ORAL HISTORY TRANSCRIPT

RALPH S. SAWYER
INTERVIEWED BY KEVIN M. RUSNAK
HOUSTON, TEXAS – 7 OCTOBER 1999

RUSNAK: Today is October 7, 1999. This oral history with Ralph Sawyer is being conducted at the offices of the Signal Corporation in Houston, Texas. The interviewer is Kevin Rusnak, and is being conducted for the Johnson Space Center Oral History Project. I'm being assisted today by Carol Butler and Sandra Johnson.

It's nice of you to join us today, Mr. Sawyer. If we could begin, tell us a little bit about your background and your interest in electronics as you were growing up and going into college.

SAWYER: Well, as I was in high school, I took all the science courses that I could get. It was a small high school. We didn't have a lot. I did build a radio. Back there in those days, some of them worked and some of them didn't, but some of them did a pretty good job. I was listening in on Europe a great deal, and that was sort of interesting. However, I guess I was more interested in the building and in the use of different antennas to see how to improve the signal and that sort of thing. So I started leaning towards engineering in those days.

RUSNAK: You went to Tufts [University, Medford, Massachusetts] for physics.

SAWYER: Yes.

RUSNAK: Tell me about your experience there as an undergraduate.

SAWYER: Well, one of the things that I was involved with for interest and for making money, I worked in a Signal Corps lab that was at the school, and it was in piezoelectricity. Back in the early days of the war, there was a great deal of effort in regard to that subject.

Piezoelectricity, it's a crystal, and if you squeeze it, it turns out an electric charge. If you put an electric charge on it, it will oscillate. So people were interested in the cut of the crystal that would oscillate, but not drift with temperature. It was also a great temperature sensor. Well, finally they came up with the cut, the BT cut, and we didn't do that; it was in another laboratory. However, we were looking into other uses of the piezoelectric crystals. I was cutting my own. Quartz crystal is about that long and about yea big around, and we had some of the best. They came from Brazil. So if you're interested in that sort of thing, it was a good location to be employed, making money in your off time, and also learning about some things. And I did use some piezoelectricity later on in my work at—well, it was at NACA.

RUSNAK: Then you went into the Navy. Could you tell us about your experience there?

SAWYER: Well, okay. I took the Eddy Test [phonetic], and if you passed the Eddy Test, you went into electronics. First you go through boot camp. I was in school in Chicago for a short period of time. That's where they weeded out those people who shouldn't have passed the test. I guess about 50 percent of the people left by request. Some of those people would go out because they couldn't do the math. They couldn't do the math. It was very simple math, but they couldn't do it rapidly enough. Some of them had master's degrees in math. It was decided that they wouldn't make it through the whole system because it was extremely intensive.

From there I went to—well, you had choices of various schools to go to. I chose what was then Oklahoma A&M, because they had 6,000 WAVES and 600 sailors, and I thought that was a good deal. However, everybody else chose that one, I guess. You just didn't choose Gulfport, because nobody wanted that at that time. It's quite a resort now. I went to Texas A&M.

When I went to get on the bus to go to Texas A&M, well, you go to the train station to get on the train to go to Texas A&M, there was my ex-roommate in the back of the bus, and I recognized his voice. I think he was singing dirty songs. Anyhow, we got together and roomed again with each other down at Texas A&M. I suppose we were there a matter of three months or so.

Every Saturday they gave us what I referred to as—well, a tough exam. They were very strict. You had to hold your pencil in the air, and then when they said "Go," you could do, and when they said, "You're through," you had to be up again. It was strictly a military sort of affair.

Then at the start of the next week, we got what I called the Sears & Roebuck catalog. I mean, it was about that thick, and that's what you had to go through. We had half a day of theory and half a day of laboratory. I was back building radios again, and it was sort of old hat, as far as I was concerned. We got quite a lot of problems in the lab, you know. There's the radio and it's got a problem, you've got to go find it, and they were very subtle at how they could put problems on you. Really couldn't just visually see.

Well, from there you had choices of going to a fleet school, where you'd be on big ships. I chose to get into aviation, so it was aviation electronics. I went to Ward Island. Ward Island is really Corpus Christi [Texas]. It has a little stream that dries up probably in the summer, and that makes it an island. Anyhow, it was Ward Island. We were the only things there. I was there for all seasons; went there in February and left Labor Day. Even during the hot weather, I would have a blanket over me. The barracks were over the water on

stilts, and the walls were screen. Before morning, before you got up, you reached down for the blanket, which was pretty good in Texas.

Then we had a compound that was highly classified and had Marine guards all the time around the gate. We marched in. We had a band. We marched in the morning and we marched out, you know, and wherever you go, you march. It was like you'd expect a military school to be.

Then I got out of there in—well, it was Labor Day, and I was scheduled to go to another school at an island off California, but I went to North Island, which is really in San Diego. I was waiting there for some period of time. The school supposedly was going to move there. Well, I don't know if it ever did or not, but in the meantime, I got assigned to the USS *Lexington*, and I went to sea finally. So I guess that's the story of, you know, the—actually, I had a degree, and it ought to be easy for me to do, but it was difficult enough because of the speed.

And I might say that when the war was declared, the first thing I did, I went downtown Boston and went to the Marine Corps, and I was scheduled to go into their training program for a commission. But when they got around to testing my eyes, you know, then I tried to get into the V-12, and—well, I got into the military, but it was the best way I could go, I guess. And if I'd gone that early in the game, in the Marine Corps, you became a platoon leader. If you're in action, you're good for about thirty seconds or so, generally speaking. So I guess maybe I lucked out, not knowing it.

RUSNAK: After the war, where did you go?

SAWYER: Well, I went back to—I was in graduate school, and I took a combination of engineering and physics and what I call economics courses. I was aiming to one day—that was before MBAs became known, I think. Anyhow, that's really what I had in mind, was

going to business school along with the engineering. I was a special student in the graduate student school. I wasn't scheduled for a degree. I had more than enough points, but they weren't all in the right things. I had more physics and engineering than any other, and there were some engineering courses I started. They did have V-12 and the ROTC [Reserve Officer Training Corps], and they brought students in from other schools. Some of the courses that I would have taken later there, when I was going to school earlier, weren't offered, so I came back to finish up some of the engineering courses that I had started. And that's about what I did.

In the spring, we had people come for interviews, and I interviewed with—maybe this is your next question, I'm not sure. I don't know. I guess not. I interviewed with NACA [National Advisory Committee for Aeronautics] for the experience. I had no intention of going there, and I had no intention of working with the government. The man was very interesting—Dr. Sam Batdorf [phonetic]. I remember his name. He called me many times, even when I was in lab. I mean, "Dr. Batdorf is on the line for you." Of course, I tried to make people think that I knew some doctor somewhere who was asking for advice. [Laughter] But anyhow, I think they'd know better. Anyway, he was on me quite a bit.

Then one of my ex-roommates was back in graduate school, and he had been stationed at Langley Field [Virginia]. He and I were in the same fraternity, and at lunch one day I mentioned I had a practice interview. "Oh, you did? And it was with?" And he had been stationed there, and he told me that really had a great reputation and that I ought to go there for a while anyhow.

So I guess I had other interviews and they paid more money, but I decided maybe I would go there because I had always lived in New England, and I thought I'd like to go down to Virginia. And I did. It was probably a good idea, and that's where I met the lady who finally became my wife.

RUSNAK: Well, it worked out well, then.

SAWYER: Oh, yes, all around.

RUSNAK: What sort of projects did you work on while you were with NACA?

SAWYER: Well, they look at your transcript and all that, and see what courses you've had and where you ought to be fitting. First off, I was in the calibration lab. I was in the Instrument Research Division. They had a calibration lab, and I was in there for probably three months. They hired eighteen of us all at one time. You became familiar with various instruments as you were calibrating them. You got some information, some background. Then they assigned you to the branch that they thought needed what you could do. It was a real good place, had an office on one side of the aisle and your laboratory right across the aisle. It was a good place to work.

At that time piezoelectricity was starting to be used for vibration measurements and that sort of thing, so I got into that and I got into coming up with circuitry that you didn't have to have a lot of amplification to record. That was one of the projects.

Another project was we had a wind tunnel that was having vibration problems tearing itself down, and it needed a lot of pressure and vibration measurements. Using the system that I had come up with, we determined what the problems were, and the props were changed out. Well, anyway, the wind tunnel was saved—we had probably fifteen or twenty wind tunnels, a lot of wind tunnels at Langley.

I was involved with various other instrument projects. We did the instrumentation for other laboratories at the center, and I was highly involved with the structures laboratory and in various beam measurements that they needed and that we provided.

I got into various other things. I became familiar with the Brown instrument series of devices, Brown electronic potentiometer. All the people who were working on antennas were very tediously plotting, and they came up with the idea they needed something better you couldn't buy. Now they're a drudge on the market; you can buy them. Then you couldn't. They came to us. Well, anyway, I put a self-synchronizing transformer on the face of this device, and it had a printer that went along normally. Then on the antenna you put the transmitting part, and as it turned, this turned. You had to change quite a lot of circuitry in the Brown potentiometer, then you used the field strength meter. Well, you couldn't have the automatic volume control and a few other circuits in there. You had to change. You had to redesign it. But after that was done, it worked as a plotter.

