing up. So, without going into details, such things as this. This is not just of curiosity. For example, when I called [Edward G.] Ed Gibson and said, "Hey, Ed, you know you're two inches taller now than you were when you left Earth."

And he said, "Great. I always wanted to be taller than my wife." But unfortunately, when he came back, the effect is immediately reversed, so he was immediately back where he followed. This is more than academic interest, because they had a terrible time. One flight on the Moon, they didn't think they were going to get one long, tall guy into the suit, because those suits don't give, and they were made to fit tightly. Well, now it's standard practice to typically allow at least an inch or maybe more for this expansion. Are you with me? We were learning to live in space for the first time.

Posture. For example, there is a single classic posture. Unlike a multiplicity of postures on Earth, which is slightly fetal-like, in space, if you now force the body, particularly if you force the body's muscles to put it into a posture that it doesn't like, as it were, this is uncomfortable and such. A chair such as we are sitting in is absolutely the wrong design. [Alan L.] Al Bean, for example, quickly discarded it, working, and all the others did too. It was easier for him to hold on with one hand and stand in this crouching posture for a task at the solar array panel than it was to try to be strapped into this chair. So that opened a whole new field.

Then Thornton's Revenge. This last crew was showing off, and I knew they were showing off. By golly, they would have been carried off if we had not modified what their exercise regimen was. But they came bouncing off. They would stand around, in contrast to the previous ones, even some of the more powerful, stronger members of the corps, even on the second flight, they'd walk into a room and the first thing they would do is look for a place to sit down, get the weight off and so forth. This last crew showed off. So they came back, frankly, in much better physical condition than the second crew.

Skylab, which I contend remains a monument and shows what can be done, what can be done, because it was a lashup. Remember, it was a lashup. For us, the great loss was that we didn't get to fly on it and we had, now, a long, long dry spell before Shuttle came into being.

I might add, by this time the lines were firmly drawn between Life Sciences and Bill Thornton. It's just simply an unfortunate fact of life.

So, two things I did. One, I began the design of a treadmill, because a treadmill was the obvious answer. Didn't have much money or anything else, but I began that. Also, although I had never done a lot of clinical medicine, I had been totally away from it for ten years, and I didn't want to wear the M.D. [Doctor of Medicine] and not be able to take care of patients. So

the best clinician I have ever known, Bill Dyess [phonetic], down at University of Texas Medical Branch [UTMB] in Galveston, took a chance and let me walk the floors again as an intern for a year there. Went down and became familiar with UTMB, had a fairly successful year down there and elected not to go on.

Now, most of my colleagues had some sort of sideline effort. This was approved by NASA. I was never that smart. My heart and soul was in that. So they got either advanced degrees or connections with university appointments, some of which paid fairly well and this sort of thing, which was entirely reasonable. But I wasn't that smart. So I went down there and elected not to stay on as a resident, which I considered—I'm proudest of being offered a residency by that particular physician; it's one of the things I'm proudest of after that year.

So I came back to NASA after that, and there had been very large changes, management changes. Deke had been maneuvered out. He was given a flight and then maneuvered out. Al was no longer there. The Astronaut Office went down. Traditional management, conventional management, driven by one individual, which I will not even comment on, but which undoubtedly people will comment on, went on. He made his own highly personalized selection of the [19]'78 crew.

In the meantime, I did such thing as worked with Space Science. Then I went into simulations. I did one highly realistic simulation of what subsequently happened when they first flew animals, and that was a life sciences simulation, and I've suppressed the name of the thing, but it was a simulated flight in which animals were the major concern. It was so obvious that the stuff just wasn't ready to go. They were unrealistic, the studies. I did help sort out some of the studies, some of the human studies and so forth. I won't go into any further detail on that simulation, but that was the beginning of [STS] 51-B.

Okay. Finally, the thing that kept me around was two things. The gymnasium. If it hadn't been for that gymnasium, if it hadn't been for the incredible support of Jennifer and the family, and also the T-38, I would have done the reasonable thing and bailed out at that time, but I hung on then, waiting for Shuttle.

Somewhere along the way, the strong personality that dominated much of JSC from then until his recent retirement, arbitrarily pulled—well, yes, there was another very nasty little thing with—he tried to get rid of older astronauts, based on they had to have degradation of hearing, vision, and so forth. That's a chapter that I'm going to leave closed for the time being. Let's just say it was another fight, and he sent some Life Sciences boys to do a man's job, and Joe Kerwin and I fought that off. But after all those years, they were going to throw us out because we couldn't see. The truth of the matter was, with corrected vision, I had—still have—the highest visual acuity that has been recorded by the acknowledged world expert on it. I went to the world's expert and got him on my side.

Okay. Shuttle. Finally launched. Most of us were pushed back in line by this time. Some of the very best astronauts to come by were the MOL astronauts that had come aboard. They met after a short time there. They met exactly the same welcome. Deke, in his inimitable fashion, called us all in, and this time it was both the scientists and the MOL astronauts, and announced that we were going to be fired. You have to admire the people like Truly. I can still see Truly raised his hand and said, "Hey, can we have the T-38 to go to Los Angeles one more time before we leave?" [Laughs] That was done in the spirit of "the right stuff."

Well, Deke was overruled, and they went on to demonstrate the real "right stuff" also. That was a great bunch of guys that came aboard. I won't take one thing away from the older astronauts, but there was a whole new selection. They were no longer called scientist astronauts.

