# NASA Johnson Space Center Oral History Project
# Oral History 2 Transcript

Paul A. Lachance
Interviewed by Jennifer Ross-Nazzal
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ROSS-NAZZAL: Today is July 18, 2007. This telephone oral history with Dr. Paul Lachance is being conducted for the Johnson Space Center Oral History Project in Houston, Texas, and in New Brunswick, New Jersey. Jennifer Ross-Nazzal is the interviewer, and she is assisted by Rebecca Wright.

Thanks again for taking time to meet with us today. I'd like to begin by talking about your work on the Gemini experiments that you touched on in our last interview last year.

LACHANCE: In Project Mercury the issues were very simple questions. They were questions like how does swallowing work; does what goes in one end come out the other end? And there was debate amongst the Flight Surgeon Corps. Some said it will be a problem, because it might be weightless in the esophagus or whatever, and might have blockage or aspiration, which was the big issue, that they might, even though we had all the positive data from the Russians, who had done it before we did, but even before that with the chimpanzees. They had no problem, but they were eating one pellet at a time. It was not a diverse food system of any type.

So one of the things that was done on Mercury was to test various kinds of foods. The flights were so short that that was not even an issue in the early flights. The longest flights were around thirty-four, thirty-five hours. That needed little sustenance. So various little bite-sized foods were made up. One of them that comes to mind is malted milk tablets, which were, you know, across-the-counter kind of thing, and then tube food of various types.

We had developed the tube food for the use with the U-2, which I helped to evaluate—the U-2 pilots, the spy plane, because they stayed in their space suits at very high altitudes, as you may remember or know. So we just simply adapted that so that it could be consumed through the faceplate through a special—that was done for the U-2s. It had to be modified for Gemini and Apollo, and in fact, one of my major undertakings is that suit.

Aerospace suits were different. The Gemini Office had its own paraphernalia and plans and systems operations, and Apollo was separate from that, different contractors. One of the things I ran into right away was that there was a difference in the size of those ports in the faceplates for drinking water, if you were stuck living in the suit itself, not being able to take the helmet off or something like that. We also wanted to measure water intake.

So it took me about six months to get the two flight suit companies to agree on a common number size port; I can't remember what it is, but there's a drawing to that effect. Then we adapted the gun, which was a gun, basically it looked like a gun, water gun, with a meter so that you could measure how much, how many ounces were being consumed, and it could be recorded manually by the astronaut. So that was that scenario.

So along comes Gemini, which had the definite mandate of fourteen days to simulate what it would take to go to the Moon and back again. So that feeding system was fairly elaborate. It had a four-day, five-day cycle. In other words, you didn't repeat the food items in the meals till the fourth or fifth day. Actually, in Skylab and in the other subsequent flights you find an extension of that, because more food becomes available. We worked with about forty-seven to fifty foods. They worked with seventy to seventy-five foods, or at least we offered that in the model that we started making, planning ahead for Skylab.

That has expanded, and nowadays the Russians supply half the food, and the Americans supply the other half, and they share a number of things. The Russians always had a simpler system of food choices. They even included alcohol, which we didn't permit. But time goes on, and one learns from the other that it's not a bad idea to have a little snort once in a while.

ROSS-NAZZAL: Why was that decision made, Paul? That was one of the questions that I wanted to ask you. And who made that decision not to include alcohol on board?

LACHANCE: Well, the Chief Flight Surgeon did that, Chuck [Charles A.] Berry. He was head of Medical Operations, and the whole shooting match, including Crew Systems. They decided without even asking that they wanted no coffee—no stimulants. So that's why we came down to one liquid beverage.

The initial beverage, which is a story in itself, we didn't fly Tang® right off the bat. On Gemini III we flew juice crystals, apple juice crystals, grapefruit juice crystals, which are made by processing, you know, into a powder, a puree of the material. But, as we were afraid might happen, is that the temperature that these storage containers for food were in the back wall, and they're exposed to some of the heat of the liftoff.

That was enough to crystallize the juices, so that what you did is you made a hard candy as a result of that. So you could put water in and shake it and shake it forever—well, not forever, but, you know, for hours on end, and not get much of a drink out of it. Not flavorful, anyway; you could get the water part, but you wouldn't get—but we already knew that General Foods was making a product called Tang®.

We modified it by adding calcium to it and a few other little things. We made some flavor combinations that were not sold commercially. But at any rate, that melts around 280, 300 degrees Fahrenheit, and so we never had the problem again of crystallization of juices, of beverages. And that was the sole beverage. They were allowed a choice of beverages, whether it was orange or orange-pineapple or whatever flavor. There was quite a few of them available, and they could tell us which ones they liked.

We had them taste every food, and there were some foods that were not consumed by certain astronauts. For example—I won't name names—they would not eat any seafood, and we had a very nice shrimp, small bitty shrimp dish, dehydrated, that was liked by the astronauts except those who would not eat fish. So I'd go back to them, to that individual, and say, "Well, you have your choice. Do you want turkey instead, or do you want beef, another beef, or chicken, or whatever?" So there were alternates available, in that sense. So that was that.

But at any rate, to answer your question, initially the front office, the chief had a lot to say about that, and the astronauts were big coffee drinkers. It was a disappointment to them, and it did become allowed in the later Apollo flights, and then subsequently after that it was a routine drink. But for whatever reason, they felt it might affect them.

One reason I can think of, from a medical-experiment point of view, is that of the eight or so medical experiments that were conducted once or twice or several times during the Gemini mission, one of them was on sleep. There was only one flight that had that; it was Gemini VII, and they had electrodes, EEG [Electroencephalogram] electrodes, put on their scalp, and then this helmet had to be adapted to fit on top of that. Obviously, if you were running an experiment using stimulants or something that might affect the sleep time, that would be a no-no.

But the rule actually was put out before that, just in general. I'm just saying there is one experiment that did justify it, for lack of a better way of saying. The experiment didn't last too long. It didn't go the whole length of the mission, because hair would regrow underneath the electrodes and pop them off, and the astronauts weren't anxious to have them on their heads, anyway. Just a nuisance for them.

ROSS-NAZZAL: I can imagine.

LACHANCE: Once you're up there, you're in charge. You can change things if you want to. They traded food, for example. I knew that would happen, and I said to them, "Just log it, and then we'll know how to count it. We'll just multiply it out a little differently, turkey versus shrimp, or whatever." But the logs were so-so. I mean, they tried very hard; wonderful crew, Gemini VII. Well, they were all wonderful crews, what I mean by that, that was not the tedious one.