We had a lot of people come to work where I was at JSC [Johnson Space Center] from Langley, so I'd find out where they worked, and if they worked in that area, I'd say, "What were you using to plot your antennas?" They told me, and I said, "That thing is old. That's an antique. It's one of my children." [Laughter]

RUSNAK: Who were some of the people that you worked with at NACA that later ended up in the space program?

SAWYER: Well, one's name, he became a branch head, his name was Chicoine, C-H-I-C-O-I-N [-E], Erwin [L.] Chicoine. And Howard [C.] Kyle, of course. There was rather a large number. Anyhow, this goes ahead. When we were at STG [Space Task Group], we were hiring a lot of people over there, and Dr. [Robert R.] Gilruth came up with a rule that we were going to have to slow this down. I'm sure that Dr. [Floyd L.] Thompson, who headed that area at Langley, probably requested that. Anyway, we did slow it down. We could not give any promotions to people then, and that did slow it down. It was rumored at that time

that we were going to go to Goddard [Space Flight Center, Greenbelt, Maryland]. They didn't want to move.

RUSNAK: Do you remember any particular experiences from your time at NACA that proved particularly relevant to your later time at NASA?

SAWYER: Well, I was in Instrument Research Division, and that was what I was in, was largely electronics, and what I got into at JSC was electronics. It was instrumentation, communication, and tracking. So, yes, it was all very relevant. As a matter of fact, there were people when I was at STG that I remembered, you know, when I'd been there before. It was quite a few years that I'd been there, but they were still there. I'd be calling up to get information in regard to various things, and I knew that there were some people there who should know the answer to some of these questions I had.

RUSNAK: After leaving NACA, you spent a few years in industry with a couple of different companies. Could you tell us about that briefly?

SAWYER: Well, I was at Minneapolis-Honeywell [Regulator Company, Minneapolis Minnesota], and at that time Minneapolis-Honeywell had just bought the Brown Instrument Company and they were out hiring. It was slack time. They have a reputation for hiring when things are slack, and they say they get good engineers that need a job. Well, anyway, I was assigned to application engineering, and they had various titles of engineers. I guess it would start with a sales engineer to a research engineer, with various things in between, application engineer. You would be an interface with the users.

I was assigned to—My area, was the nuclear area, which was pretty new at that time, and the instruction I was given, "If you have a chance to get any of this work, bid on it, and we want it bad enough for it to cost us money." So I was in a good area.

I was working for an individual and an organization other than the one I was interviewed by, and I think it was due to they had bought this company and they were kind of in the midst of easing people out who came with the company. As a matter of fact, Mr. Brown, who owned the company, I'm sure they were trying that. And it was not the greatest atmosphere, but I received a lot of inquiries that I answered, and having worked for the government before, gee, I was impressed that I could dictate a letter to the secretary and it would go right to them, didn't go through the "in" basket, the "out" basket, the "in" basket, the "out" basket. So there were advantages.

However, I was at an IEEE [Institute of Electrical and Electronics Engineers] meeting and I ran into some people I had known at Langley, and they were working for, well, relatively speaking, a small instrument company [Hastings Instrument Company] in that area, Hampton. Well, anyway, I got recruited. They had made me an offer at the same time I had accepted at Minneapolis Honeywell, but they decided they had new work and they needed me badly, and I took the money. Besides, it was getting me back where my girlfriend lived. [Laughter]

RUSNAK: That's a reasonable reason. Why did you end up returning to the Navy as a civilian for several years?

SAWYER: Well, the company that hired me, because they had a lot of work, was getting most of their work from the government, DoD [Department of Defense], and it is a sine wave. I mean, it's up, it's down, it's up, it's down. We did have other commercial work. One of the big things that we made was a very sensitive—well, it was a sensitive pressure device and a

flow meter, was more of a flow meter, and it was a normal metal thermocouple, and they were in series. You put it in the flow and it would cool. It was extremely sensitive. MIT [Massachusetts Institute of Technology, Cambridge, Massachusetts] bought more than anybody else. Whatever work they were doing, they needed sensitivity.

So there was other work, but I then got recruited by another place, and I went there. I thought, you know, we're going to hit the bottom of the sine wave. When that happens, it doesn't matter how good an engineer you are. I mean, dollars are dollars, and they have to live, and the only way they live is making dollars, not losing dollars. So I did go with the Navy lab, and I was kind of familiar with the Navy and all that sort of thing.

RUSNAK: What sort of projects did you work on when you first returned to the Navy?

SAWYER: Well, when I first returned to the Navy, it was in a local area to where I was living. It was at [United States Naval Weapons Station] Yorktown [Virginia]. The work I was in was in advanced undersea weapons. It was torpedoes. I became pretty familiar with about half a dozen different torpedoes, and it was kind of interesting work. A group would be firing at a target, and the target was a huge rock down there in the ocean. They would hit, and they were supposed to explode. They didn't. Some of them came back. They weren't great things to be around. They had one that they wanted to use one of our facilities for doing things. We had facilities. Well, they had tremendous bunkers, and the weapon was put in the middle, and if it went, it went up, not out.

Well, anyway, group brought one there, and one of the project engineers for one of the latest weapons which was being handled in [United States Naval Underwater Ordnance Station] Newport, Rhode Island, was there. He and his entourage convinced me that I should be in the work that they were doing. I got recruited again. So my wife was not terribly happy about moving to Rhode Island. She's a Virginian. But we went to Rhode Island.

One of the things that they recruited me for was, well, the thing that I was really recruited for was to put in a new [undersea tracking] range. They had had a hurricane, and the [undersea tracking] range got wiped out. I worked on that. Then I used piezoelectricity sensors again, and they had been using that prior to the time. We improved them some; they were more sensitive. And then I used another undersea device that was for a strictly different purpose, but we put some different electronics in it, and it was in a box that could be sealed and water wouldn't get in it, it could go to the bottom.

I was about to finish up on that. It was just about installed, and then the project engineer—well, the one that recruited me from where I was before, quit. Why did he quit? Went back to where he was working previously. He was the project manager, I guess you would call him, on the latest weapon at the time, a Mark 35 torpedo. It was being built by GE [General Electric]. We had a lot of early ones made, and it was then in the state to determine whether it would or would not go into production. It had to meet certain requirements and it had to go to Key West [Florida] to be tested, but the real reason he really left was he couldn't stand the gaff. We didn't get along well with that particular—the Navy base in Key West. Our history was not good getting along with those people. It was a problem on both sides.

Well, anyway, they had to have somebody to go and take his place and be the project engineer on that weapon and conduct what's known as a Hit Shot Program. Well, my wife and I were both cold in February in Newport, Rhode Island, and I'm sure they tried to get some other people, but I think they homed in on me because I had had quite a lot of experience with other weapons—torpedoes.

Anyhow, we went, and it was hard finding a place to live down there, even then. That was the days when I guess [President] Harry Truman, you know, was going there. He had the winter White House. Well, I finally had to get smart to get a place, and I would go to the newspaper and say, "Hey, I know you've got some ads in here and you haven't printed

them yet. Tell me some places." Finally got so they would tell me, and I found a place. It was just one room. We had a bed and we had a stove and we had a refrigerator, and it was fine. It was okay. We didn't plan to stay very long anyhow.

Another engineer had been there and set up the initial part of the Hit Shot Program. This was called the BuOrd [Naval Bureau of Ordnance]. We had bureaus in those days. BuOrd Hit Shot Program, they had the target submarine, it was called the *Manta,* and they had two destroyers that were assigned there, the *Sarsfield* and *Saufley*. We would fire at the *Manta*, and it would be staged and it would be broadside and it would be not quite broadside, it would be no side, and, of course, one is much easier than the other.

We came up with how well the weapon worked with that sort of thing. It was my job to be on the firing vessel, be on the target vessel, and my real job was to work with a Navy chief. We had a Navy chief who was a genius, as far as I was concerned. He could plot what the weapon had done, what the ship had done. I would use his information and write a report and send it back to Newport.

Then after that was over, they were deciding what they're going to do next, and they decided, "Yes, we will go on, and the next step before it goes into production, it has to be approved or rejected by the fleet." They had the Surface Antisubmarine Development Detachment at Key West, and that's the group that does it. Well, anyway, they didn't ask me; they told me that I was going to do that. I guess they thought I could get along better with the Navy group down there than they had experience with. And during the previous program, as I got information, I took a copy to them. Anything I sent to Newport, I gave to them. I didn't sent it through them; I gave it to them. I guess that was something new for someone from Newport to do that.

Well, anyhow, the Hit Shot Program by the fleet is as close as you can get to actual warfare. The target submarine goes to an area which the destroyer knows, but it gets there long before the destroyer leaves, and there's an area and he can go hide or do whatever he

wants to do, and the destroyer is out there to find him. I'll skip a whole bunch. I did that many times, and the *Manta* was an old sub. When we got down to any particular depth, there wasn't a pot in the galley we were catching water.