We were now all called mission specialists. Believe you me, the requirements for the mission specialists were nothing at all. Like they could get in, and some did get in, with just B.S.'s [Bachelor of Science degree] and so forth. I will not make further comment. The pilot selectees had their usual abilities. Some of the mission specialists—some of the mission specialists—carried on the same tradition of the—well, yes, I will name one name. [Norman E.] Norm Thagard comes to mind. Superb pilot, superb physician as well, for example. That's just one of several.

Shuttle began to fly. There was some disturbing things, even on the flight. One of the world's great pilots got into physiological problems on return. I don't know how widely this is known, but there were some real significant problems, and as it began to fly, there were some other little things that indicated that, hey, going up and flying back a high-performance vehicle just might bring in a body—it doesn't take a month for a body to change in space; it can change in a week. The news media began to weigh in on it and so forth.

In the meantime, frankly, I'd begun to do some bootleg studies. The office was still a close-knit office and I had enough respect in the office that I got a few little simple studies done that way.

Then, finally, the real breakthrough. The news media were making quite a hullabaloo about space motion sickness and how it might cause the pilots to crash and burn, flying the Shuttle back. It was a total unknown that experts in the field, who were scheduled to fly a mission something like eighteen months down the road, oh, they were happy to beat the drums, "Yeah, yeah, this is real dangerous stuff. You see how important this is," and so forth. However, it was still going to be eighteen months before they looked at the problem, and it just wasn't acceptable.

So with various pressures and such, I talked the commander—and, yes, I am going to use names, because [Thomas K.] Ken Mattingly [II] is one of the incredible people. Incredible pilot. He could have been a doctor. He could have been any kind of a scientist that he wanted to. He was one of the class that dedicated his life and his brilliance, and he was brilliant. Hard driver. I won't go further than that, but hard driver, but brilliant individual. I talked him into demonstrating that we didn't need to wait eighteen months to make some of the key measurements, eye motion being one of the key measurements that was need for what was happening in space motion sickness.

I did this because they had some excellent amplifiers. Everybody was looking at the heart, what happens to the heart when you launch. So they launched with an EKG for the life scientist, the person in mission control, to sit and stare at this one piece of data that he had during the launch sequence, which was an EKG. Everybody knew that heart rate went up and the commander's especially, on launch and this and that and the other and so forth. But they had a superbly designed amplifier that was overdesigned, and that amplifier was normally used to record the EKG during launch. That amplifier was normally just thrown in the trash and recovered after the flight; it wasn't used again.

So I showed Ken how to use his thumbnail—there was a little set screw that he could use his little fingernail as a screwdriver, increase the gain on this amplifier such that we could record motion of the eyes, using exactly the same electrodes. There were plenty of spare electrodes on board, using the same channel, because there was plenty of bandwidth on the EKG channel for the eyes. Nobody would dare do such a thing now, but there was still autonomy in the Astronaut Office, if you didn't do something dumb, such as signing off mementos in flight and selling them afterward and that sort of stuff. But if it were honestly done, you could get away with things.

So Ken, for the first time, started shipping me back this data that nobody knew what it was, but it was all sent to me. And I was able, after his flight, to say, "Look, you don't have to wait a year and a half."

So there was enough pressure that they began to let me do another series of DTOs. Now, there was no space for it. I had to come up with the under-seat bags. The only place to put stuff was under the seats. I put together a little laboratory, with the support of the Shuttle Program Director in Washington, an Air Force person that went on to head the Star Wars Program [Strategic Defense Initiative], and with his aid and so forth, put together the first of a series of increasing studies that looked at not only eye motion and other things that went on in flight, but also I slipped in, since there was no assurance that this fluid shift—some people thought that, hey, you may be getting cerebral edema, so we needed other studies. So I then began to put on a much simpler way of measuring that. I managed to get the treadmill on board early on.

So I began to get a series of studies back and finally they became large enough that Thagard, to his disgust, was detailed—Thagard really wanted to do greater things, and I can understand that. But in spite of his disgust at being detailed to do those studies, he was detailed to the seventh flight, flight seven, and did an absolutely superb job, came back with—and he made other observations. He listened for the first time and we began to get hints of why there was vomiting. The space motion sickness simply shuts the upper GI [gastrointestinal] system down, stops all motility and such. That's normal. When that happens, contents build up. When it reaches a certain point, it triggers a mechanism and you vomit. You get this typical vomiting, and lots of other stuff.

So I was detailed then, on the basis of these studies, I was detailed—and probably the first person and, I'm sure, will be the last person to ever write his own—primarily now, I had a

lot of other duties. I did other duties as well, primarily just TV shots and various and sundry things, but my primary mission, which I wrote the time lines and such for, but also left myself targets of opportunity, was to go up and do a medical investigation using my own lab equipment. I had put together a crew that designed basic little laboratory. I was flown for the first time on eight [STS-8].

Let's call a halt here for a moment. We're running long on this now.

JOHNSON: Do you want to pause for a moment?

[pause]

THORNTON: I was put on kind of at the last minute and, as one of the crewmembers observed, "Well, there goes our change of underwear." [Laughs] But, listen. That crew, oh, I could not speak more highly of Dale [A.] Gardner, especially Dick Truly, and so forth, the things that they tolerated from me.

So, one stormy night. You wouldn't think of launching the way we launched there. I mean, that was a real line of Florida storms that came through that night on our scheduled launch, and, unfortunately, southern people seemed to have a large contingency of friends and such that show up for such thing. About half of my little town had showed up. So we were waked up, and I was wearing all kinds of instrumentation and stuff. So we go out to the pad and it was still lightning in the distance. It had struck—a couple of nice pictures of lightening strike at the tower a couple of hours earlier.

