NASA JOHNSON SPACE CENTER ORAL HISTORY PROJECT
ORAL HISTORY TRANSCRIPT

THOMAS V. SANZONE
INTERVIEWED BY REBECCA WRIGHT
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WRIGHT: Today is August 23, 2011. This oral history is being conducted with Tom Sanzone in Houston, Texas, for the Johnson Space Center [JSC] Oral History Project. Interviewer is Rebecca Wright, assisted by Sandra Johnson. This is a continuation of Mr. Sanzone's oral history that began on July 26, 2011. We thank you for coming back.

SANZONE: I'm happy to be back.

WRIGHT: Last time when we talked we pretty much went through a lot of what you did during the Apollo program. We know that you started in 1968 and continued through the Apollo program. We thought today we could work through the years that were between the end of the Apollo program and the actual Space Shuttle era. Tell us how you became involved with the Space Shuttle and what were some of the first tasks that you had working on this new spacecraft.

SANZONE: Do you want me to talk any about from the end of Apollo up to Shuttle?

WRIGHT: Sure.

SANZONE: Okay. The immediate program that followed Shuttle was Skylab. My expertise and experience had been in portable life support systems on the Apollo program. Hamilton Standard

bid on but did not win the EVA [extravehicular activity] system for the Skylab program. We had built all of the ground support equipment for the space suits and the life support systems for Apollo. We also had a lot of experience in helping training the crews, and maintaining the training equipment that they used.

Our NASA manager Harley [L.] Stutesman decided that he didn't want to give up all the experience that we had. Many of our folks were actually laid off after Apollo, but there was a relatively small group of us that he wanted to retain, primarily because of our experience. He had experience working with us, so there was a small contract generated for us to maintain the ground support equipment that was being used and to also assist with the training equipment for the Skylab astronauts. So I participated in that. It was certainly at a much lower level than I had done in Apollo, but we were trying to hang on until the future.

So when ASTP came around, we had very little to do with that. I do remember working on miscellaneous things like the Emergency Oxygen Mask Assembly, EOMA; it was used if they had smoke in the cabin or something like that. It was a much lower level of support, but I think they actually ended up using those masks at one point in the program.

Once Apollo-Soyuz Test Project was over and Skylab was over, now we were really into a hanging-on pattern, and Hamilton bid on and won a contract that was called MIST; the M stood for MIUS, modular integrated utility system, and then it was an integrated systems test. And it was a program where NASA was actually the subcontractor to Housing and Urban Development [HUD]. It was at the height of the energy crisis and [long] gasoline lines. HUD knew that NASA had expertise in integrating systems.

Our expertise was in integrating life support systems, but they wanted an integrated utility system. By integrated, it meant for example when you burn the trash you put heat

exchangers in the exhaust stack of the incinerator, and then you took the heat that was transferred and you heated up water, and stored it in a large tank. The whole idea was to smooth out the utility demands, because utility systems are built for the peaks. People get up in the morning and do laundry and take showers, and the utility systems have to be built for that peak, and then once they go off to work the demand is much lower. The idea was to try to level the peaks, or smooth the peaks out as much as possible.

We had two big storage tanks. This MIST program was a relatively small scale, although from NASA terms it was very big scale compared to working on the life support system. It was done in Building 32J, which doesn't even exist anymore, out in back of the Space Environment Simulation Laboratory [SESL] building. I don't want to call it a shed, but it was a very big shed, and it had a control system, a major control system. It had a diesel engine generator. It had hot water storage and cold water storage and all kinds of control systems and pumps, and an incinerator with heat exchangers in the stack. Several of us worked on that program.

I remember the amount of the program, but it seems like a ridiculously small number now. We did the whole thing for $700,000, including buying all this equipment, diesel engine generators and control systems. That was a while ago, 35, 36 years ago. I was young and single, and I wasn't particularly worried about the future, but I should have been more worried than I was. So we hung on. Then during this time period in the mid 1970s, Hamilton Standard was in the process of bidding on the Space Shuttle Extravehicular Mobility Unit [EMU].

In the Apollo program there were actually two contracts, two separate contracts, for the EMU. The suit, which was done by ILC in Delaware, and the life support system done by Hamilton Standard. It was truly portable, and had straps and hoses that came around and plugged into the suit—so that was Apollo.

When Shuttle came along, NASA said we want to buy one integrated system, one EMU. So Hamilton Standard, ILC and Air-Lock, [Inc.] which was the company that made the helmets and many of the metal connectors on the suit and the life support system, they joined as a team. I still remember the proposal theme. It was, "The best of Apollo joined for Shuttle;" that was the theme.

There could only be one prime contractor, so Hamilton Standard was the prime contractor, and ILC was a major teammate, and did virtually all the suit stuff. Hamilton did all the life support stuff, and also the integration, which NASA had done, integrating the system. NASA had done the integration in Apollo and they didn't want to mess with it in Shuttle, and I didn't blame them. In approximately 1977 Hamilton was actually awarded that contract, and that really started us on the road to the future.

I don't think I told you the other day, but I was living in an apartment, because every year I thought was the last year. I ultimately never bought a house until I think 1981. About 1981 I thought, "I think I'm actually going to be here for a while." I'd already been in Houston for 12 or 13 years. It was as a contractor in the pure contractor sense, like you're going to be here for Apollo, a couple years. Even my first assignment was for a year, they said a year, maybe a year and a half, in Houston.

So around '77, Hamilton won the prime contract and the development work started. Almost all the development activity was at our headquarters in Connecticut, so we still had a skeleton staff in Houston. We certainly weren't going to lay anybody off because we knew we needed to start ramping up to be able to do all the things in Houston that we would need to do, so it was a lot of travel of folks up to Connecticut. The folks in Houston had most of the hands-on

experience of dealing with the system level equipment and the astronauts and training, so we were involved in the proposal process from that aspect.