Anyhow, one of the fastest submarines came into Key West. It was the *Razorback*. I don't know why I remember that. It was faster because they had redesigned the screws, the propellers. It was commandeered to be a target, and well, he [the captain] got in one afternoon, he was commandeered to be a target the next day, and I decided I'd ride the submarine that day. He was grousing about being the—the crew does not know they're targets—and he was grousing about being a target, and he had other things to do than that, personal things. It would be within his rights not to be a target, because he was supposed to unload certain tanks before that happened, but [he said,] "You can't hit me anyway, so let's go."

Anyhow, we did, and in the morning we had another exercise going. They were firing Hedgehogs. Hedgehogs are about that big, and they set out as a blanket, and you could hear them hitting on the sides. In the afternoon we were to have the Mark 35 weapon used, and we were in the area, and we had sailors on deck with binoculars looking for that firing vessel. Well, anyhow, you knew when they saw it, because bodies and binoculars came down through the hatch, and the last one screws that hatch, and the "Ah-oo-gah, Ah-oo-gah, Dive! Dive! Dive!" Just like the movies.

Well, the technique that the skipper was using was go deep, and then when the firing vessel got within what he figured was the range that they were going to choose to fire their weapon, he would surface at maximum speed, forward and up. That's what he did, and the crew doesn't know what's going on, but they read meters real good, and they can read the meters that says what we're doing. They know that if you broach a fleet sub, it breaks, and that's not good. They were nervous. Well, you could hear the—it's like a hornet going around your head.

Anyhow, it finally hit. The submarine, as you know, it's a cylinder, but it has a conning tower, and that's called the sail. Well, the weapon hit in the sail, and the weapon weighs about two ton, and it's going—well, it used to be real classified. It was going at a reasonable high speed for under water. I mean, we really rocked. I mean, I guess if I were a crewman, I would think that we had broached and the end was near.

Anyhow, that was a good hit and we did fire two more that day, and we had the same technique. We had the other ship come in and went through a procedure. It found us and we did the same thing. He felt that was a good technique, and the skipper said that was luck. Anyway, he tried the same thing, and, well, he got hit again, but not in the conning tower. He got hit on the side. The crew knows now what's going on. We hit him three times in one day, and I guess that's how come the weapon became a weapon. I'm sure it went to the fleet and is probably being used today, but I have no idea. It's an area that probably needs a lot of work done, because submarines are what the Chinese has most of, so I presume that that area of work is important.

But I really enjoyed what I was doing. I went back to Newport, and I had to go give a speech every day, seems like, had a new bunch in, in regard to this weapon. Anyway, a decision was made that they were going in production, and I was assigned the job to write up how you ought to be testing weapons and so forth, new techniques.

Then the area at Newport, we didn't get along too well with headquarters either. The Bureau of Ordnance was headquarters. The technical director knew a lot of admirals with a lot of stars, but he didn't realize they were getting old and disappearing. People at headquarters also knew a lot of people with a lot of stars. He got forced out. The way they forced him out was we had a PD review. A PD review means that if you are a 12 or above—and I was—you're going down one grade. Well, it takes a long time to do that. They don't admit that that's the case.

So I waited for a long time and I did look for another job. One place was Dahlgren [Virginia] Naval Weapons Lab, and they wanted me to come and do an exterior ballistics lab range, and here I am on the range again. I knew that if I waited long enough, I'd get demoted at Newport. Well, if you're working for the government, you have to know the ins and outs, and if you get demoted, fine. But then if you get promoted back to where you were, it gives you at least one or two steps above where you were.

So I convinced the weapon lab to wait until the time was ripe, and they did. I went there, and so we moved again. We went back to Virginia. Well, my wife's happy about that. That was one reason why I went back to Virginia. She had relatives in Washington, D.C., which was fifty miles from Dahlgren, and a sister in Norfolk, and family. So we were back in Virginia.

RUSNAK: I also wanted to ask you about the Polaris missile that I believe you worked on while you were there. I know the Polaris proved important for the Apollo guidance and navigation systems. I'm wondering if there was anything comparable for the systems that you worked on.

SAWYER: No, not really. I mean, the experience I got there was I GFE'd [government furnished equipment] some tracking equipment and it was quite a lot of design work. GFE was a new thing with me, GFE'ing from a company. I used something that was used by the Air Force in their missiles, and they had plenty of space. The Polaris did not have plenty of space. We used the same technique, but we had to shrink it tremendously. We got into various, various problems. I had worked with the Air Force because I was using their money to develop something for the Navy. We were going to pay them later.

Then the Navy had higher reliability requirements, and that didn't go over too well. The only way I sold that was the chief engineer from the contractor, which was Convair

[Division of General Dynamics], which built the device, he was on my side, and I guess that's how come we got that straightened out.

Then dealing with the contractor who was doing the actual work, and I'm providing it to another contractor who is the prime contractor for the Polaris. Well, I'm getting beat on in two or three ways. I mean, I'm not getting it there soon enough and I'm beating on these people too much to get it there soon. I'm trying to give myself a little pad.

Anyhow, it was good experience, and I GFE's government-furnished equipment a lot in the Apollo Program. The experience I had, it's sort of like Marine boot camp. If you get through boot camp, nothing is going to be worse than. So I felt like I'd been through boot camp.

Polaris was—well, they were saving the nation. We were racing with Russia, who we beat, and the Navy was really interested in saving the Navy versus Air Force or other military. It was very, very, very intensive, and the people who worked in the program project office in Washington worked Saturday. Saturday was a workday, and you had to have permission not to be there, and permission usually wasn't granted. Fortunately—and Polaris had full sway in the Navy. If there was anybody they wanted, they could have him, and they could have him there. They didn't usually want them there, because they wanted a small office to control things.

SAWYER: Well, anyway, for one reason or another, I was chosen as one of their people and I was allowed to stay where I was, as long as my real job didn't interfere. My real job was the Exterior Ballistics Branch.

RUSNAK: How did you end up joining the Space Task Group?

SAWYER: Well, I was in the exterior ballistics work, and that meant that we had airplanes and they were dropping shapes, and we were also firing 16-inch rifles downrange, and the range was the Potomac River, about five miles wide there, and you had forty miles downrange. The advent of the jet airplane drove us out, because they were getting into our danger area. It was only a matter of time until we took one down. So the Navy, very wisely, took this work away from that center and sent it to the desert. I had no idea of going to the desert, although I know people there and they wouldn't live anywhere else after they'd been there a while.

I was about to go fishing down at Nags Head [North Carolina], and when the Sputnik came along, we were tracking it with very long focal-length cameras and cine-theodolites that can plot trajectories. We were out plotting at night, the Sputnik, and the National Science Foundation was interested in what we were doing. As a matter of fact, they sent me some money to improve the lenses on the cameras, or they thought they could tell something about the shape. I was reading about it in *Aviation Week*, and I saw an article that had to do with a man in space, and the only name that I could remember was Bob [Robert R.] Gilruth, who was the head. While I was at Nags Head fishing, I called, and I was going to be back in Norfolk and stay with my wife's sister's family. Brother-in-law and I were going fishing in Back Bay.

So I called Dr. Gilruth and he said, "Well, while you're up there, come on over to Hampton and we would like to talk to you." Well, I did and he did, and he introduced me to Max [Maxime A.] Faget. At that time [W.] Kemble Johnson, I remember, was really attached to Langley Research Center, but he was handling the personnel work. There weren't very many people there then. He was the last one I was to see, and he said, "Well, when do you want to come to work?" So I told him, "Well, you're going to have to move my furniture, and I've got to give two weeks' notice," so it all worked out. "Then you've got to put that in writing."

I was happy to get back down there, and one reason I was happy to get back down there was, we were scheduled to go to Goddard [Space Flight Center, Beltsville, Maryland]. As I said, my wife at that time had a sister up there, family up there, so we were interested in going to Goddard.

RUSNAK: What were some of the first jobs they had you doing when you joined STG?

SAWYER: Well, I tell you, we were busy, in that we had to go to the contractor, which was McDonnell-Douglas, St. Louis. We were there for three days every month, and we went through everything that was going on, and we kept the phones hot in the meantime. In my particular case, I was going to the vendors that they had, and their major vendor [Collins Radio Corp.] was in Cedar Rapids [Iowa]. I should know the name of the company. They have since been sold to Rockwell [International]. They made very good equipment.

What was being used was not development at all, it was what was available, and do things to what's available, that can stand the environment that it's going to be in, which is a different environment than it normally would be in. So, vibration and temperatures. Changes were made in that regard, I believe.

I think one of your questions was about the first electronic lab and why did we need it, could it be done somewhere else. Oh, sure it could be done somewhere else. A lot of the people who were there—when I got there, the Langley Research Center had moved to the west area, and a lot of it was still in the east area. Some of the wind tunnels you can't move. But we were in what had been the administrative building, and was in a—well, I call it the smoke-filled room. There were about fifteen of us in there, and you had to walk sideways to go between the desks.

We had two telephones, one inside, one outside. We were on the outside phone quite a bit, due to the vendors. You couldn't hear anything because of the proximity. Well, we got

some pasteboard and made a cage and lined it with insulation, and put the phone in there, and we could get about that much of it in there, and you could make out what was going on on the phone.