But Dick had a good buddy. Crippen was the weather pilot that night and they were great buddies, and some way, Crippen managed to find a ceiling of 20,000 feet, which was the limit. He went up in a T-38 and found a ceiling that was just marginal, but, nevertheless, there was a lot of "Should we launch or not?"

So we go out there and I can still remember standing around at the base of the elevator tower, up to the bird. They told us not to go up. There was water dripping off the tower and we're trying to keep ourselves dry. Dick got a call from Mission Control. He got a funny look on his face and said, "Okay." He put the phone on his chest and he says, "They say we can go if we want to." [Laughs]

We looked at one another and said, "Well, okay."

Dick calls back and says, "Okay, we'll go." And we punched the elevator button and we went up and went through the usual strapping-in, and I was busily putting electrodes on. I was in the mid-deck alone. I put my own little array of lights and this and that and the other things that I was doing, and I was measuring blood pressure and so forth.

One interesting things is when I finally got strapped in and ready to go, as you normally expect rise in heart rate and blood pressure before launch, but when we got a go, mine fell, and I know why it fell. All I could think of, lying there, is, "All of those gol-darned people are going to have to go home without seeing anything," and I was so relieved, literally. I've got the records. It's in the books. You can go look at it.

So, launched then, and I got the first-hand experience that I'd been waiting for. It's too late to change your mind at that time. Hey, you know, you've already dealt with all the things that can happen and made your decision. So you go with it regardless, and you don't waste time thinking about that, but you can feel the motors swivel and the countdown. Then, yes, you can

feel the twang on the towers, it's loaded up from the several million pounds of thrust there. Then the solids kick in and things roughen up, and the ride up—we were on one of the smaller underground lines in London [England] and the tracks were a little rough and it was bucketing around, and, as I said to Jennifer, "That feels just about what the launch felt like." It rattled around a little bit. It was severe enough that you'd have trouble really seeing plainly. Nevertheless, we lit the sky up there. It didn't take long before we were gone into the clouds.

(A), that was the first night launch of Shuttle. (B), no one had ever launched into clouds, and we got all kinds of reflections. About this time I began to hear all this—now, remember, these are cool, "right-stuff" guys, and this was over the intercom; it wasn't getting back to Earth. I was hearing, "Hey, check your fuel pressure! Check you're fuel pressure! Look at those engines vary." And what they were seeing was the varied reflection lights that they'd never seen. And all of this went on for a minute or two in the cloud.

Finally, I said, "Hey, what's going on up there? If you guys don't tell me, I'm going to unstrap and come up there and see." So I'd done a few things, and I guess they thought I might actually try to do it, because after that, before anybody got excited, they'd call down and tell me what was going on.

Okay. The launch, after two minutes, we were off the solids, it gets as smooth as glass, like riding an electric motor. You get a little bit of G-loading. If anybody that's flown high-performance airplanes or compared to the G-loading that the earlier crews took, it was trivial. You get about 3.5 Gs, eyeballs in. Then suddenly you're floating, only unlike the zero-G aircraft, this doesn't go away.

Gardner and I, thank goodness we had rehearsed all of the moves that we had to make, because I had a lot of extra gear and stuff that had to be stowed and other stuff that had to be

unstowed. We very quickly and efficiently got through that, with busily setting up some of the early studies for me. Dale says, "Did you see that?" He had had a big burp. I didn't pay much attention to it, and before long—now, remember, I was up there to study space motion sickness—before long, he had his first big bout of emesis. It's just one what we call in medicine clinically it's called projectile vomiting, which is a good description. Everything comes up in one big fell swoop. So there it was. The first.

So at this time I grabbed him and began to do some conventional 1-G studies that you can't do in 1-G, and I began to turn him and tilt him, and when I tilted him into the sagittal plane, when I began to tilt him there, he came up fighting. He said, "Don't do that," because certain motions give you a terrible sensation. I learned more in that first hour about space motion sickness, I suspect, than a lot of experts still know, just simple hands-on examination and such.

Anyway, for me, it then—and, yes, I was well prepared. I had a couple of towels and this and that and the other, because I, too, expected—I wasn't particularly susceptible to motion sickness on Earth, but sure enough, when it came up with me, I wasn't fast enough to catch it all, and that's a disaster, because vomitus floating around in space is a mess.

Anyway, we got things under control. Then you began to feel bad; malaise, sleepy, loss of drive. All you want to do is just go get in a corner. Nevertheless, I had a job to do and I had waited seventeen years to do that job, so we got on with it. We strung the wire, we did all the other things. We did what was programmed. I didn't take on anything. This lasted for thirty-six hours.

Next day, Dale and I were still affected. You didn't eat anything. If you did, it came back up. Vomiting wasn't the thing; in spite of conventional wisdom, nausea, unlike sea sickness on Earth, as [Joseph P.] Joe Allen had said, he said, "I don't know what space motion

sickness is, but it ain't sea sickness," and he's right, because you don't have the sort of acute nausea. And there were various and sundry other differences, but all of this was exactly what I was there to study. The other three members of the crew, they weren't affected at all.

So anyway, they all participated in the studies that I came up with. I didn't get any sleep the first night. I wedged myself in between two spacesuits and tried to sleep. So the second night, though, I woke up and suddenly realized, "Hey, it's all over," and all I could think about was all the opportunities that I had missed and the things that I had to do, so I got on with it and the crew got on with it. I spent most of my time on the mid-deck, drawing everything from—drawing my own blood.