That was also a flight in which they slept more, because they just were flying fourteen days, and they were able to do only so many experiments and do only so much limited exercise that they were capable of doing. There was no movement from the seat. You're just strapped into—or you can float a little bit, but there's no—if you look at the spacecraft; I don't know if you've ever crawled into one, but you ought to try it, if they'll let you. There's not much space, especially with a suit on.

Then on top of that you have to be able to unzip the suit to go to the bathroom, so it's a little bit of an undertaking to do even things like that. As far as other conditions, bowel movements, you had to be a good friend to your buddy, put up with odors and things like that, although they were fairly decent.

The menus were low residue, preflight; in other words, up to four days they had very little foods—in other words, you wouldn't have a lot of grains. You wouldn't have a lot of vegetables. We didn't have that many vegetables to begin with, but the point was that they didn't want to have to go to the bathroom. It was such a tedious and difficult undertaking.

So they had to make a—I lost my train of thought.

ROSS-NAZZAL: You were talking about the astronauts going to the bathroom in space and low-residue diets.

LACHANCE: Yes, right. Oh, the residue diets. So that had an effect. In other words, what happened is they would not have to defecate for about three to four days. They'd do it on purpose to not have to go because of the difficulty of the undertaking.

Then, of course, there were two parts to that. Of course, the urinary path, that was a tube. The first flight, Gemini III, the amount of urine was actually put in a tank, and it was stored on board. They didn't want to have any penetration to the spacecraft that might leak, but there was a limit. You couldn't continue to do that. You were the storing the water that was storing the urine, and we were interested in the samples of urine from Gemini VII, of course. We wanted to be able to measure calcium balance and other tests of urine, so we had to find a way to take samples.

So anyway, to go back to the initial thing, first in the earlier Gemini, I can't remember whether it was IV or V; well, actually, it was on IV and on V. They actually made a penetration spacecraft where you could open a valve, and the urine could flow out right into the—well, there's no atmosphere, but call it atmosphere for lack of a better term. [Laughter]

It was [Walter M.] Schirra on V[I] who came to the press conference and just kind of made a comment that if there was a beautiful picture he'd taken through the window of these objects of different colors beaming off the Sun, showing up. He said, "And this is Constellation Urion," and he needn't say anymore. The press didn't pick up right away that that was really freeze-dried urine going by the spacecraft window, and that we actually leave a few things behind up there.

But for Gemini VII we needed fourteen days of storage. We would never have found space to do that, and store the water, too, because every pound of weight of any type, people and equipment, takes a thousand pounds of thrust to put into orbit. So you weigh everything, even including the contents of their pockets. That's how close the measurements are taken for liftoff, or were at that time.

So there's a tube then that runs, if you can visualize that, a metal-sheathed tube. It's a heavy-duty tube that goes in connection to the spacecraft for dumping, and they had to have a heater. They had to build a heater on the dumping valve, because it would freeze. It's very cold, and it would freeze if you didn't have a—you could keep it liquid so that it wouldn't crystallize, as we mentioned before.

That went up to—expanded to the point of the—with not too much freedom to spare, to the opening in a suit, where you could insert the penis and urinate. That took a number of tests, which I was involved with, also, and the design of a suitable thing that would not leak. When you had the vacuum on it, that was one big question, is would you get sucked down the tube. Of course, that did not happen. We tested it ourselves by perforating little holes around the edges, so that there would be air coming in as well as the urine, and that you would not trap the organ in a spot where it would cause a lot of damage.

At first I had a Crew Systems guy, [William J.] Huffstetler. Bill Huffstetler and I worked out and tried to make it—we used a condom, different condoms, and we had it so that you could roll the condom back over the organ, over the penis, and you had to cut off one end. So I called them "Catholic condoms." But we found that in running the experiment that didn't work very well, because everybody's a different size, and I had just ordered one size. [Laughter]

ROSS-NAZZAL: Were you testing these in the pressure chambers or the KC-135 or just on the ground?

LACHANCE: Just on the ground. We could run these other tests if we needed to. We just needed to run them on the ground, I mean, right there in the little mini-labs that we had available to us. We had machinery that we had another gentleman whose name I don't remember at all. He was a pretty good engineer who designed it; you know, brought in a pump and measured the amount. Put enough vacuum on the pump and this kind of standard equipment, just to simulate, if you will, what would happen. Then the three or four of us that were involved—well, there were probably five of us altogether—would each take our turn testing the equipment to see that it worked and did not jeopardize anybody.

So we ended up with a hard tube with holes in it, a little bit, at one end, and then the other end—and it was lined with a rubber dam that could be compressed, if you will, around the penis, and then you would not back-leak. You had to be careful, because if you got leakage, then you had a mess on your hands, and you didn't want that. On top of that, with Gemini VII we didn't want to lose a drop, because we had to take and make aliquots.

So the tube, the micturition tube, was altered at the top with a device where we added—we had a contractor devise it for us, make it up. You had to go; you went all the way, as much as—you know, your bladder empty. It went into a bag, and the bag, you would turn a detent at the top that actually put in a small amount of tritium, which is an isotope. The isotope, you would mix it in.

You just shake your bag so that the isotope was distributed, and you would move the detent one more time, and you would take a small—if I remember right, they were 75 or 60 to 75 ml [milliliters] little containers that could be hitched on so that you could take a sample of the urine from that particular micturition or that particular hour, and store it where the empty food containers were being stored for return, with all the dates on it, the hour, and all this stuff. Then the rest was just put out, just dumped into space, the remaining urine.

The bulk of the urine, in fact, when you think about it, because we were taking very small quantities, but we were dependent on the dilution of the tritium to tell us what the volume was. In other words, we had a sample of urine that we could do analysis on, but we had to know how much urine there was. Was it 500 ml? Was it 1,000? You know, this kind of thing; the dilution factor from the tritium is the way we measured that.

ROSS-NAZZAL: The calcium and nitrogen balance experiment, what was the purpose behind that?

LACHANCE: This is an interesting story. It goes back before space program. Whedon and [Ephraim] Shorr—[G.] Donald Whedon was the head of one of the NIH [National Institutes of Health] laboratories—institutes—and had published in his earlier day after World War II, "The Effect of a Half-Body Cast on Bone Loss." So he had taken an interest, and he and Larry [Lawrence F.] Dietlein [Chief, Biomedical Research Branch] and other people got interested in that, the fact that in weightlessness, microgravity, you would also have a similar thing where you have no way to put—you know, you have no foot—you have no bearing, you know; you have no weight on—you're in a cast.