So anyhow, we were in two other quarters while we were there, more of a laboratory quarter. This was strictly office.

RUSNAK: So what was the state of Project Mercury when you joined?

SAWYER: Well, it was ongoing, and the contracts had largely been awarded. I was trying to get on board. We had a lot of young engineers that might have been in Korea, but they were there. They were in the Army and they were right out of school. They needed laboratory work to become familiar with—well, we didn't know what we were going to do at that time, but it was important to have a laboratory that they get some experience.

RUSNAK: Do you remember some of the requirements for the communications systems on Mercury?

SAWYER: The requirements.

RUSNAK: The basic requirements for the system.

SAWYER: Well, gee, you know, I've got one book that I brought home with me, and it's the book on Mercury. No, the requirements wouldn't be in there. It would be a write-up of the systems and the subsystems. We had to communicate, of course, with what was on the ground.

There wasn't much on the ground at the time, and probably communication—communication with Mercury was pretty good. We used VHF [Very High Frequency], and we had to find the thing when it got dumped in the ocean. We used HF [High Frequency] for that. I was in on the testing of that, because that was considered quite an important piece and device. It was an aerokite type of antenna, and what you had really was a piece of wire, and it was held up in the air by an aerodynamic shape that was full of helium or—yes, full of helium.

We went down to Eglin Air Force Base [Florida], and they can come up with all kinds of—they had a big facility—all kinds of wind and all kinds of rain, if you want rain, snow, hail, sleet, whatever. Anyhow, it didn't perform that well.

Then we had a life test, and that was really the test. The balloon was made of mylar, and you cannot put mylar together with helium in it and it not leak. Well, anyhow, we discovered that. We had a problem. So I guess we had a whip antenna. I've forgotten how we solved that problem, frankly. It was the landing people who were most concerned, the people who went out and picked up—my neighbor was one of the people who was always on an aircraft carrier that picked them up. That was the HF frequency.

We had VHF. VHF was kind of a workhorse, the voice and information down. I remember some of the systems we had in the lab. I know they talked about the clock, and I figured it was an atomic clock. Well, it was made by Waltham Watch [Waltham Precision Instrument Company, Waltham, Massachusetts], and when we got that in the lab, I was really surprised. It was really a programmer and it had quite a lot of slop in it. I remember telling my supervisor, "Boy, I can sure design something a lot better than that in a short time." Well, he was a mechanical type, not an electrical type, and, well, he, in essence, said, "Over my dead body." [He was right – it worked fine.] Well, anyhow, I told him all it lacked—it was made by a watch company and all it lacked was the pendulum, but anyhow. [Laughter]

It was one of the things that we were giving our young people some experience with testing. It was available.

There was sort of a funny story. My boss was very interested in this, and he was always the one who went to that company. They wanted to do a zero-gravity test, and they went to the highest part of the building and they had a padded container at the bottom, a basket, I guess, and they were up there and they dropped it. I got this from the young engineer who went with him. Well, it missed the basket. [Laughter] It became a G test. It was not a flight item, you know, merely a prototype. No great damage done, but I doubt that it improved its operation a great deal. But as far as I was concerned, it didn't hurt it a great deal either, with all the slop in the system. [Only the prototype had slop.]

RUSNAK: During the development period, what interaction did you have with the Mercury tracking network, those folks?

SAWYER: Well, that was very easy. They were right across the field from where we were. That was at Langley at that time. They were going to go to Goddard, but they were at Langley. As a matter of fact, one of the people—I didn't know, I knew of him, was in IRD [Instrument Research Division] when I was there years before, [G.] Barry Graves, and he headed that area. We did have—well, going there and their coming to us was very easy, and by phone, of course. We had to be compatible in that, for instance, we had C-band and S-band radar and had transponders. The ground equipment and the transponder had to know how to look, they had to look at each other, so we had to have all that sort of thing squared away. Plus in the other systems, transmitters that we had and receivers on the ground. It was, I guess, convenient that they were that convenient. It turned out that way.

RUSNAK: Good. With the operation of the communication system on board Mercury during actual missions, what were you doing during that time? Did you have any role there?

SAWYER: Well, it was planned that we—I guess at that time Max Faget headed the Onboard Systems Division, which later became the Engineering and Development Directorate, about the time we went to Houston. Anyhow, it was planned that our people, some of our people, would go to the receiving sites. I'm sure that was hashed over many times. It finally came out that we were not. I think they made an excellent decision, because the operations—we had two operations directorates [later]. I think starting early was really a good idea. I don't know, I can't remember that well at that time whether we had—I guess Apollo had not started at that time. I mean, you know, we weren't going to go to the moon and all that. No, I guess not.

Well, we were building a lab, and the first lab happened to be what I brought in. I brought in an oscilloscope and a signal generator and a soldering iron and VARIAC, and as we could get our hands on some of the early equipment, we would work on it. But we became exposed to the hardware mainly just before the flight, because the capsule that's going to fly is in the clean room at the contractor, and I was at the contractor for the first three vehicles that were to fly. You either accepted or rejected that system.

That was kind of a hectic time, in that we did it system by system by system by system. You'd be called to be there by X date and time, and they hadn't quite finished the other system. Then they had a problem on the system, and your hours could turn to days, and your days could turn to weeks. Usually when I went, I went to go to stay a maximum of three days. Well, many times you go buy another pair of pants and you buy another shirt and that sort of thing. I always stayed at the same motel, and I finally got smart enough to have spare shirts, spare pants, and they put them down in the basement.

Our biggest episode, as far as the flight was concerned, was certifying that the systems were up to snuff and the contractor that they had doing the communication system, the lead man for that, was there while we were testing out in the spacecraft, and you're all decked out and have to wear things on your shoes and so forth.

RUSNAK: How would you describe the relationship between NASA and the contractors at that time?

SAWYER: Well, I thought that McDonnell-Douglas, before I went there, I thought McDonnell-Douglas was one of those small contractors. I knew what they made. And they were, relative to some of the big airframe companies. But they were very, very well managed. Mr. "Mc" [James S. McDonnell, Jr.] ran the company, and he ran it extremely well. When we went there once a month for a meeting, he would attend the last meeting, which was usually a dinner meeting, and if you had a problem and you wanted it solved, you could bring it up. Of course, he ran the place. I thought it was one of the best contractors I had ever worked with at any time. I thought they were very good, and the relationships were very good.

RUSNAK: Great. Do you remember any other specific episodes during the development of Mercury communication systems that stand out in your mind?

SAWYER: Not specifically. Of course, sending [Alan B.] Shepard [Jr.] up on his affair, I mean, you know, those things stand out. And John Glenn doing his thing. All stand out, of course. It was all really exciting. However, it kinds of falls into the background after you've gone through something like Apollo, and it's longer, longer, longer ago.

RUSNAK: While we're on that subject, we go through a period where there's essentially a missile race between the United States and the Soviet Union, like the missile gap, as they call it, and then we're getting to this space race during Mercury. What were your impressions of those episodes at the time?

SAWYER: Well, I kind of figured that we were in a race, and I never doubted but what we would win the race. There were things that came up, I guess, that you might think, gee whiz, maybe they are going to be there first. However, it all worked out in the correct way. The same, of course, was true in regard to the Polaris that I worked on.

RUSNAK: Another question about Mercury. I know on Gordon Cooper's flight, they had a form of television there, like a slow scan television camera on board. Did you have anything to do with that?

SAWYER: I don't remember that now. No, I don't remember. I know that that was the case, but if I had anything to do with that, I don't remember that. It was at a later date that I had a television section. Much later date. It could be that some astronaut wanted television on board and he got together with a contractor. I don't know. You just couldn't put one on. It had to go through some qualification. If I had anything to do with that, I sure have forgotten it, and I don't believe I would have forgotten that if I had. But I know what you say. I remember it now that you tell me about it. [Olin Graham remembers an extremely slow-scan TV for recording on-board. He does not remember any usable images. I may have had a TV Section at that time with Max Engert as the Head.]

RUSNAK: Obviously television became important as we moved into Apollo.

SAWYER: That's kind of a story, but television didn't really become important [at the time of early Apollo]. Television became very unimportant. [Television was removed from the program, but was added later, as I describe later in the interview, and became very important.]

RUSNAK: When was it that you first heard about a lunar mission that became Apollo?

SAWYER: Well, I don't know when that was announced. [President John F.] Kennedy [Jr.] came here, gave a speech out at Rice Stadium. I don't know whether he announced it then or at some other time. But when that announcement came out, I decided that it would be a long and expensive program. I asked Dr. Gilruth one time that same question: How did you feel, Dr. Gilruth, when you learned that you were going to be the head of the team that was going to put astronauts on the moon and bring them back? And he said, "I was appalled." So I was probably more than appalled, but anyhow.

RUSNAK: What was your first involvement with the Apollo Program?

SAWYER: Well, when it was first started at STG, we were more organized at that time and had a few more people and were sort of in position to go ahead. Of course, you had each technical area came up with requirements. In our particular case, our requirements are predicated by other people's requirements, because largely we're doing measurements that are required. Our initial entry into the Apollo really was a development flight instrumentation [DFI] for the early, early flights. That was GFE'd, and it was a long program, because we did that for the many, many, many flights that were rightly flown to make sure we weren't going to get in a big problem when we had the astronauts on board.