All the crew participated in other things. In those days, you didn't think of asking for blood from the crew. You certainly didn't think of asking them to put down a nasogastric tube, which, frankly, I'd intended to do. We needed to know pressures and motility. We needed to confirm what was going on in the stomach, but I just couldn't make myself do it when I should have.

But sometime near the end of the flight, when all the rest of the crew was gone—it wasn't a big thing on Earth to slip this tube through your nose, down your throat, into your stomach. But that was the one time the crew almost rebelled, because I was hacking and coughing and carrying on, and finally, Dale stuck his head over the edge from the flight deck and looked down and said, "Thornton's finally lost it. Don't go down to the mid-deck." There I was with a tube hanging out my nose, making the measurement I needed. [Laughs]

But anyway, it was great. I didn't take much time to look out the windows, but the sights that you see, the sunrises, the sunsets are unlike anything you will see elsewhere. The stars

aren't all that different, but you know you're seeing them in a new way, and you look down on Earth and, yes, it brings a lot of things home to you.

So we came back in, and I was busily making measurements. It breezed along and I didn't even realize that we were on the ground. But then I fully began to realize just how significant the changes were. As a matter of fact, short guys like Ken Mattingly had deduced that, hey, something's happening to the muscles, leg muscles particularly. They had been practicing, trying to regain strength on the way down, because the Shuttle brakes are tough. It takes a lot of pressure to stop those things, and it was all they could do. So they had been practicing previously on the way down, but I was still unprepared. He told me to look out for this, but I was unprepared for when I unstrapped, attempted to stand up. Might as well have left the straps on, because I felt as if I were pulling 3-Gs. You struggle up and you stagger around for a minute or two and you sit back down. It was as if you were pulling about 2.5-Gs. But you do this two or three times, and you literally get stronger by the minute. Otherwise, you'd have never walked off that thing. This was a phenomenon that has still not been given any attention. I don't know why. Nevertheless, I verified that.

Came back. Ton of data to get through, which I didn't handle—well, frankly, I wasn't given the support to handle it very well. But the big thing was that space motion sickness was no longer the great bugaboo. You could work through it.

But the additional data that I brought back from the leg studies and that Thagard and others had gotten from the others, we began to understand this fluid shift, and it is fast. It happens in minutes. Also, we began to understand that you had better replace that fluid if you expect to pull Gs, even with a G suit, when you come back, and that, yes, this was known and

they had put in some minimal amounts of fluid. But even though I rehydrated myself very well for the first time, I couldn't complete a stand test about an hour after the flight.

Okay. Opened up a whole new vista, as it were. Let's fast-forward. That was a dream flight for me. High point. Has to be probably the high point of professional career. Fast-forward to an assignment, unexpected assignment, again, because I had dealt with the animals, and that was 51-B. I used that same lab for the Senator's flight. He brought back some good data. Unfortunately, he was so sick, he missed a lot of the crucial data, but, nevertheless, he brought back some good data.

Let's go on then from what, for me, was a dream flight, to what, quite frankly, became a nightmare, and that was the first large animal flight. There must have been some way to have gotten more cooperation, and this wasn't Bill Thornton, but the commander and some of the other members of that second flight that I made. It became so obvious that those cages were not ready to be flown, that some of the other more onerous experiments were not ready to be flown, life sciences, but nobody was listening.

So anyway, Thagard and I were together on that flight, and all of this was other people's—and I had the primary assignment for care of animals. There was a huge furor just before flight. It wasn't enough that we were being—yes, it was a nothing, but we were literally receiving life threats from the antivivisectionist group and this and that and the other. So this was a touchy, touchy thing all the way around. But internally it was even worse, because they were going to fly four monkeys, a dozen rats, a bunch of mice—no, I take that back. No mice on that flight. We had had mice on the other one. And I was determined to get those animals back alive, in spite of the inadequate cages. I was able to get some work-around measures in case the cages failed and such.

But then just before time, at the last minute, we were forced to make some studies and found a virus, Monkey B Virus, and all the animals that they had planned to fly—now, Monkey B Virus doesn't bother the monkey. However, from time to time, it is transferred to humans, and when it is, it makes rabies look like a desirable death, because it is a slow version of dying through progressive destruction of the nervous system. Needless to say, this caused a furor. The animal experts, "Well, we work around them all the time. All it takes is a little bit of care." Well, NASA was not about, in a closed atmosphere, was not about to launch such a thing. So they had to find substitutes, and they could only find two substitutes for monkeys. One of those was a pet monkey. You never use pets for experimental purposes. Nevertheless, they "trained" these two animals, and I get up there and I wore the very elaborate suit, two of us wore the things, and they were miserable and so forth, and various and sundry things.

The flight was not a good flight. Shoot, some of the mission specialists were vomiting even before they unstrapped, and there were troubles in the other experiments. That was the longest day of my life. Things had been added at the last minute, some last-minute stuff, both inadequately stowed—I spent an hour and a half going through all the trash bags and so forth, trying to find a lost set of instruments. Finally, they figured out where it was stowed. I got the thing out and—yes, I had space motion sickness again. Not as bad, but I had it by that time. I open the flap and about forty big, fragile, glass sample tubes took off in all directions. Finally got those things collected, made the samples.

Somebody, unfortunately, called me and said, "We had trouble reading your writing that day." It was a mistake—this was after we got back to the ground—to mention that to me, because I was trembling, for several reasons. I'll admit I wasn't writing very well, but I was trembling.