They got quite a lot of loss of calcium, of bone, even though you're repairing a bone, supposedly. You put them in a cast to repair the bone, and that does take place, and yet on the other hand, you're thinning the bone because you're losing calcium because of disuse. But not only calcium but other components of calcium, but calcium hydroxyapatite being the main mineral that you want where, well, 95 percent of their calcium in their body is sitting in bone, anyway.

So we wanted to see if we would get bone loss and what would happen over time. Even today between the Russians and the United States with the length of the missions we've had and the Russians longer than we have, there is loss of bone in astronauts, and the recovery. There is a period of recovery after, sometimes not perfectly true, not perfectly back to their preflight value. So that theoretically if the same astronaut were to fly again two or three times, they might be at greater risk of getting bone loss, which is small at first.

The bone loss, there were two different studies of bone loss. One was an X-ray densitometry of the os calcis, which is the bone at your heel; your heel bone, I guess, would be the best way of describing the os calcis. That was done by taking standardized X-rays against a aluminum wedge, which was used as an equivalency for bone density. That was developed and worked on by Pauline Berry Mack, who had devised this technology for measuring bone mass differences at Penn [Pennsylvania] State [University Park, Pennsylvania], where she was a professor in the late thirties or early forties.

So she was along in age when we were doing this in the sixties, but someone had discovered her technique and adopted it and had decided on using it. Larry Dietlein probably made that decision, because I inherited the experiment from him, and got to know her very well. She was a wonderful lady and had a number of students working on different aspects of this problem by doing bed rest studies, with no casts or anything.

So I had started a bed rest study in the Air Force. It made sense to me that if a person was incapacitated in bed for a period of time, they would get decompensated by one type or another. We were both concerned about the heart and the circulatory system and also the bone mass.

So we let a contract out to a research group in Philadelphia [Pennsylvania] at the Lankenau Hospital, in which the main investigator was Kaare Rodahl, who came from Norway and had become very famous for his discovery of vitamin A toxicity in Eskimos in Greenland. The two are not connected in terms of rationale, but he was well known and had become Director of Research here.

He won the contract. He won the contract, and we had volunteer students, Mennonites—of course, the Amish area and Mennonite area of Pennsylvania is quite substantial. They wanted to help their country without having to go to war, and this was a way to do that, or be 4-F or whatever.

So four subjects were put to complete bed rest for six weeks, and their bone density measured before and during and after, but mostly before and after, because it was hard to do during. You had to take them out of bed to do that, and that wouldn't work.

They did tilt tests on them. I don't know if you're familiar with the cardiovascular tilt test, but if you have a decompensated person whose heart is not functioning well and you put them onto a tilt table and they've been resting horizontally all this time, and you tilt them, feet down or head down, either way, both ways, you put a tremendous strain—with the feet down, of course, you would because the blood goes into the limbs.

We almost lost one of the subjects. His heart stopped and had to be revived, and so we decided that never again would we need six weeks to show that we can decompensate the heart. Subsequent experiments were three weeks.

The bone also changed. The bone of the os calcis was not a big number, just small numbers, 2 and 3 percent, bone mass differences, but that was enough to encourage us, and she had seen that in bed rest studies.

Pauline Berry Mack had done bed rest studies also for calcium metabolism purposes. So she was funded by NASA to do both the bed rest studies at different levels of calcium intake and different durations of bed rest, and was using students at Texas Woman's [University, Denton, Texas]—well, they were not from Texas Woman's, but the technicians were Texas Woman's individuals. The subjects were from the other colleges in town, [University of] North Texas [Denton, Texas], and volunteer and be paid a small token to do this. We actually published a paper in the *American Journal of Clinical Nutrition* on the effects of recumbency in spaceflight on bone density, and that was in the *American Journal of Clinical Nutrition* in 1967, where we showed some of these changes that took place.

Of course, the whole drive here is to see what's going to happen with fourteen days of weightlessness. The experiment was done three times on Gemini IV for four days, on Gemini V for almost eight days, and then on Gemini [VII] for fourteen days. Interestingly enough, the amount of bone loss was less in fourteen days than it was in four days or eight days, eight days being much more than four days. …

And that was compared to what would happen if you compared them against the diet. Of course, we only had two subjects. You have the command pilot and the pilot, and then you have whatever data that you have from bed rest studies. The changes in density were considerably more than you've got in that amount of time in a bed rest study, which was a very small amount, but definitely negative. So the losses were about, if you took an average of those three things, about 12 percent density change—decrease—in taking an average of four, five, and seven, and that's preflight, postflight.

One of the things I found very interesting in doing these bed rest studies and looking at what happened to astronauts is that we also measured the density of the little finger, phalanx five, and nothing ever happened on the ground. Where the os calcis would shift and show a change, the finger would not. But in weightlessness, in microgravity, the finger does show a change, and that's probably due to the fact that you use your hand for so many different things that you got enough exercise on the ground, but you could compromise it with zero gravity a little bit more, enough to be able to at least show a change; not dramatic, but the fact that it would shift to the negative was fascinating.

Of course, the whole area is fascinating, because as we continued every—in Apollo there were only four medical kind of flights, and that was 14, 15, 16, and I think 17; I'm not sure, but I have that. I actually published that myself.

ROSS-NAZZAL: Did you start giving the crews calcium after Gemini IV? Did you start increasing the calcium that the crews would consume?

LACHANCE: We tried. We had no numbers to work with. There was a National Academy meeting of the Space Science Board, where that was discussed; that was earlier in the program, about the time we were doing our thing. They felt that the recommended dietary allowance of 800 milligrams a day would be a good target. Today NASA believes the number should be higher, and the number actually in some of the bed rest studies were higher, went up to 1,200, to see if you could slow the process. But, in fact, it still is there. It's present.

So in the latter flights, not Skylab, but in NASA's Space Station, some of the astronauts are taking vitamin D, which doesn't seem to make a difference, which is rather interesting. Interestingly enough, I tried to find the actual dosage, and I think it's an RDA [Recommended Dietary Allowance] dose which is very small. Maybe they didn't give enough. And of course, there are other parameters, calcium metabolism, their hormonal and others that one can measure.

One of the things that fascinates me about that area is that in the longest trials, in the studies that have been done in the long-term Space Station kinds of things, is that there are changes in the blood chemistry in terms of hematocrits—not so much hematocrits, but more sophisticated chemistry than that. But the synthesis of red blood cells, the factors involved in it, ferritin saturation, transferrin, are decreased. Of course, most of those red blood cells are made in the bone marrow. So when you start thinking of the bone marrow and the weightlessness on the bone marrow, it's being affected. So the bone is changing; the bone marrow is changing. Which one is affecting which is hard to say. Nobody knows.