Well, I have a picture of the—well, this is an early GFE. We put a breadboard together, and our technicians put it together. It was a piece of plywood about twelve feet long, four feet wide, just covered with electronics, and we checked that out as a unit. Then we took all that stuff off, packaged it, sent it to the contractor, and that's the contractor on the West Coast and the contractor on the East Coast. Our technicians would go with it, put it back together again, and check it out again as a unit. After it checked out and the contractor got familiar with it, they would install it on the spacecraft.

That success in regard to providing the DFI—we called it the R&D instrumentation to begin with. That's what it was known as. Well, the research centers disagreed with that. We had to change the name. We called it the development flight instrumentation. It went on for a long period of time and was growing, growing, growing, and in some cases we couldn't procure the equipment. I know we had a signal-generating problem, signal-conditioning problem.

Well, we built our own, and we used the Technical Services Division a great deal. In order to make the chassis for this, they, in essence, carved out a big hunk of aluminum and made compartments, and we would put this piece in here and this piece in here, and gave us good separation so we didn't have interference of one with another. In the telemetry systems, we did have to come up with some that were not available commercially because of the quantity of information we were sending, more than anyone else had sent, I guess, and we had to design our own and build our own and meet a schedule.

RUSNAK: Had there been something similar for Mercury or Gemini?

SAWYER: No. No, there had not been [to that extent].

RUSNAK: So why the need for Apollo?

SAWYER: Well, Apollo was a lot more complicated, and doing this—and the contractor, when told about doing this, was really not in position to do it. There was quite a bit of competition in regard to who was going to do it. I remember writing a memo, and the memo said that here's what we would do in regard to this, this, and this, and here are the people who I would assign. I suppose there were some other memos from other places, and whoever makes that choice made the choice, and we got put in the job.

RUSNAK: What were some of the other areas of responsibility that you had at this point during the Apollo Program?

SAWYER: During which point?

RUSNAK: Pretty early on before they started the actual flight phase.

SAWYER: Well, we were responsible for that which the contractor was building, and we had the same types of interface with the prime contractor, Rockwell. I guess it was North American [Aviation, Inc.] then, became Rockwell. They came up with one of the lead subcontractors was the company in Cedar Rapids, which they eventually bought. We had quite a lot of problems with that company in this program, but eventually the prime contractor came up with an incentive contract, and that really took care of the real problems. It speeded it up. They had trouble getting delivery. With incentive contract, those problems went away.

RUSNAK: Do you remember some of the specific problems?

SAWYER: Well, they weren't necessarily technical problems. They were just "not turning it out" problems. I presume that the contractor had other contracts for other people who had a tight schedule, and they were being pressed. And money talks if you have incentive contracts. They learn how to make money. It probably was easy for them to do. Maybe somebody's program just didn't get delivered, I don't know.

RUSNAK: What were some of the particular new challenges presented by Apollo compared to the previous programs?

SAWYER: Well, it was tremendously larger requirements for sending back information, and we came up with—well, I guess it was the unified S-band. It was the workhorse. I remember we had problems with various subsystems. As the requirements are known, you come up with a system and you build that system. You find the problems with that as you use it, and, well, then you come up with the Block II, and it will handle more equipment, more measurements, and you take out those things that you've discovered what were the problems. You take those out. So Block II was a great improvement. We went through that sort of thing with the S-band system, and it was the most complicated system. It was the workhorse.

Then we had other systems. We had to communicate with the astronauts, had to put that in the suit, backpack. We had to make their measurements that they needed on the man and on their equipment.

RUSNAK: Why don't you tell us specifically about the lunar walkie-talkies, I guess, as they were called, in the suits, and communicating during EVAs.

SAWYER: Well, I don't know which program, I can't remember how we did this, whether we had the contract for the communications system or Crew Systems [Division] had that. I don't know. Let's assume that this particular one was the one we had the contract—and I don't know that it was. It was up to the Crew Systems Division to tell us what measurements they wanted insofar as their equipment, which cooled them and all that sort of thing. Then we had to be told what they wanted with the EKG [electrocardiogram] and all of those temperature and respiration and so forth.

We were implementers, strictly implementers. We were always told how expensive we were. Well, we were expensive, but what determined the expense was how much do the other people want. If they want a lot, it'll cost a lot.

RUSNAK: Can you describe the kind of hardware that was used in this instance?

SAWYER: Well, we used the VHF. It was around 296 [MHz], I guess. Initially we were going to have only one man out, and that's the way we built the system. Then it was decided we'd have two men out, and so we had to change the system. The least expensive way to change the system was for one astronaut to talk through the other astronaut, so we came up with a change that was not expensive. The system—well, it always worked, and it met the requirements. As time changed, the more measurements were added. We didn't have to go through a Block II; we were able to put other things in with what we had, with modifications.

That's what contractors love, is changes, you know, like go get the contract so you're losing money, so we'll get it back when the changes flow in.

RUSNAK: Speaking of contractors, how did the relationship with the Apollo contractors compare to Mercury, which you described as excellent?

SAWYER: Well, it was my opinion that it probably was not as good, but it was a bigger, more extensive program, with greater requirements. I don't say they were bad. We had different people who were heading it, and I don't know that that was a real problem with any one of those people. I'm trying to think of the man who had the eye patch [Dale D. Myers]. Can't think of his name. Sometimes I can't think of people's names. [Dale Myers was a good manager.]

RUSNAK: That's okay. If you could, just briefly run through the hardware for the Apollo system actually on the spacecraft, the communication system specifically.

SAWYER: Okay. I probably decided that that was—I don't know as you want all this. The unified S-band was, as I mentioned, the primary communication system, and it had to handle many different phases of the flight—the translunar injection, translunar flight, lunar orbit, and the LEM [lunar excursion module] descent and landing, and the LEM launch and ascent, and the docking with the CSM [command and service module] and the trans-earth injection in flight, and the separation of the command module, reentry and landing.

Of course, we had blackout during part of that when it was coming in, and there's nothing you can do about that. There were people who were thinking of trying to do that. However, I guess Dr. Faget came up with the quotation that "Blackout during landing is a physical phenomenon, it is not a problem." So we didn't come up with any means of getting around it.

We had the VHF near earth. It was a secondary voice link with the ground. Of course, we had the astronaut in the spacesuit equipment, and we had the LEM VHF, LEM voice telemetry, and the LEM telemetry to the CSM for relay to the earth. CSM had VHF arranging for determining LEM range rate during rendezvous. Then, of course, we had the landing radars and the rendezvous radars.

Overall, it was a reasonably—unreasonably complicated system, I guess you might say. It was necessary that we have that equipment in our laboratory, because there were many problems. We had a copy of the ground equipment, and later on for the next program we had a copy of the satellite equipment. During Apollo, we came up with a lot of problems, and we could solve the problems in our laboratory, we could have the astronauts with us, and then when it gets written up to send up to the astronauts who are up there with the problem, the astronauts on the ground who know what they're looking at and can write it up so they will understand exactly what to do. That was important, that we have it here at this location, and it was important that the astronauts be here at this location for doing their thing.

RUSNAK: Okay. If we could take a short break now to change out our tape.

SAWYER: Okay. Okay.

RUSNAK: All right. The first Apollo mission, Apollo 1, as it was going to be, in early 1967, what were your memories of that episode?

SAWYER: Well, it was a tragic sort of thing, and I knew all of those people. As a matter of fact, Roger [B.] Chaffee was one of the people assigned—well, I guess he assigned himself to the communication. I'm not sure he didn't have a Ph.D. in communication. Anyway, he was interested in that. And, of course, we all knew Gus [Grissom] and Ed White.

Well, I'm looking at your words, and I don't know whether you're telling me about a problem we had or not. [Reading from notes.] "Get off to a rocky start, the day of the first fire." The day of the fire and earlier, they had many communication problems between the spacecraft and control centers. Actually, the problem was between the test conductor at the Cape and the crew. It was not a CSM problem as such. As a matter of fact, Roger Chaffee

did say, "How are we going to get to the moon if we can't communicate between these two buildings?" So the problem really was in that local system.

As a matter of fact, one of the men that I had down there, Mike [Michael B.] Luse, stayed down there and worked with them in regard to solving their intercom problem, and it was a major redesign. That was written up by [Wendell] Mendell, and [Donald D.] Arabian, and I'm told that that's in classified storage.

RUSNAK: Do you remember any specific changes necessitated to your systems as a result of that fire? I know there were sweeping changes.

SAWYER: We had, in essence, a moratorium, like we did after the Challenger thing. Took us a long time and all systems were looked at, of course the power system. And then we changed the quantity of oxygen that we utilized. There were many, many changes, but insofar as the communication system as such was concerned, I don't believe we made very many changes. It wasn't necessary.

Actually, you said "What was your—" Well, you haven't asked me that one yet, about the— [Laughter] "What was your reaction when you saw TV pictures broadcast from the moon on Apollo 8?" Okay. Apollo 8 didn't work too good, and it didn't work too good because they pointed it at the earth, and it did just exactly what it was supposed to do, it crapped out. But they did use it later when [Frank] Borman read the Bible. It was operating. It had healed itself.