Okay. We blundered our way through that. Next day, one monkey was fine. The rats seemed to be okay. We monitored as well as we could. One monkey was just huddled into the fetal position, basic withdrawal position, and the people on the ground were ecstatic. "He's got space motion sickness. He's got space motion sickness." Pet monkey. No, he didn't have space motion sickness. I was very familiar with the psychology and the physiology of what happens to animals that are in a totally different environment.

Anyway, this went on for the next day, and then came the time that we had to open the—there was an outer door that we opened—we had to do things to the cages and so forth, and that's when the real trouble began. The air was supposed to have been sucked into the cages, negative pressure, such that air always flowed into the cages. We knew very well that the cages were under positive pressure. I opened that door and there was literally like a shotgun blast of feces, detritus, and everything else came flowing out. Missions could not succeed without duct tape—D-U-C-T—duct tape, because I launched with a bunch of it in my pocket and two rolls beside me. So I began then to seal all the stuff there. Same thing on the rat cages. Okay. I sealed it up, shut the doors.

But then we had a crisis on our hands, because we had a monkey that was—monkeys aren't that big. They don't last long without food and water, and I was not going to bring a dead monkey back without a fight, even if it meant fighting the crew. But fortunately, the commander was with me. The ground wisdom was, "He's got space motion sickness. He'll get over it." They had to initiate the drinking and so forth. No way. So the third day, I opened the cage—it was protected by mesh—and I began to play with him. I coaxed him out of that, began to play with his food, got him to eating and drinking and such. Hey, he wanted a friend. It was that simple. Okay. They insisted that I shut him up and I had to go through overnight and let him

take care of himself, so I had to go through the same thing the next day, but anyway, brought him around.

There were multiple failures in those cages. Kept them going. There was one unfortunate thing that may have cost the commander—I don't know how much it cost him, because he didn't know that he was on the ground loop, and he made some pithy remarks about finding monkey feces in his commander's seat, and had no doubt that what it was. This, unfortunately, was heard by media.

What's the name of the guy Zimmer?

JOHNSON: Marvin Zindler [consumer investigator for ABC, Houston affiliate].

THORNTON: Marvin Zindler publicly, as a result of that, presented our mission with unsafe for human consumption. [Laughs] So they made us troubleshoot. They stopped everything and made us troubleshoot the ground loop so that couldn't get by.

We get back down. I'm not going to dwell on this mission anymore, but that really sealed it, that mission sealed it. The messengers often get killed, and that sealed it for any further flights for me, in retrospect, in spite of what they were telling me and all of the rest.

I hung around. I don't know why I hung around, but I did. I tried to document all the stuff that I had done. I was very quickly pushed aside. Life Sciences became a major player. The Astronaut Office had people in it that did what they were told. The autonomy was totally gone.

I kept hoping that I might fly again. I tried to publish stuff. Ran into problems with that. With UTMB, I began the first large-scale study of ambulatory blood pressure, the taking of heart

rates and such as that with some devices that I had driven the development of there. I began to move toward that. I tried, but finally turned up with a couple of severe spinal stenoses. This is what happens when the disks have had a lot of abuse. In my case, they had had a lot of abuse, so they bulge into the canal and begin to impinge, and that was disqualifying. I was talked into having a neck procedure in which some of the neural arches of the spine are removed to be sure that the cord is not compressed and such as that. Whether it was the right thing, I don't know, but anyway, I did it, and that put the nail into it.

I could have stayed on in NASA, but the only way I would stay in NASA was in the Astronaut Office, so I medically retired in spite of what the Director, with whom there had been considerable differences in Life Sciences previously, in spite of what the then Director said, that I voluntarily retired. No, I would never have voluntarily retired, in spite of their pressures.

So I then, after a brief period, went to UTMB. The Department of Cardiology asked me to come down and help them with setting up an improved program for teaching physical diagnosis. You see, there has been a reversal in medical practice from the times that I entered medicine, when it was all hands-on, with relatively little, to now it is all machine analysis, if you will, machine and administrative. And, frankly, physical diagnosis capacity was suffering. This is recognized in medicine by many of the wiser physicians, and there was a good physician there heading Cardiology.

So I went down and helped them put together and then took over a teaching program in which students are taught hands-on medicine, to do physical diagnosis. And, as usual, there were problems. The big problem is that there's nobody to teach it. Hey, medicine has become so expensive, you can't detail physicians, and my course has expanded such that I had, I think

there were eight professors helping me, seven or eight, and you just can't sustain the cost of that sort of thing.

I had been developing medical adjuncts to improve the teaching of that, so I went on and put together a system that would replace the physician, i.e., the didactics of it. It was an interactive program that the students could interact with, but in addition, by means of some simple hardware, we would call it subsystem training, by means of some hardware and some unique modifications to the program, they could listen with their stethoscopes, hear what you are going to hear on patients, a device allowed them to feel the pulses that they would feel. In other words, it was a highly accurate simulation, and then they could interact.

I did some other devices that also allowed small-scale simulation, and, unfortunately, one of the classes, for whatever reasons, I suspect maybe a little bit of rebellion—normally, the senior graduating class turns any money that it's accumulated, they'll buy a picture or an expensive series of books, or something like this and put in the library. This bunch, to my total amazement, donated the money to me and my efforts, and I'd been doing it on a small scale. Well, what can you do under those circumstances? And then this attracted other money. That money was almost trivial, but that attracted a large amount of money.