But it is an interesting and important question as far as going to Mars is concerned. The Russians think they can go to Mars and come back without a problem. The Americans don't say anything, because actually it slows, the process slows. It's still there, but you could go quite a ways before you destroy your bones completely. They've been landing their cosmonauts on ground. It's a heavier strain, and I don't know of any broken arms or legs, so even with their long-term missions. But that would be one of the things that would happen if you were there too long and your bones become that brittle

So that should answer your question about why bone metabolism and why calcium metabolism, because you want to know what's going on here. Is [bone] not being made? Is the synthesis stopped? Is the breakdown gone up? We're not exactly sure even now which of these factors is taking place greater than another, because in the rat, when [one exposes the rat to microgravity for days], bone formation stops, and so it's hard to say. Our chemistries have not shown that to be the only thing going on, at least to date.

ROSS-NAZZAL: Earlier you had mentioned that the astronauts did a little exercise. Were you having them do exercise as part of those experiments or those two experiments?

LACHANCE: Very good question. One of the medical experiments by itself was an in-flight exerciser. It was flown on three missions: IV, V, and VII. What it was was a bungee cord. I think it was a strap at one end and a handle at the other. Remember, you're sitting in a very tight spacecraft. You have no way to go song and dance. All you can do is put your foot into the strap and do so many pull-ups with the handle on one leg and then the other leg for so many times a day, so many times at a time.

For some reason or other, the frequency—I'd have to find the experiment, because I wasn't in charge of that; Larry Dietlein was. I have not seen the data about how often they did it, but it was a fairly rigorous routine for them. They were all athletically oriented. They were tip-top shape, so I would guess they probably did it for thirty minutes four or five times a day.

Now, if you think about that, you've got a strap at the bottom of the foot, and so the data on the os calcis being lower in the fourteen-day could very well have been done to the exerciser, and yet the exerciser was used in all three flights. So is there a point at which it works—you know, begins, like for example, the bone loss was greater and the bone density was worse in V than it was in VII, but maybe they were exercising in all three.

Again, the question of exercise. Today we have more exercise going on. The Russians have been big pushers of exercise compared to us, although we now do it faithfully, they tell me, and there's even some arrangements there one way or another. Some do it more than others, I guess, for lack of a better way of putting it, because if they're trained, and they have more sophisticated equipment.

So that was an example where one experiment might affect another. There was also on Gemini VII a phonocardiogram trying to listen to the heart. Because what happens with the blood pressure cuff is that it's hard to instrument it to figure out how to send that information back, whereas a cardiogram, a wave signal is easier to handle. At least it was with the technology that we had and how compact things were to begin with.

So that's a possibility. That's an answer to your question; I hope I answered it.

ROSS-NAZZAL: Oh yes. One of the questions I had for you, too; you had mentioned in our last interview that you had gone out to one of the ships and were taking perspiration off of Frank Borman.

LACHANCE: Oh, both astronauts. That was the Gemini VII, and that was part of the calcium balance study. In other words, we did bone density—when they got on board, they had a whole protocol of medical staff who would do different things and things they were interested in. There was a procedure at which the bone densities would be done. Obviously, the suit had to come off, and they were anxious for that to happen. They had lived in it for fourteen days except for unzipping it to go to the bathroom or to urinate or whatever; the helmet, and then the suit itself.

Then I was there with a plastic basin that had been prewashed sixteen times with distilled water and whatever, and had them stand in it. When he got down to his what I'll call a union suit, which I guess is the old expression for a long lengthy garment, that was taken off and allowed to—the perspiration and everything, everything we could think of. Then we poured measured amounts of water through the hair and the face and the body itself.

So [both men are] standing naked with medical staff all over the place. Everybody's taking their piece but me. I was just trying to get as much sweat off his skin as I could with a facecloth and without disturbing other things, and using just the amount of [distilled] water I had allocated to do this. And, of course, freezing a complete sample for both astronauts so that we could measure how much calcium balance [changed], which involves not only urine and feces, which are the biggies, the urine being the biggest indicator; but fecal material, it carries calcium, depending on the absorption that took place and the type of diet and a few other things; and then sweat.

We'd already had prior studies, or concomitant studies were being done by Doris [H.] Calloway at the University of California, Berkeley [California], with bed rest students. She was measuring—well, she wasn't doing as much bed rest as she was trying to measure how much change there is, how much calcium is excreted by the body. She even had—well, I don't know; maybe I shouldn't mention that. But I will. They even were allowed to ejaculate, the subjects were, once a week or whatever it was they were running these studies.

They would then try to simulate as much as possible the nitrogen losses that were occurring through the skin, through the urine, through the feces, and monitoring with blood and analysis, and even—they sat them in a tub, and in the old-fashioned tub you get a ring around the tub, which is a deposit of skin. All of that was collected. It's the most sophisticated study of nitrogen balance techniques that I know of that ever has been done and ever will be done. She is deceased now but that is published information in terms of the basic baseline information on human nitrogen and balance on Earth, at 1-G.

So we were doing everything possible from that point of view from these different samples. I had them frozen, and all of my urine samples had to be taken off and frozen, also. I used liquid nitrogen, and so they were well frozen. They weren't going anywhere. I had a corpsman come up to me; I was on his flight deck, the one below where they keep the helicopters, and I had my Dewar flask loaded, a very sizeable one, huge, to put all my samples in. He wanted to know what I was doing, and I said, "Oh, I'm a spacecraft plumber." I couldn't think of anything else to describe what I was doing. [Laughter]

ROSS-NAZZAL: How long were you on those ships? Were you there before the flights took off, or were you at KSC [Kennedy Space Center, Florida] before the astronauts flew and then you got on board the ships after that?

LACHANCE: No, we actually did the studies preflight, actually a couple of days preflight, at the Kennedy, as far as the preflight was concerned with the astronauts. We had standardized the preflight diet, so the diet on the ground—one was fresh foods and one thing and another, but we calculated and had an analysis done of the diet that they were consuming to make sure what we were feeding preflight. Then of course they had the in-flight food system for fourteen days. Then they had postflight, certain foods for a few days; we had them follow through that way.

I left KSC [by air to the carrier] with Dr. Vose, George [P.] Vose, who was from [a Texas Woman's] University Lab. … He knew how to calibrate an X-ray [machine]. So the two of us were the team on the carrier, so that after the splashdown we each had our roles. He had to recalibrate the X-rays so that when the time—you know, when they were doing all these measurements postflight, we would take our pictures of the os calcis and of the hand.