But when we—okay, for Apollo 8, television was not a popular thing among the crew. The crew did not want television. The television was removed from the program, and when the television got removed from the program, the head of the television section, Olin [L.] Graham, put it in those that were available, he put those in bonded stores, and you wouldn't have flown a television on 8 if he had not put them in bonded stores, and the world

would not have seen the first footstep on the moon and the astronaut using those ten-frame-per-second pictures, would not have seen what they saw. I think it was a very good thing that he put them in bonded stores and that it was decided to take it on 8 and to take it on 11. I think it worked out.

You asked how did I feel when I first saw the TV pictures from the moon. I was elated. The thing worked and there it was. You know, when he got out, he pulled a lanyard and the thing flopped down to take a picture where his foot was going. Well, it didn't flop down and fall on the moon; it did what it was supposed to do. Hell, I was elated.

RUSNAK: I think we're all glad that we were able to get these pictures, the first shots of the earth as a whole, and the first man's steps on the moon.

SAWYER: Right.

RUSNAK: How did the equipment come about that they used for this? Were they standard television cameras? What sort of development was put on these to be able to use them in space?

SAWYER: Well, they were made to be very, very light, and they were made as special units, I'm sure. They were made by RCA. It was a contract for the contractor to do that.

You're not going to ask me the next question?

RUSNAK: Go ahead.

SAWYER: Okay. "What was your reaction to the TV camera burnout on Apollo 12?" Well, my reaction was, the camera did like it was supposed to do. [Alan L.] Bean and [Charles C.

"Pete"] Conrad pointed it at the sun, and it did what it was supposed to; it quit. Then they hit it with something, and somebody said, "That's better," so they hit it again. Well, it didn't work after that.

RUSNAK: I believe for Apollo 15 and later missions they had a different type of tube so they wouldn't burn out if that happened.

SAWYER: We used what we called silicon-intensified tube.

RUSNAK: And for some of the television, I believe there was an Emmy Award involved. Could you tell us about that?

SAWYER: There was a what?

RUSNAK: An Emmy Award.

SAWYER: Oh, yes, there was—yes, I haven't seen it in—I don't know. I've been retired ten years. I guess some years ago I noticed up in the outer area of the director's office—well, I suppose now there's a bunch of places there where they have various awards, and this is one of them. I believe the wording on it—I don't know. I copied it down once. But anyhow, it did say the IESD—I don't know whether they spelled it out—Instrumentation Electronic Systems Division, and that was the division that we were in.

RUSNAK: I'm sure that was a proud moment to be recognized for that.

SAWYER: Well, yes, that was a good thing. [We provided all the color television as GFE.] [Laughter]

RUSNAK: Can you tell us about any other developments that may have been made to various communications or instrument divisions as the later flights progressed, particularly the longer surface-stay missions?

SAWYER: We did come up with a lunar unfurlable high-gain antenna that could give you better pictures. As a matter of fact, it was used on at least one flight, to take a picture of the LEM leaving the moon. That was a rather outstanding picture, I thought. I wish I had got one of those, a tape, which would have been easy for me to do when I was working, but I don't know that anybody can find that anymore.

Well, all during the program we were doing the [DFI], which—the DFI, as government-furnished equipment, and it was an ongoing, ongoing, ongoing forever, it seemed like. We did the LCRU [lunar communications relay unit], which was television and a voice system that was on the—I don't know if I brought a picture of that or not. Well, anyhow, there it is. That's the television transmitter. A lot of people say, why did you gold-plate it? The answer being, well, solid gold is too heavy. It reflects pretty good. You can see a mirror on there.

And we also, in our laboratory, checked out the vehicle. They were worried about the electrical system driving the wheels, you know, interfering with things. We did that in our anechoic chamber, which, when we built it early in the ball game, was one of the biggest—well, it was the biggest one in the world. Air Force has built one bigger since to put airplanes in.

RUSNAK: With other Apollo flights, do you remember any particular problems that occurred with the communications or other instruments that particularly affected your systems?

SAWYER: Well, speaking now of the LEM, we had—I think it was on the LEM. Yes. We had equipment out in the atmosphere. It was atmosphere, as a matter of fact, the atmosphere created by the vehicle itself. We had corona problems, and we sealed the boxes. That was one of the things that we learned. When people were talking about power from space, you know, you use the tubes, the huge vacuum tubes, to send down.

Some of the eminent scientists were saying, "Well, there you are in a vacuum. You don't have to even put any envelope on." Well, anyway, we learned that if you've got any structure that came from the earth, you do have, and you will have, corona. So as we went on in our programs, if anything was going to be out in the vacuum of space, we would seal those boxes to eliminate any problems of that type.

There were other GFE things that became required. For the Space Lab we came up with what I would call a teletype, you know, that would just run and send up information to the astronauts. They didn't have to man it or anything, just go pick it up. We evaluated three different manufacturers and came up with what we thought was the one that could be modified to be suitable. And there were several. Actually, the program offices used us quite a lot in regard to GFE'ing equipment, because it was a lot cheaper for them. As a matter of fact, the Air Force had us doing some programs for them.

RUSNAK: What kind of programs, do you remember?

SAWYER: Well, it was associated with our work.

RUSNAK: You mentioned earlier that Roger Chaffee was one of the astronauts that worked with your division. Who were some of the other astronauts that did, and what contributions do you feel they made?

SAWYER: Well, Apollo 10—I've forgotten his name. He became a lieutenant general.

RUSNAK: Tom [Thomas P.] Stafford?

SAWYER: Tom Stafford. He wanted—normally I can remember names, but sometimes I don't. He wanted color television on his flight. As a matter of fact, he used to call me many times. He was at the Cape getting ready to fly, and he was worried that we weren't on the ball. He would call to ask me how we were doing, and I would tell him we were doing just fine. I would imagine that, knowing him, he probably called the contractor to find out whether or not we were, but I don't know that. I never asked the contractor. Anyhow, we did fine, and we provided it and it worked fine. He was happy with his television, I presume.

RUSNAK: Going back to Mercury or Gemini, did astronauts work with you then?

SAWYER: In the Mercury Program, an astronauts was assigned to a technology area. [M.] Scott Carpenter was the one assigned to our area. I can't remember specifically, but I expect that he was on some other trips that we made, you know, to the vendors, and I know very well that Tom Stafford was with us one time when we went to the vendor in Cedar Rapids. Well, when we went to Cedar Rapids, we ate in very good places. As a matter of fact, the best restaurant in the world is there; it's called the Flame Room. I don't know whether it's still there or not. I remember being snowed in once, and I was very happy to be snowed in, because I liked the hotel I was in. Anyhow, I ate there all the time.

But this time we ate out in Amana Village, and Amana Village is what you might expect it to be, I guess, the type of people. There were houses where you could go eat. Bischtangle [phonetic] was the big thing. That is a rhubarb wine. You'd go sample some Bischtangle. Well, anyhow, you wouldn't think that would be what they would be doing in places, this religious-type group of people, but they have very good food. We were eating in one of those places that was set up to handle a whole group, and we had people from the contractor and our group of people, you know, from my division, and probably somebody from the program office.

I know one of the waitresses, they knew that there was an astronaut in that bunch, and they were looking everybody over. They couldn't decide, you know, I guess, some one came up to me and said, "Which one is the astronaut?" I said, "That bald-headed old fellow right there." [Laughter] Anyhow, Tom was bald-headed way back then. Well, they found out who the astronaut was, and they seemed very happy. Oh, that was great. And I presume they got his autograph and all that sort of thing. It was a good affair.

RUSNAK: Great. I'd also like to ask you some about some advanced communication systems, like you looked a little bit into optical communications. Can you tell us what that involves?

SAWYER: Well, optical communications. I mean, the only reason to go into optical communication is that you need a very wide bandwidth. You have a lot of information to send, and that's how we went into the S-band. We had a lot of stuff to send. It was too narrow when we got into the next program, called Shuttle, so we went to the KU program, KU-band, a wider bandwidth. As you get out of the RF world, you get into the optical world, and it can take a tremendous bandwidth. The communication companies are really getting into that sort of thing and they're using cable, fiber-optic cables, and they can put a

tremendous amount of information on. They can handle the cable TV and they can handle your telephone and all sorts of things.

But it really had no tremendous application, as far as we were concerned, an application that we might have, and we did a contract in regard to a laser communication. Not laser communication. A laser radar. It was with the Cubic [phonetic] Corporation. It was one of the things that was going on when I left. When I left, I recommended that they cancel the contract, because they were very up to date in regard to getting rid of money, they were ahead of schedule, but as far as getting accomplishments, they were way behind schedule. What they did, I have no idea. I wasn't there.

We did have other laser things. We had a laser range early in the ball game. It was over in Building 14, and that long thing off to the side was full, a laser tunnel, and it was in there. It was a cylinder about as big around as this room and had a track in it, and it could be evacuated. That was not exactly my idea; it was my boss' idea, who I had just inherited. It was Barry Graves who was working in the ground system. When he got through with the ground system, they sent him to MIT, and then when he got through there, he came to work down here. He was a director, and my group of people were put under him. We did come up with a laser range.