So I then hung on. I couldn't keep up the teaching load that I was carrying, so I then agreed to develop this program, this so-called self-teaching system, which is now in place. There's some twenty-five units. It doesn't cost a whole lot, but it turned into a very successful teaching program. The students actually prefer the automated teaching to the gold standard of teaching, which is you can only have a small group when you teach this sort of stuff.

So that is that, and the last thing, my last hurrah, is we are dealing with a literal pandemic caused, once again, by a combination of government and successful technology, and that is the

excess of cheap food, which has been very successfully advertised, and that, with the lifestyle changes in America, has produced a literal pandemic of a very serious problem, and that is the gross obesity which is growing by leaps and bounds. Medicine, if it didn't have enough load already to carry, now it is having to carry the additional load of diabetes beginning in children, going on up through. This is a problem, going right back to my big fights over diet, my development of mass-measuring devices, my utilization of all of that, it comes to a head.

So I am currently working on a professional—it will be a doctor-administered program, which has a piece of smart hardware that the patient takes home with them. They simply have to get up every morning, measure under the proper conditions, take a weight, and then because of other stored data and other things that I won't go into, the monitor then, which is called CalBal [phonetic], then Cal, instead of HAL [Heuristically-programmed Algorithmic Computer; computer in *2001: A Space Odyssey*] will come up and suggest to the individual that's trying to control their weight what they should leave off during the day. No big changes, no new diets, no strange drugs; just modifications, small modifications over a long period of time. That is what I'm in the process of doing, as well as trying to get some of the things that I learned into some more formal format.

This has been a terribly egomaniacal harangue. First of all, I have left out so much of what I was privileged to work with. The dedicated people, dedicated to a goal that is worth it, because whether you like it or not, sooner or later, not until things are done better than they are today, NASA couldn't think of mounting a program with its present configuration, the country can't afford it, but sooner or later, if we don't annihilate ourselves, men and women will continue to explore, just as they explored the Earth, they are going to continue to explore and, yes, what our President proposed is a nice, logical program, isn't likely to happen, because other

Presidents have proposed equally logical things, but I can assure you, Presidents notwithstanding, politicians notwithstanding, Administrators of NASA notwithstanding, the people, somebody, are going to explore, going to populate space. How far beyond, I have no idea, but I do know that I was very, very privileged to be allowed to associate with other people that shared that goal, the engineers, the administrators, particularly, of course, the astronauts. So it was a very privileged time, and I can't begin to tell the other side of the story of the wonders that I saw and such as that. I have concentrated on my own particular interests.

Finally, there is no way that I could express the appreciation for the support that I had, the family support that I had during that time, the families and all of the other infrastructure that supports all the other astronauts, all of the other people that worked incredible schedules, were never there when they should have been. Listen, I'm sure that you are getting some of the histories of those people, because they're the ones that made it possible.

Okay. I will finally shut up, and if there's anything else that you want to hear, I can't imagine it, but I'll be happy to try to answer.

JOHNSON: I think we're going to change the tape real quick.

[tape change]

JOHNSON: I just had a question about your studies with the space sickness studies. You mentioned that on your first flight you got sick, but you said there were two or three of them that didn't get sick. What was the main difference or did you, through your studies, find out what the difference was?

THORNTON: No, no. That is still the question that no one knows why certain individuals—and frequently these individuals may be affected by ordinary motion sickness on Earth, where some of the most resistant people, people you can't make sick on Earth with conventional means, are most affected. We do not know.

If I have to make a guess, it is—and by the way, I would say, about 40 percent are moderately to severely affected by space motion sickness, and probably about 60. Not as many as the conventional wisdom says get sick. If I had to make a guess, it has something to do with the wiring of the way the signals are interpreted. Either that or particular sensitivities. Some people may have, just as I have, basic visual acuity twice that of the ordinary person. I also had, once upon a time, much keener than usual hearing, once upon a time. It may be that such individuals may produce more sensory feedback to the processing, the central processing may be tuned to deal with that, whereas the individual more likely to survive can ignore, they are not as upset. They're basically tougher individuals, if you will, that can do things in this particular environment. However, that still doesn't explain totally why the difference, why the people that are resistant on Earth may be susceptible there. It may be that there are slightly different pathways and signals in weightlessness which they are not used to suppressing.

Listen, don't think for one second that we did anything but scratch the surface on what we discovered. We built some foundations, but in many ways the surface hasn't been scratched, particularly in the neurological system.

JOHNSON: Were there any medications that would help with space sickness?

THORNTON: One of the old traditional ones that was done by one of the outstanding flight surgeons—who I will use his name, [Dr. Charles K.] Chuck La Pinta, who deserves credit—had discovered that it was effective by intramuscular injection. It appears to be moderately effective. The drugs that were so touted and that the astronauts were forced to take, it turns out, simply delays the onset. Once they come off the drug, they were then susceptible. I saw that happen on my second flight.

Other questions.

JOHNSON: I was just wondering, looking back over your career, what do you think was the most challenging part of your career with NASA?

THORNTON: You're raising issues I'd rather not, but you asked. The biggest challenge I had was to keep from being thrown out of flight school. That was the biggest challenge. That was really nasty, and I don't want to talk about that anymore.

Obviously, the challenge of being selected is a major challenge, because, make no doubt, I very cold-bloodedly pursued that for several years, doing what I thought was needed most. Now, as it turned out, I was lucky; happened to choose the things that were badly needed. That was a lot of luck involved in that, but, yes, that was the second most challenging thing.