I would do the collection of all the urine samples and the fecal samples, which could wait, actually. But the sweat, which took a little bit of doing, because after fourteen days in the same union suit—"long johns" is the right word, I guess; but a French Canadian expression, "union suit," I think. But anyway, that was all part of the postflight collection, and [also] the blood tests were taken. [All analyses were done at Cornell University in Ithaca, New York, by Dr. Leo Lutwak.]

So then we steamed from the pickup site to Cape Canaveral [Florida], where they use today for cruise ships, to unload, and different people went in different directions. You know, most of it went back to Houston. Does that answer that question?

ROSS-NAZZAL: Yes. I have some different questions for you, not related to the experiments, unless there's anything else that you wanted to say about these couple of experiments that we haven't touched on.

LACHANCE: Well, I think it might be interesting, or not interesting, but valid, to point out that as the Skylab missions got longer, there were greater losses of calcium. We didn't have a density machine at the time, but the percent change in the bone mineral between each flight duration was negative, more negative as you stayed there longer.

So we've mentioned it already; it's a real bone, density of bone, mass is a definite issue. You could build up mass, I suppose, and do that. The recovery is—the balance comes out fairly decently, there's losses. You don't recover right away. It takes a day or two for that to come back, and the bone mass had not come back after forty-five days. Now, I have not seen newer data done by the same technique.

One of the things that emerged from this whole bone density studies, bone mass studies, is a portable piece of equipment that's now used by some physicians for measuring bone density in people. So I think it's a contribution of NASA that these bone density devices, which are used—we use the radioisotope source as the source of energy to do that in flight. You could measure mass during a flight, not of VII but of a Skylab or a long mission, you could do that.

But the whole idea of doing something like that has spun off commercially, and I don't think many people know where it came from.

ROSS-NAZZAL: I had not heard that before. I did have one quick question for you about the experiments that I had thought of. … How did the astronauts feel about participating in, say, the metabolic study, where urine had to be gathered, the fecal matter, and then the gathering of the sweat and perspiration?

LACHANCE: Well, they both looked at it as a part—well, the backup crew, too, [Michael] Collins and [Edward H.] White were backup. They went through part of it; that's in Gemini, anyway. My best judge is from them, because I worked the hardest with them. There were other studies done, but not till Skylab, which I was not a party to, in terms of the experiments.

They took it very seriously. I was always impressed that they followed through as closely as they understood the instructions. They didn't want to mess us up.

The thing they worried about the most is that somebody would discover something about them that would keep them from flying. I'm one of the guys who took and convinced on one experiment—which will remain nameless, because that way I won't be divulging who was involved—that they might discover some impediment or some thing that would keep them from being the senior pilot or the command pilot or whatever, being able to do the mission. You know, with all the sophisticated equipment we had, they wondered whether we would find something that would hold them back.

But I convinced them with one experiment that that would not be the case, and they shouldn't worry about it, and they trusted me. I guess, because of other things I was doing with them, they trusted me. [Laughs] I don't know.

ROSS-NAZZAL: Oh, sure. Well, that is important. We've definitely heard that from other folks. One of the things that you mentioned today is astronauts and food choices. Did you do any sort of sensory testing with the astronauts to determine preferences preflight?

LACHANCE: I mentioned that earlier in our conversation, but of the forty-nine or forty-seven or fifty foods that we had, I urged them all to eat each one and tell us which ones they preferred. If they had problems with them, we could modify them. We were able to modify the menu within, as I explained, with using chicken—chicken, beef, or shrimp—as equivalents, basically, dietetic equivalents, in terms of composition and whatever.

So they were given an opportunity to do that, and many of the trials that were done, the short-duration experiments that were done for the crew. I don't know. I can't think of one exactly, but let's say egressing of something or trying to get out of something, we would sometimes give them samples of food to just give them the idea of what it would be like while they were waiting or whatever. We had one astronaut who took a very big interest in it, so that was important to [Russell L.] Schweickart. He kind of was interested in all this.

It didn't change any of the formulations. The juice crystals got changed to an imitation drink, which we fortified with calcium. That's how we standardized our calcium, incidentally. We put it in the Tang®, because they always emptied the container, because they had nothing else to drink, anyway, other than pure water. So that was one way to get it in. But if I had anything that had empty containers, it was the drink containers.

So the food containers couldn't be emptied completely, and sometimes they just would tire of it and throw it out—or not throw it out, but throw it in the bin. I put Velcro tags on each [meal] packet so that they could paste it to the wall or hang onto it or whatever, but also they were different colors. So we went black and white for Gemini, two-man, and went red, white, and blue for Apollo. So that was their meal chosen by them, so that if there were differences between preferences, they would have to eat the right meal. But they traded, as I said before.

Some people wanted to hurry it up. One person, who passed away recently, was one of the astronauts who wanted to go to all bite-sized because he didn't like the amount of time taken to rehydrate the food to get their freeze-dried food there, which was more like backpacking food. As a matter of fact, we did a lot for the industry as far as that's concerned, too. When you start thinking about it, a lot of good technology has spun off to the backpacking industry from the foods that were made for the space program.

That's a diversion, but I just thought I'd leave it in there.

ROSS-NAZZAL: Yes, absolutely. You mentioned adding fortifications to Tang®. Did the astronauts ever take a vitamin or did you ever inject any of the other food with additional vitamins and minerals?

LACHANCE: Good question. The Chief Medical Officer said no. He wanted no vitamins and minerals given to the astronauts. They do take some now. So we were dependent on our experiments. We had a calcium lactate added to the drink, because that met our need to standardize, but we had to do some pretty sophisticated calculations—well, analysis—of each food to know how much vitamin and mineral whatever, and then back calculate from their waste containers what they actually, in fact, had consumed. That's the way we had to do it. There was no fortification other than that calcium fortification.

Today I think they're allowed some of that. I'm not sure of that, but they could always be, as I thought it was for a while. But with us when we started out, it was a no-no, so it made life a lot more difficult for us, but we did it. I don't think it changed the values very much. I've done a lot of fortification work; in fact, one of my claims since I left NASA is by doing fortification technology and publishing one of the few books of references on fortification.

ROSS-NAZZAL: Was there any food that you noticed that the astronauts particularly didn't enjoy consuming during Gemini?

LACHANCE: Well, I wanted to finish the story with the bite-sized foods only.

ROSS-NAZZAL: Oh, sure. Sure.