We had a few programs there, and some people in headquarters really were “foostering.” They were giving me money to do laser things, and I knew that the Electronics Center was to be put in the Boston area, and I knew that as soon as they got that, that money would dry up, so why get into that too heavy. I turned down a lot of money. We did some things. I know we had a sun pump laser and various laser communicating things. But then I guess we irritated them by cutting down, and he admitted, "Yes, well, when they come about, that’s where we’re going." I said, "Well, I can't build this up and then the bottom come out. What do I do with it?" So we gave up part of our antenna range to put in a laser facility, which didn't have a tremendously big application.

One day we may very well be using optical devices, laser radar, in other words, for rendezvousing or for other close measurements. May very well be. But I don't envision a tremendous amount of that sort of thing in the near future.

RUSNAK: You mentioned the Electronics Research Center. That has sort of a controversial history. What were your thoughts on that?

SAWYER: Well, my thoughts were, fine, if that's what you want. There were certain things that could be done, that could be spun off from that to the other centers. However, the other centers were very much against that because they all had electronic capabilities of different sorts. I would imagine JPL would have been very much against it, but I don't know that.

As far as I was concerned, I believe I could have lived with it or lived without it. It really didn't matter a great deal to me. It would have been the research. We were doing research also, and it would have cut that back quite a bit, so I suppose down deep I might have sided with everybody else and not been terribly upset when it was disbanded. It appeared to be a place to feed their neighbor, which was MIT. Probably some of the other universities were against it, too. I don't know.

RUSNAK: Moving on to Skylab, what was your involvement with our first space station?

SAWYER: Well, we did provide, as I mentioned a little bit before—well, it was a big place and we, I am sure, put in about a dozen ports for intercom and probably an audio system as an intercom, and then we would put in a teletype affair so you could send messages up and no one have to attend it. Those are the things that I recall that we did. Offhand, I can't recall any other things. It's too bad we didn't put the means on it to give us another few years up there. It would have been probably better than what we have been using, the Mir.

RUSNAK: After Skylab, we had the Apollo-Soyuz Test Project mission, which you were using some Apollo hardware, but obviously with it having interaction with the Russians, that probably provided some new areas for you. What was your involvement there?

SAWYER: Well, we built another radio at 121 or so megacycles, which was their frequency, and we could converse back and forth on it. Then we volunteered to give them our 296. Well, it was 296.8 VHF AM. Theirs was VHF FM. We had a 296.8 MHz VHF AM. It was in the form of voice and also ranging. In other words, another one of those on the vehicle could be used as a transponder for ranging purposes.

So what you had, in essence, was two simplex systems, push to talk, in other words, but if one side got on—if they got on one frequency and we got on the other frequency, then you had duplex; you could both talk back and forth. So that was fundamentally the communication system. We had probably a drag-through cable or something when we had first docked, you know, for communicating. We had people over there from my division many times in Russia. They became real buddies with some of the people. You know, no matter who it is, you can be friends, even if you don't really understand them.

Then we had a dozen Russians in our laboratory [for three months], our electronics systems test laboratory, where we were evaluating the operation of the system, and we had ground stations as well, of course, complete systems. It could be done there better than anywhere else, and they were very well organized. They were never late for work, and they and our people had a meeting every morning as to "Here's what we're doing today." I was impressed with the Russians. They did very well.

RUSNAK: Did you have an opportunity to go to Russia yourself?

SAWYER: No, I never did go to Russia. I remember one group that was over there and they telephoned back and said, "We're in London," or some place. We had just put mines in one of the harbors over there, among the enemy. They said, "Should we go on?" And the answer was—I guess they called the State Department, I don't know, but anyway, the answer was, "Yeah, sure, go ahead. If they kill you, we'll kill a bunch of them." [Laughter] So, anyhow, but the people kind of enjoyed their trips over there because it was different. And they had get-togethers here. One of the things you could always be sure of in a get-together here, they'd have boiled potatoes and butter. [Laughter] And vodka.

RUSNAK: Do you remember any particular technical or even personal issues that came into play during ASTP, from your perspective?

SAWYER: No, I don't remember that we had any tremendous issues, technical issues or nontechnical issues that were a problem, as I recall.

RUSNAK: Perhaps any advice for those people working now on the International Space Station with the Russians, from your experience there?

SAWYER: Well, we're in a different circumstance. Actually, another branch of the government and the head of our government has arranged for us to do what we're doing, and it's kind of a bailout. We're interested [there] in not making money by selling things that they have, and the technology that they have to certain other places, and I guess we're paying the price. From a space-only standpoint, it's a losing cause. However, from an overall standpoint, that's out of my pay grade. I don't know if it's a losing cause or not. [Laughter]

RUSNAK: With the Space Shuttle, obviously we're going to have a new vehicle here that's completely reusable. That was the thought in the first place. What challenges did this reusability have for you?

SAWYER: Well, equipment has to last longer, and the things that really get to you as time goes on, if something is going to fail, it'll fail on the first flight. It usually doesn't with us because we test it so much and we go overboard in—we don't go overboard. We test it for things greater than it's going to see.

However, for longer flights, I think the vibration problems—and there's a lot of vibration on the vehicle—temperature problems. Vibration and temperature probably are the things that could give you the most problem, and I guess they've been pretty well taken care of because I don't think that there's a big problem with equipment failing.

Every now and then a computer fails. I don't know. I am not into that. I wasn't working in computers. Of course, everything is computers now. I don't know what causes them to fail, but that, as I recall, is the device that's failing most frequently. They have upgraded those and they haven't been failing lately. It's kind of amazing, you can keep using it, you know, and it's not babied. It's used. The vehicle's used pretty roughly, because it has to be.

RUSNAK: Was the technology from your division at the time state of the art or pushing that edge, or how would you describe that?

SAWYER: Well, actually we were pushing the state of the art when we used a research frequency [KU band] for the program, and we were planning, at the time I was working in JSC, to get into KA-band [for the space station]. For one reason or another, Lewis Lab was put into a communication area, and they had a satellite that they put up. We were planning to

use KA. I don't know whether they use KA-band or not in the satellite, but we were planning to work with them on that. That would have been pushing the state of the art, because KA-band back in those days was—well, the research frequency, like KU-band was in the previous program [shuttle].

Yes, actually we had no choice. As time went on, we had no choice but to be in the state of the art. As a matter of fact, when we moved from the temporary buildings to the site, the building I was in was 15 at that time. We had transistor-making capability, and it held us up for a while to get in, because the chemicals used are not at all good for people. It had to have a separate air-conditioning system. We were making transistors in various applications that we were using, and that was very true when we were doing the DFI, development flight instrumentation, and other programs we were doing.

We were also building, shall we say, better televisions in our laboratory, and we came up with the—well, we used a color wheel in television, and that was the old, old CBS system way back then, that flunked the course and you didn't have it in your living room. You would have had a color wheel in your living room. Well, we reversed it, because we could save weight that way in putting a color wheel in [the camera] and made a simpler television system than you would have if we had gone with their system [color wheel on the receiving end].

We put the complexity on the ground, and we had on the ground what we called a colorplexor. It was as big as a piano. We didn't try to make it terribly small. The first one we built had failures every now and then, and we had an engineer with it all the time [during the flight]. We built a better one, and then we decided this is no longer an engineering feat to stand by it, and we turned it over, and the people who took it was the photo lab.

They were nervous that they would be blamed [for failure] and all, so I had an engineer there during the time it was going to be used for all flights. As a matter of fact, they went even further and they even had me sign a piece of paper that I guaranteed it was going

to work. I'd sign it, and it saved an argument. Just write your name down. If it hadn't worked, well, it didn't work. I didn't meet my guarantee, I guess. [It worked on all flights.] I don't know what they thought that paper was worth. But anyhow, that's why we did it, to put the complexity on the ground.

RUSNAK: Obviously on the ground, size isn't a big deal, but on board, size and weight are very important, and not only for Shuttle, but obviously for the earlier programs.

SAWYER: Oh, yes, that's why the ground stations have a 10,000 watt transmitter, and we have a 10 watt and a 20 watt. I mean, we don't use the 20 watt very often. I'm going back to Apollo, of course. Then they have the 210-foot dish and, I don't know, we had a much smaller than that dish.

RUSNAK: What were some of the other ways you came up with to decrease the size and weight of the onboard components?

SAWYER: Well, as you decrease size in some electronics, you can have interference between—in one box you can have interference, so you make it as small as you can and you have the shielding that's required. As you're making things smaller, you're raising the temperature points. In the old days we had problems with transistors burning out because of temperature problems. So the temperature and self-interference, I guess, in making things smaller is one of the things you have to take into consideration. There's tradeoffs both ways.

RUSNAK: So how would you overcome that?

SAWYER: Well, you have good heat removal wherever you put it. We had a development program at one time, using a power tube. I've reached another mental block. I can't say. But there is a device that—well, anyhow, it's the change of phase of a liquid that—well, anyway, we were using—it's a very well-known—[heat pipe]

RUSNAK: Sublimator?