Then, of course, there were the challenges that I was aware that I was stealing time, taking time that, with my skills, could have been used outside. But the one that probably hurt the most, I knew that I was stealing time from family. Fortunately, Jennifer took the slack up with the children. They didn't seem to suffer unduly, like some of the children in the program did,

didn't seem to suffer unduly from the odd life that I was forced to lead and things like that. That was also a part.

Other question.

JOHNSON: What do you feel would be your single most significant accomplishment, if you had to just name one, as far as NASA's concerned?

THORNTON: I don't like to talk about it, but the single accomplishment was persisting until I was allowed to participate in the things that I was skilled to do. Being thick-headed, if you will. [Laughs]

JOHNSON: That's a talent.

If you don't mind, I'm going to see if Rebecca and Jennifer have anything they want to ask you.

THORNTON: Yes, and I'd like for my Jennifer to have her opportunity.

JOHNSON: Okay. That's perfectly fine.

JENNIFER THORNTON I wasn't prepared for that, so your comments were appreciated, so let's just leave it at that.

THORNTON: Well, they're not really adequate. Jennifer?

ROSS-NAZZAL: I had several questions for you that I thought of. One of the things you talked about was, when you first came to the program, that the scientist astronauts weren't necessarily welcomed, but that you had parties at your houses.

THORNTON: Oh, well, now, this was our own parties. This was our own parties. Look, we were allowed to participate. For example, there were some unheard of goodies, such as we were offered—and only one other member of the corps turned it down, and I turned it down, I thought for well and good reasons. It wasn't smart. But we were offered brand-new cars to drive each year, with our own little sticker on it, we could park anyplace where we wanted to, without being ticketed, on the lot. Later on, we could get two cars from two manufacturers per year. And for a guy that was driving the vehicles that I drove, that was no small thing. As I say, I wasn't smart enough to take advantage of it. I had feelings about it and so forth.

But there were all kinds of good deals. I mean, oh, my gosh, the astronauts were wined and dined, and we were immediately—some of the luster had fallen off, now. We were not greeted the way that a "real" astronaut was, but, nevertheless, we got treated fairly well when we were in the barrel. You've, I'm sure, heard of being in the barrel. So that week that we were in the barrel, we were generally out on speaking tours and so forth, prepared or not. We were treated well and such as that.

However, believe you me, there was a strict—and I think I'm correct in saying this—there was a very strict pecking order, both in the Astronaut Office and, to a lesser extent, in the families. So the scientist astronauts initially hung together fairly well, if for nothing else, common misery.

But, no, no, we had, at our little place in Friendswood [Texas], we had a couple of good parties at the beginning, and the stresses took their toll, though. Was I there for that last party? Yes, I was. When we had the last such party of the group, stresses had manifested themselves in the family, various and sundry things. It wasn't a happy party, was it?

JENNIFER THORNTON: Which one was this?

THORNTON: This was the one that you were out walking some of the ladies, some of the wives. Let's not get into this. Let's not get into this. But I remember that very well, because I was having to make peace and one thing and another.

ROSS-NAZZAL: Was there any sort of camaraderie between the scientist astronauts and the MOL astronauts, given the fact that you were both about to be fired and that you weren't necessarily welcome?

THORNTON: Yes, we were sort of thrown together into the second tier, before the '78 class was selected. We were thrown together and, yes, there was some slight feeling of that. However, don't think for a second there isn't always going to be a difference between the guys that have demonstrated they've got "the right stuff," the guys that can fly the fastest, highest, best, drink the most—I won't go into the details.

Listen, [Tom] Wolfe, in his own way, was a kind of a genius with that book that he wrote [*The Right Stuff*], because he captured, oh, in grossly exaggerated terms, but he still captured the

essence of the guys that fly these things, the commanders and so forth. And let's face it, they do have a particular responsibility. I won't go any further than that.

ROSS-NAZZAL: What did the scientist astronauts think when there finally was a geologist selected for the last flight of Apollo?

THORNTON: Oh, by that time, we were probably so benumbed that we didn't think a whole lot about it. The physical scientists, I'm sure, would have felt much more strongly. They applauded it. But remember something; there wasn't a huge shift—and by the way, there have been some recent excellent books out. Read [Eugene A.] Cernan's book. It's got some good stuff in there about that selection. I'd recommend that.

From a scientific standpoint, you have to argue that it was correct. However, don't forget that there were two guys with "the right stuff" flown on all the Skylab missions and only one scientist astronaut. Don't forget that. Now, this is a mission that went on and on. And, yes, the current missions you do certainly need someone with flying abilities, but I can say this, that there are members of the astronaut—well, let's don't get back into the Apollo capsule days. But you can find members in the mission specialists that also have the right stuff. That was what was so galling to Norm Thagard, is that Norm had flown with the best of them. [Manley Lanier] Sonny Carter [Jr.] had been through TOPGUN School [U.S. Navy Fighter Weapons School] and all of that sort of thing. So there is a mix of that.

ROSS-NAZZAL: I just had one more question for you.

THORNTON: Please.

ROSS-NAZZAL: You've given us a good history of the Astronaut Office, and I'm wondering if you could explain how the '78 class changed the office. You brought in minorities and women, for instance. How did that change the office?

THORNTON: You really want an honest answer to that?

ROSS-NAZZAL: I would love an honest answer to that.

THORNTON: There'll be a lot of revisionist history. That '78 class recommended the culmination of a long power struggle at the highest levels. Not the highest levels, not Washington [D.C.], but at JSC. Let's face it. That Astronaut Office is what makes the difference in manned space flight. You can say what you want to. You go try putting monkeys up there, you go put robots up there, as great as robots are, it is that Astronaut Office and control of that Astronaut Office that is the single biggest driver in the space program. Because the space program is driven not by scientists, not by logic; it is driven by the same emotional response in ordinary people and the people that pay the prices for this, that drive them to do things, to explore things and so forth. It is just human nature. Am I making any sense to you? Okay. That's the basis of it.