LACHANCE: To keep them from crumbling, we had to be careful. We didn't want crumbs floating around the spacecraft, and that had been an issue of other kinds of cleanliness, other particles floating. As they went into orbit, Gemini III, they said, "Gee, there's stuff floating around in here." So subsequently to that they would shake the spacecraft upside down and get little pieces of wire and just little bitty pieces of things that would stick that would have got into the spacecraft, even though it was done in a cleanroom, to get rid of any possible problems that might have had, aspiration or otherwise, or shorting equipment or whatever.

But anyway, we had a high-melting-point fat coating on these bite-sized items that were very well liked. They were strawberry squares and some other fruit squares. What we did, we took cornflakes and mixed in freeze-dried fruit, compressed it into a very, very tight square, and then they would just chew them, you know, pop them one at a time, and then they'd get this nice freeze-dried flavor. They were very dry, but the coating, they had to have a coating, and we had used a high-melting-point fat for that so that it would be tight all the time.

But the problem with that is that fat doesn't melt at room temperature or even at human temperature very well, in other words, at ninety-seven degrees, you know, body temperature. So the coating sticks to the back of your palate and becomes a real pain. So that led to him deciding that no, he's not going to have an all bite-sized menu, because I had told him, "I don't recommend it, but I'll do it. When you're down there at the Cape, I'll give you a couple of days, and you try it out."

That's what came out of it, that he didn't want to change after that. Secondly, we made a new coating, a protein coating for all these bite-sized foods so they would not get this high-melting-point fat coating on the inside of their mouth or on the palate, because it took forever to get rid of. Couldn't drink enough water; you know, it was a high melting point. So it's things we learned, too, through experience of their questions.

ROSS-NAZZAL: Was there a food that you found that the astronauts enjoyed eating, that they would come back from the flight and you found that they [had consumed all of it]?

LACHANCE: Yes, bacon squares.

ROSS-NAZZAL: Bacon squares?

LACHANCE: Yes. We had a product which was bite-sized; it was a bite-sized product where strips of bacon are cross-linked or crisscrossed by pressure, forced. You make a wafer, basically, a mini-wafer—not a mini-wafer but thickness, it's not too thick. Very chewy, bacon bits and fat, whatever. It's fairly lean, but in fact, it was a good source of vitamin E. In all of the foods that we had, it was one of the best sources. They loved it, because they loved to chew gum and they loved to chew this stuff. It makes you think a little bit of beef jerky, in terms of the chewiness of it, except it was bacon and bacon squares.

Usually I didn't get any bacon squares back. That was always consumed. They would just hang onto it or whatever; they'd eat it in stages, because it was pretty high-calorie. It was very well liked.

ROSS-NAZZAL: One of the things that you mentioned last time is that you were concerned that no one had really looked at certain issues, one of which was what happens to the skin and the astronaut when he lives in a space suit for a couple of weeks. You mentioned a little bit about that last time. I'm wondering if you can tell us more about that test and what you learned and what changes you made.

LACHANCE: Well, when I left the Air Force, Wright-Patterson [Air Force Base, Ohio], to go to Houston, and that was assigned these experiments, to monitor and to set up the food system, I had discovered immediately that no one had really eaten the foods and the meal pattern for any number of days. No one had worn a spacesuit for fourteen days, even though they were going to be in it for fourteen days. And no one had thought about, you know, you may want to brush your teeth once in a while. How do you handle it?

We had to have a way to get urine and feces. We already explained how we got the sweat, so that's one done. But the urine I've explained, I think, quite adequately. The feces, they had to unzip the suit and kind of spread the suit a little bit so their cheeks were exposed. Remember, they're in weightlessness, and we had a plastic container, bag, with a stick-um around the edges.

I don't know if you know what colostomy tape is. It's a two-sided tape. You can buy a two-sided tape, masking tape, same thing, except you wouldn't use it on human beings. This could be sterilized, and it's used in a hospital in the surgery for sticking a bag onto the abdomen when you do cancer operation or take out bowel or whatever. So it's a pretty good stick-um, and you can line that up and do your thing.

The problem with that is that its contents are weightless as well as everything else, and that comes up; that floats up and kind of messes up your skin in the whole area. So you then have to use a whole bunch of wipes to try to clean it out, and you don't want to go again. I mean, you have no room. You can't turn around. You can't get on your knees. You just can slide off the seat a little bit and your knees are already against the—it's a really compact space.

Your buddies have got to understand what you're doing and try to accommodate accordingly in whatever directions you might be able to help with. So that was the most difficult collection of all the collections, be it blood or urine or skin or whatever, was this getting fecal samples and getting—you know, we need it all.

The way we found out on the fourteen days, we give a dye. They eat a dye on the preflight, the day they take off or just before the preflight—I mean, during the preflight, not just the day they take off; that doesn't fit. But anyway, we used it as a marker so that—and then we do it at the end—so that we can measure. When the blue dye shows up is the beginning of the period in weightlessness. Then when it ends, after the flight is the end of the period of weightlessness, of being in flight. You understand that?

ROSS-NAZZAL: Yes.

LACHANCE: So there would be several bags involved over that time period. The first four days they didn't want it, and they avoided it like a passion, but finally they had to get some regularity. So there were a number of bags, depending on which astronaut was aboard. They were about the same; they're not dramatically different. But they had a terrible time with it.

In Apollo, you see, we had room for them to move from the seat to a potty, and the potty had a vacuum. So you put your liner in the potty, and you can do your thing, and the air is going by and pulling this material into the potty, into the liner. So you could seal it, and it was a lot cleaner. But you had no way to do that in Gemini.

In Skylab you actually had a toilet seat. It was very much closer to the real thing than anything we've done. The astronauts were all flight qualified, and they knew. In a plane they just have a tube, and they just let things go through the tube. Some people don't like to know that, but I used to tell my students, "You get rained on once in a while." [Laughter] Nobody's ever proved that, incidentally.

ROSS-NAZZAL: Were you testing that in KC-135, or just doing that on the ground as well, like you did with the urine collection?

LACHANCE: No, in KC-135. We had to design the bag and see how it would work, and we made a device that made simulated feces and would try it that way. But in the KC-135 we had people who were ready to go who were taken through the parabola and would try to evacuate during the zero-G period of forty-five to fifty seconds. That was a real undertaking, but it did demonstrate what the problems were.

The best we could do in terms of capturing the material and not losing any, not having some go to the wrong place or mess up—none of the spacecrafts were contaminated, were messed up, so they worked hard at doing the job right and giving us what we needed. The subsequent flights, too, for that matter, whether they were using an experiment or not, they still had to cope with this problem. So that's how we handled that part.