SAWYER: No. You probably could buy one in a novelty store to cool your coffee. You stick it in there and it would cool it right away. Well, anyhow, we were working on different ways of lowering the temperature. As a matter of fact, I worked with my son one time using one of these [heat pipes] that he did in a science program, a very simple thing, and the one that I procured was for a temperature different than you would use there, but we used hot water. It would bring boiling water down to a very low degree in a short period of time. That was a long time ago, so they've been around a long time. But I can't say the name. Well, I've said the name of everything else today, so—[heat pipe].

RUSNAK: You remained here until 1989.

SAWYER: I retired in '89.

RUSNAK: So during that period of the Shuttle operations, do you remember any of the flights that stick out in your mind, either good or bad, related to your job?

SAWYER: The flights, all the flights?

RUSNAK: Shuttle in particular.

SAWYER: Well, of course, everybody remembers the Challenger. That was not a good memory. I guess that's the one that stands out. We were again shut down, you know, for a period of time as we were after the fire, and there was a great deal of soul-searching. It was the people who had the things that can explode and so forth, that had the greatest problem, but we had to go through all of our paperwork and make sure that everything had been done that could possibly be done to alleviate there being any other possibility of anything of that nature. It was a long, long process, and it was a process of everybody knew it was important and had to be done, but it was not an exhilarating process, let's put it that way. It wasn't exhilarating for the reason we were doing it, you know, the past reason we were doing it. But I guess that we looked at it as necessary for the future reason we were doing it.

RUSNAK: What was the impact on your division?

SAWYER: Well, we had to spend the same amount of time that the other people were doing, going through all of the work that had been done before.

RUSNAK: Why did you choose to retire when you did?

SAWYER: Well, it got so I couldn't sit at my desk, I couldn't stand at my desk, and I had to go have a second back operation. I'd had one previously. My boss was Henry [O.] Pohl at the time. Well, he said I could just go get an operation, see how things worked out, and then come back to work after a while. I told him, "Well, I've been here a long time. If I go have a back operation, I'm in great shape, I may just stay on. Today I'm in a mood to retire, so that's what I'm going to do." So I retired.

I went in the hospital—well, it was within a month of that time. Well, everything worked out okay. I walk a little different than some people as a result. Anyway, I'm a lot better than a whole bunch of people. I think everybody's in good shape if you don't have something real debilitating, if you have cancer, anybody in your family has cancer or some other real debilitating problem. So you're lucky if you're not in that shape.

RUSNAK: So what have you been doing in the meantime?

SAWYER: Well, my wife is involved with Meals on Wheels, so I get involved in that occasionally. We've been on several cruises, went to Alaska, been to the Caribbean a couple of times, and I was planning to go to—well, I was interested in going on a trip. I belong to the Senior Friends, which is at Columbia Hospital, and they have a lot of big trips. We've been on a lot with them. They had one that was going to Athens and it was going to the islands in the Mediterranean, and I was really interested in that. Then I found out the itinerary. You get on an airplane in Houston and you go to New York and you jump on another airplane, get off in Athens, and I decided, well, that's too long for me to be on an airplane. Then I came up with, well, there's a way around that. I'd just take a flight today, and tomorrow I get up and get on the airplane. But I decided, well, I'd just go on trips where I stay with a group.

Prior to that trip, I had been on a bus trip with another group of people that I belong to. NASA has NARFE—National Association of Retired Federal Employees. We have several trips. We had one to the plantations on the Mississippi. When we got somewhere in the region, we stayed just south of—oh, boy. This is my second—can't remember a name. It's where LSU [Louisiana State University, Baton Rouge, Louisiana], the city where LSU is. Anyway, we were south of there, staying at a motel, and I got sick. It turned out that they put me in a paddy wagon, an ambulance, and took me to the hospital, and everybody else went

and toured the museum and the houses. Well, the analysis was that my heart had stopped, and it stopped for, I guess, a good reason. I fell and so forth.

So I asked my doctor—the church I go to, we go on work episodes in various and sundry places, and one was in Costa Rica. I asked my heart doctor, "Hey, Doc, can I go to Costa Rica?" And he said, "No, you'd better not go. Their facilities there aren't all that good." That was before I had a heart operation since that time. So I don't know, maybe I can go on some of those, but if you're going to a doctor, you might as well do what he tells you, what he advises, because he knows better than you do.

RUSNAK: You've certainly been leading a fascinating life. If you look back on your career as a whole, what would you say the greatest accomplishment of your career is?

SAWYER: Well, I think the work I was doing in Polaris was the greatest accomplishment, because that was a race we couldn't lose. [I enjoyed and appreciated the opportunity to work on Apollo, which was one of the greatest feats of the century.]

RUSNAK: And your greatest challenge?

SAWYER: Well, I guess that was, because I had to work with this contract [Polaris work previously described], I had to work with the Air Force, I was using their money with their contractor, and I was delivering to another contractor, and that became a challenge. That was teaching you how to get along with people. If you're using their money, you know, you have to be—well, you have to be diplomatic, I guess may be the term. Everything has turned out reasonably well during my working life.

RUSNAK: We appreciate you sharing that with us today, and we thank you for coming.

SAWYER: Well, I thank you very much. You're very patient people for somebody just spewing out information.

RUSNAK: Before we wrap it up, I would like to ask both my colleagues if they have any questions for you, if that would be all right.

BUTLER: I have just a couple. You had mentioned earlier that you liked being on the East Coast and that your girlfriend, and then wife, had a lot of family there. What did you think of the move to Houston?

SAWYER: Well, there were rumors about going other places. There was a place in Florida that I would have voted for if anyone had a vote. My wife, I was concerned mostly, because she thought it was snakes and sand and this sort of thing. When they came and got our furniture, it was snowing. I wasn't really thinking they would come, but the furniture people, it doesn't bother them any. We had about a foot of snow, it was cold, it was blowing, and she went then to stay over with her sister when the furniture left, in Norfolk, and I drove down to Houston and found a place to stay.

Then I came back, flew back, and we went down on the NASA shuttle. Her sister was there, and they were unhappy about our leaving. She wasn't very happy. We had two children. One was about two and a half years old. The other was three months old. When we got down to Houston, we stayed in a motel until our furniture arrived, but the day we went out to go in the house and set up housekeeping and putting the furniture in, it was February and it was 85 degrees and the sun was shining. It was a day like yesterday was. She decided that it's not at all bad. She liked it pretty good. Our children's health—they had

bronchial problems where they'd been, and it improved. But it was a temporary improvement. So it turned out not all that bad.

I knew Houston. I'd gone to Houston. I was at [Texas] A&M, and I'd go to Houston occasionally on a weekend, so I was familiar with Houston. I didn't think it was all that bad. I wasn't terribly apprehensive. But I rented, just in case we decided we didn't like it. We rented for two years over near—it was in Meyerland, near Meyerland, near the shopping center, and we utilized the Sharpstown shopping center. It was a great place. It was the only one covered [and air conditioned] in those days.

I still commuted when we went into the center here, and it was in 1965 we moved to Friendswood, and we've been there ever since. We do flood. We didn't flood until 1979, so we were there a long time without flooding, but everything built around. I'm still thinking about moving someplace. I've been thinking about it for a long time. But maybe I'll implement it, now that the—it was decided they would take care of the problem with Clear Creek about thirty years ago, and they had I don't know how many studies. They've come up with another three-year study, and, of course, the people downstream don't want anything done to Clear Creek. But if something isn't done, I guess Friendswood will become a pond, or some people in Friendswood will be in a pond.

BUTLER: Hopefully that won't be you.

SAWYER: Well, it will if I stay where I am. I just haven't found a place that I wanted to go, and I'd like to stay. There's two or three houses up the street, and I'm looking into a "for sale" sign on those places.

BUTLER: One last question from me. When you first started out, would you have ever even thought about where you would end up, where your career would take you?

SAWYER: No, I figured I'd be in the Boston area forever. [Laughter] You know, early, until I went to Virginia. I kind of like living in the climate that we have here. People up North say, "We like the changes and we wouldn't want to go someplace where you—" We got changes. I mean, you know. We got changes. You know the difference between summer and winter here, and we have a spring and we have a fall. As a matter of fact, April and October, those are the two months. April and October. [Laughter] But you can do a lot worse than this area.

BUTLER: I'm glad it's worked out for you.

SAWYER: Well, good. Thank you.

BUTLER: Thank you.

SAWYER: How do you like it here?

BUTLER: Especially this time of year, it's pretty nice.

SAWYER: Where are you from?

BUTLER: I'm from Colorado.

SAWYER: Well, you're from cold country. Everybody's close by.

BUTLER: It is.

SAWYER: And you've been back occasionally. Well, we went back to Virginia this year. We had a big family reunion and we had over forty people there. It worked out perfectly. Had just enough planning done to work out well, and we all stayed in the same motel, and it was a great place, great place to eat. Then we really had our reunion at a place nearby, which one of my wife's nephews has, and he had a big swimming pool, took care of all the little kids. They could do their thing. We had barbecue, had so much that we went back the next day and had some more.

BUTLER: That's wonderful. Thank you very much.

SAWYER: Okay.

RUSNAK: Sandra, do you have any questions?

JOHNSON: No.

RUSNAK: Okay.

[End of interview]