So the battle is really the battle for the Astronaut Office. The times that I talked about, it was a kind of a stroke of genius of putting Deke Slayton in, because Deke was tough as nails. I have talked about that. He was tough. Now, the office itself, when Al Shepard was there, by golly, nobody, nobody got to that office unless he was probably at least at the highest levels of

NASA, and sometimes they didn't even get to that office even at the highest levels of administration. Are you with me? It was a power—hey, it wasn't a self-sufficient power. They had to get permission to do this and that, but don't think for a minute that that wasn't a power, that Astronaut Office.

So what happened? I'm not going into how Deke got euchered out. Deke was slipped out and such as that. And a person that, for better or worse—and I'll leave history to deal with that; we all have our opinions—for better or worse, became the power in manned space flight, then he basically took Deke's job. He, for whatever reasons, ran it very much the way he felt it should be ran. Superb politician, had incredible personal powers and such as that, but, nevertheless, it was ran as a dictatorship.

Now, dictators can't get everything they want and so forth, so he had to have the aid and support of many people and, ironically, one of his strongest supports came from the Life Sciences group, because this myth, this self-serving myth that the human body is not going to survive a trip to Mars and return until we have spent years and years studying it with, quote—"good science," unquote—has just taken over and is dominating, has become a dominate feature of much of the space program.

Now, people that receive billions of dollars for this, that can support the institutions, can support their own little pet projects, can support an army of graduate students and such as that, they're not going to fight with this. The various other institutions are not going to fight with this. It's a very conventional, but, sadly, untrue story. I'm not going to take it further than this to point out why this particular individual aligned himself so strongly with Life Sciences, but this has occurred throughout.

His personal selections, the individuals, whereas Deke undoubtedly had considerable influence, and whereas Deke before, if a person made it in, he was going to fly, unless he did something pretty awful. He might go to the end of the line, but if Deke was there, you were going to fly and you were going to be treated as an astronaut while you were there. You were not on probation or anything else. No. It's totally changed now, and during this person's tenure, it was in his hands, who got the assignments. I have no doubt, I was totally amazed when I got that second assignment, and I think I have some insights into how it came about. But if you were in his favor, if you were one of the imperial guard—and astronauts were used like that—if you were one of the imperial guard, you could virtually do no wrong and you could be assured of flying, even though there may have been—no, I'm not going off any further. I've said enough.

WRIGHT: I just had one question for you. [Charles F.] Charlie Bolden [Jr.] talked to us a little while back, and he cites that you and Joe Allen were very much responsible for him making the transition from the military point of life into a more civilian point of life, because he feels very fortunate that he was put in the office with you and Dr. Allen when he arrived. Can you give us your insights on meeting Charlie Bolden?

THORNTON: Yes. Let me say that I have never seen a finer human being than Charlie Bolden. It wasn't a one-way affair. Unfortunately, if Charlie got anything from us, I'm amazed. Conversely, if I could have just picked up a tiny fraction of what Charlie Bolden's personality and such was, I would have come out much better. I am amazed at that, because—now, Joe, unlike me, Joe's smart. Joe was superb. He is small in size, but he's an absolute giant in the

way that he knows how to deal with people. One of the most attractive people, particularly with Bonnie [Allen], the combination and such.

Joe was a good scientist, did the work, all of the work and so forth, and has carved out an outstanding career subsequently. And, yes, Joe Allen was an excellent mentor. I'm amazed that he would include me in that, because Charlie saw a guy with the wrong stuff. I mean, as far as that sort of thing could go, yes, the only thing that I can think of that nobody, nobody gets through the astronaut life without running into hard spots, and it may well have been—the only thing that I can think of, I might have given Charlie some insights into the reality of the program, which is quite different from the military. Charlie and I both came through the military, he much more so than I did. But that's the only thing that I can think of.

And, yes, occasionally Charlie had his vehicle, his beaten-up—as my early vehicles were, and they weren't given new vehicles when Charlie came aboard. Other than showing him how to fix that vehicle or occasionally going out and getting it started for him, I can't really think of anything that I did for Charlie. [Laughs]

JENNIFER THORNTON: Well, I'd like to add that I'm very sorry that we didn't see more of Charlie and Jackie [Bolden], because—I don't know where the time went then. We weren't having people to the house, and I'd love to have had Charlie and Jackie and other people, too, but it was just a bad time professionally for Bill, trying to keep ahead of the game, that we didn't do more things like that.

THORNTON: Yes, I was a loner. And, in addition to the usual loads that Jennifer carried, that was an added load that she had to put up with.

JENNIFER THORNTON: We had other loads as well at the time.

THORNTON: Let's not leave on a sad note. Hey, it was an unparalleled opportunity to do the sort of things that I had dreamed of doing, that I had been, as it turned out, uniquely trained to do, whether it was learning as a child in the barnyard, or whether it was learning as a high school individual teaching myself electronics, or going through medical school, all of it came together possibly in a way—it did come together in a unique way, and I was so privileged and, unfortunately, not able to pull my feet out of some of the ordinary mire, I was so privileged to have been part of such a program that I contend will go on as long as human beings continue to look up to the sky.

JOHNSON: We appreciate you taking the time today.

[End of interview]