Then we got some airmen. I had them ship some suits up to Wright Field, and I got some airmen to volunteer to live in the suits. We put them in a chamber that we had at Wright Field, and I had some photographs of them simulating defecation in the simulator with a suit on, and feeding them the food. All this food was fed to other people before the astronauts, you know, the complete profile. That would give us information on the consistency that we expect at the other end, and that it not be too hard and not too soft, all kinds of little problems like that.

They didn't shave, but we did run some experiments on the easiest way we could come up with for wiping their face, washing their face. The wipes were basically the thing that was used, like you use today, toilet wipes. That probably emerged out of the space program, too, for all I know. Well, it could have, J & J [Johnson & Johnson]; I never thought of that.

Then we said, "Well, you want to brush your teeth, all these different food particles in different places," and then we had a little cup that they could spit into. We had the water gun to simulate how they would put the water in. We tried brushing with a brush alone, no dentifrice—a dentifrice brush. We tried a gargle, but that was difficult to maneuver, to handle in weightlessness; you'd have stuff all over the place.

So we looked at the dental hygiene. What we did is we took each subject and took a picture of their mouth, looked if they had cavities, documented all that, took X-rays. Also took microbiological specimens of their mouth to see if they were harboring certain kinds of organisms or not, and then had them eat the food for fourteen days; and take it all apart again at the end to check them. We had a certain number of them using this. We didn't have a lot of subjects. We had the phases, a couple of different times, but we would try. You didn't need to do the fourteen days to get into the teeth.

But what ended up is that the dentifrice was a pain to deal with, and the toothbrush alone did a fairly good job. It's surprising how much a toothbrush by itself, just using their mouth fluids, could free up and clean out the mouth quite a bit. They were allowed a gum, Trident—only one kind, noncariogenic gum. Most astronauts are gum chewers. You may not know that, but they chew gum while they're flying their jets. So they liked that. That was their gum supply. They were all given enough of that, and that also helped with their teeth.

So what did I cover now? The rest of the residue all on the skin, everything, that had to stay there fourteen days. We did culture it. We cultured these different areas to see whether very serious organisms like staphylococcus, the staphylococcus microbacterium and these kinds of things would grow or be a problem.

They were pretty much under control, because when they put the suits on, the long johns or the union suits have been sterilized. They've been all cleaned up just as can be, they make them. We don't handle them as if they're sterile, but they're very clean, and so they pick up every little thing and try to keep them comfy. You can't scratch your back, you've got to have something that's got some resiliency to it that you're all right.

Anyway, that's the way that was all pretested. Those reports are available through the Air Force, or through the Technical Documents Branch. Those reports were never published in the open public.

I thought of writing a small booklet on—because I got thousands of letters from children asking how the astronauts go to the bathroom. I finally wrote a flyer, about two pages, four-page size, showing the pictures of the equipment, and getting it approved took six months. I mean, the Baptist culture, I guess. I don't know what culture it was, but somebody was afraid it might show something we shouldn't show, I guess. But it's still a question that kids will ask, you know, and no one has explained it to them, what was done at first and later on and how it checked out and all these kinds of things. Still being proper about it.

ROSS-NAZZAL: Well, I think it's fascinating. It's amazing to me all the things that you were working on that people hadn't even considered at that point.

LACHANCE: You want to remember we were a small group of people that went to Houston. There were thirteen rental properties, and I arrived there after most of those were in use. The different divisions were in different buildings, rental properties, all kinds of rental properties.

I was in an oil refinery, an oil pipeline building. They had some office space. I had a desk and a telephone, and that was my lab. That was my workbench to get these things done till the first building was built at Clear Lake [Texas], and then a couple more. [Crew Systems] didn't rate for Building 1, [till the second one, number 4] was built and we had some space in [there].

Then as they got more and more buildings, we had bigger space and a little bit of lab space, and things got fancier. But getting the problems done, it had to be done before all that stuff, all the concrete had been put into place. So we had our hands full.

That's why I was working on it. I had done and designed the experiments for VII, and we were going to try to do something in Apollo, but Apollo was kind of reserved as an engineering feat. It's only after the Moon landing, or after [Apollo] 13, I should say, after the explosion, the interest of the public.

I've always talked about Americans being very fickle. You know, "Oh, we've done that before." It didn't matter. They didn't realize how much risk we were taking and how many educated guesses we were taking. It's just incredible, what it was all about, and I've always been a big believer in NASA, because you have to keep thinking out of the box. You've got to keep doing it all the time. It doesn't always happen, but when you look at some of the marvelous satellites that have been sent up there, you just say it's doable.

ROSS-NAZZAL: Let's stop for just one second. We need to change out the tape.

LACHANCE: Okay.

[Tape change.]

ROSS-NAZZAL: I wasn't sure if you'd like to talk about your work on the Skylab food system, and then any other thoughts you might have had or any other work that you did that we might have overlooked.

LACHANCE: That's a tall question. I'm trying to think. Some of the issues that we've written about that we didn't mention, but have been in the more recent papers that have been published; the issue of motion sickness, which some astronauts have and some don't. It takes them a while to accommodate, and then they're able. But that affects their food intake. I did not have a problem with Borman and Jim [James A.] Lovell. I mean, they were fine, but other people were not that did subsequent flights.

The other is the fact that you get exposure to ionizing radiation. Some of the things that are just beginning to be—the astronauts are treated as if they were radiation workers; in other words, they get more radiation than we do because of the ozone layer and the fact they're in orbit with the Van Allen Belts above them, and they're loaded with radiation. That will be one of the barriers we'll have to cross when we go to Mars. I don't say "if," I say "when."

Then as far as food, that brings up the food issue, and what we'll do. Rutgers [University, New Brunswick, New Jersey] has been one of the three universities that's had a $5 million grant from NASA to look at over five years some of the issues of growing food in space, a miniature wheat, making of breads [and pizza].

My theory is that if we could carry all the spices we need—we can carry a lot for a year mission by carrying vitamins, minerals, and spices, food additives—then we can handle the macronutrients, the protein, fat, and carbohydrates, by various techniques, some of which we can grow and some of which we'd have to process.

But one of the ones that impresses people—it's not that we've done it, but you know those little dough ovens? Not a lot of people buy them anymore or use them, but you put dough in this little bakery machine, and it makes a bread.

ROSS-NAZZAL: Oh, the bread machines.

LACHANCE: The bread machine, and it rises and everything. We've done that with material grown—with space [-grown] dwarf wheat and stuff like that, to try to get a whole grain out of it. We've also made some pizza with all kinds of different [components]; the pizzas don't hold together very well if they lack gluten, which is the elastic protein that holds the pizza together.

Anyway, we've been—how do you build that equipment, how do you make it work? When I was in the Air Force, we'd dabbled with this idea, and I published a paper then. It was talking about a Moon base. One of the things we talked about was edible door knobs and edible mattresses, for protein. You know, it would be a foam that's also edible.

But your biggest problem is water. You can't make the stuff. You've got to have it available, and you've got to have a way to—you can make it with a fuel cell, which was used in the later Apollo flights and Skylab and places like that, but I'm not an engineer, so I can't talk about whether there are some efficiencies here that could be used or not, but I think there are. But it's that kind of out-of-the-box thinking that is helpful, I think. It makes you think of how you'd go about doing it.

ROSS-NAZZAL: You were doing studies on motion sickness as early as Gemini and before that point?

LACHANCE: I didn't have much to do with it, itself, but it is a concern, because it affects a person eating. You know, they just don't want to eat, or they're barfing, and then our fecal containers were the barf bags, also. So all of that, these are things to think about. That's what Bill Huffstetler and his Crew Systems Group were all about, [designing] these containers that did all kinds of different things, including the injectables, the drug containers, the emergency supplies, all kinds of little things like that, barf bags, whatever.

Of course, fit them into the spacecraft, and now—in fact, when we had to put food into the spacecraft, it had to be packed a certain way, and we even had a set of blueprints, which package goes in which way. Then they were all [connected] by lanyards by different colors, the red, white, and blue, or the black and white, so that they could pull it out one at a time, and it would be a vacuum-packed meal with all their subcontainers inside, so they'd have to open one and then open another.

Then we found out over time—John [E.] Vanderveen did some of that work at the School of Aerospace Medicine—that you could fly the parabola in the KC-135 or in other jets, and that in weightlessness you didn't need to have a squeeze tube. You could actually propel a pea into your mouth. If you handled it correctly, you could actually not make a mess.

So some of the containers that came and that were used then for Skylab were these we made, like the pudding containers. You've seen those; we sell for kids and other people, juice. Well, the pudding containers are a good example of a pull-top, and then you can eat right out of it with a spoon. It sticks to the spoon. In fact, there's more water underneath a fork than there is on top of it in weightlessness, if you ever get a chance to go weightless.

ROSS-NAZZAL: Right. Well, I guess there's a possibility now, if you have a lot of money.

LACHANCE: Yes, that's true, that's true. But anyway, you can see that you can devise—the containers, my juice containers became accordion containers so that you could accordion the soup or beverage or whatever through that system. You didn't have to have a separate bag for everything. Or you could collapse it; it would also be convenient. It would be all collapsed and you use less storage space.

So those are the things that sophisticated the Skylab. We already had pudding mixes, and those went over quite well. They were nominal puddings. We had some brownies that were pretty good. Some of these things carried over and were liked. I did work with freeze-dried ice cream, but I didn't think it was very—it didn't really taste like ice cream when you got all done. It's just a novelty that's still sold once in a while by some people, but it doesn't do much for me. It wouldn't function very well up there, unless you were able to make a machinery that would do that by itself.

So some of the things we have done and worked with extruders to extrude different—well, Cheetos are an extruded product. A lot of dog foods are extruded products. You can make different consistencies and all kinds of other things. But you can make a mini-extruder and make different kinds of shapes and forms. Just add your flavors, and you'd have something that would be tomato one day and be something else another day, if you can envision that.

That's the sort of thing that these multimillion-dollar projects—ours has been done a couple of years now. I think Cornell [University, Ithaca, New York] has it now; Purdue [University, West Lafayette, Indiana] had it one time. It's a nice contract or grant or whatever it is to work on, because you're always trying to find another way to do something, and also to keep things sanitary and deal with that problem, which you still don't want—I mean, that's why my standards were so strong.

Even today, I was reading the other day somebody finally decided that they should measure—oh, I know, on the Chinese food in *Newsweek* this week—you know, that they should measure staphylococcus and streptococcus. All I can say is "I told you so." It's easy to contaminate. They tell you not to eat any of the Chinese shrimp, and they put out a lot of shrimp worldwide. Anyway, that's neither here nor there. It's just an example of how all this stuff becomes integrated over time.

I can't think of anything else off the top of my head.

ROSS-NAZZAL: I just had another question I thought of. When you were working on the initial Skylab food system, were you thinking about freezing food at that point? I know they ended up actually using frozen food.

LACHANCE: We used frozen food before that time.

ROSS-NAZZAL: Oh, you did. Oh, okay.

LACHANCE: Yes, in Apollo. That was tried in Apollo. In fact, if you see the movie *Apollo 13*, Jim Lovell and whoever's playing him is knocking a hot dog that's frozen, showing how hard it is, and he can't even eat the thing, it was so hard. But there were breads, irradiated breads, that are still around.

Helen [W.] Lane, who runs your program down there, can show you all that stuff. She's got samples of all kinds of things, I'm sure. She just published a recent paper in *Nutrition Today*, which is quite good, about long-range missions; some of the summary of the things we've talked about, some of the new packaging. You may want to take a look at that. She has a menu, a three-day menu—a six-day menu. It talks about the Shuttle and the foods going out.

ROSS-NAZZAL: I'll definitely take a look. Actually, I'm working with Helen right now on a project, so I'll have to mention that to her.

LACHANCE: All right. Yes, give her my regards.

ROSS-NAZZAL: Absolutely. Did you both work together?

LACHANCE: No, she came long after I did, maybe ten years. Malcolm [C.] Smith, who I had left behind, and Paul [C.] Rambaut that I left behind, one took the experiments. Paul Rambaut took the experiments. I tried to get him earlier, but he wasn't an American citizen, and I had to get his citizenship straightened out. And Malcolm Smith, who you told me he was dead, was an Air Force [Veterinary] officer with a master's degree from Purdue in food technology who handled the food part for quite a while.

Then they [hired, contracted, for an in-house research and development lab]. See, I didn't believe in contractors for this. I thought the [US] Army [Natick Labs] was doing a good job and we didn't need to have an extra government laboratory, that we already had one, and we could use it. But that's my own personal viewpoint in terms of the efficiencies of one type or another. …

ROSS-NAZZAL: I certainly appreciate the time that you've taken to explain all of this, because this is something that as part of the project we haven't documented. So I think it's great. It really fills out the history that we don't have.

[End of interview]