There were a lot of trips to Connecticut. Story Musgrave was the astronaut who was assigned to assist in the development of the EMU, so we got to know Story really well. We made many many trips together, all of us, primarily up to Connecticut, and those folks came down here. Around ’79 or so initial hardware was starting to arrive in Houston, and we started doing the hiring process.

In aerospace it’s always been cyclical. I’ve said to folks you’re never properly staffed. You have too many people or not enough people. This was a time period in the late ’70s when it was difficult to hire engineers. I was still managing a small group of, I think we called it, systems engineering. There was an engineering manager. Somewhere along the line he decided that he didn’t want to do that job anymore. He was really a good engineer, but he was working his tail off. He went to our project manager and said, “I want to be an engineer, I don’t want to be an engineering manager.” So this project manager came to me, and maybe with the NASA project manager that we were working with too, and they asked me if I would become the engineering manager. I was really intimidated to tell you the truth, because this guy who I was going to replace was a tremendous engineer, and I wasn’t a tremendous engineer.

I expressed some concerns and some doubts. It wasn’t like the typical promotion, yeah, great. I really didn’t feel qualified to do it, particularly compared to the job that he had been doing. He had been doing such a good job. So I said, “I’m nowhere near the engineer that he is.” I still remember the comment that I got back from my boss, project manager, and the NASA boss. They said, “We’ve got plenty of engineers, we need a manager.” So I thought okay, I can try to manage. I literally—and I’ve shared this with other folks over the years, because I saw

how much engineering he was doing, and I knew how little pure engineering I was going to do—I actually felt a little bit guilty that I wasn't going to have anything to do. That lasted for about two days, and for the next 30 years I was busy.

We actually had a very large group of people in Houston. I think I had somewhere between 50 and 75 people at one point that were working under me in our engineering organization. Of course we had suit stuff and life support stuff, and we were doing a lot of testing. All the certification testing of the hardware occurred in Houston. We had thermal vacuum chambers over in Building 32 in the Space Environment Simulation Lab; we were doing testing over there. Then we were training astronauts.

I'm jumping ahead a little bit, but up until the end of 1985 all the EMU processing, prep for flight, all the chamber run training, all of that was done by Hamilton Standard and our team with ILC. We didn't have any Air-Lock folks based in Houston. It was primarily Hamilton and ILC folks. We were doing all of this activity, all out of Building 7.

Matter of fact, there was a concern at one point that the number of people that it was going to take to do all this processing was just going to burst at the seams and cost a lot of money. I remember my boss Fred [Fredrick] Keune [Jr.] starting to understand learning curves. We all talk about climbing the learning curve. Well, there's actually a science to learning curves. I'm not a scientist of learning curves, but I remember he had a little slide rule type thing. Basically it said—to oversimplify this—whatever it takes you to do the first time, the second time it takes you X percent less, and the third time Y percent less. The learning curve actually comes down, and the number of people that you need is also—if you're processing your tenth suit, it's not one tenth of everything that's happened before, it's actually much less. If you

compare the first processing to the tenth processing it might be 20 percent of what it was the first time.

I remember us having to sell NASA management on this philosophy, because they were about to choke on the perceived costs or what they thought the costs were going to be, if it was a direct relationship between the effort of processings and the number of times that we were going to have to process. It was interesting from a business perspective, because we were actually having to downsell. Normally you're pushing for growth in a business, but we were going to price ourselves out of business if we couldn't get the cost per unit down. So we were able to do that.

Jumping back to the first Shuttle flight, I remember we did not have a planned spacewalk for the first several Shuttle flights. I guess even before the orbital flights we did the Approach and Landing Tests. We didn't have a whole lot to do with that. I think I remember vaguely working on some backup life support system, or something that they would potentially need. Once we got into the orbital flights it seemed like STS-1 was a long time coming. Matter of fact, somebody dug up a photo not too long ago. We all had beards. I think it was because we said, "We're not going to shave till STS-1" flew. Somebody found this picture from 30 years ago. But STS-1 was on the pad for a long time. It just seemed like they were always chasing something.

WRIGHT: Did you have a timeframe of when the first unit would go on board?

SANZONE: As I remember we flew EMUs on the first four Shuttle flights, but there was no consideration of doing a spacewalk. They were on as much as a backup life support system as

anything. One of the things that I got personally involved with as a test subject had to do with the fact that when Hamilton proposed the EMU, and this was not a requirement imposed by NASA. Hamilton's designers designed the front-to-back dimension from the front of the display and control module box (we called it) on the front of the suit to the back of the primary life support system to be 19 and three quarters inches. They advertised it as a special feature that they could get from the mid-deck where the suits were stored up to the flight deck through the opening, which is probably 20 inches. Because it wasn't a requirement, it wasn't a really big deal, but as we got into the program, obviously people wanted to know if we could really do this, if we had to, in an emergency for example. Could the guys come downstairs, get in the suits, and go up to the flight deck, pressurized, and fly the orbiter?

Somewhere along the line I was a test subject over in Building 9. For years people would come back to me and ask me, because I was the test subject, "Can you really do this?" My answer then and now was, "If the question is, could you physically get a person in a pressurized EMU, from the mid-deck to the flight deck, with somebody pulling and somebody pushing and you having no control whatsoever, because you had to go one arm forward and one arm back?" It could physically be done. Would you ever want to consider doing it? No. I wouldn't recommend that it ever be done.

On the first several flights, we had suits on board. I remember actually being at the Cape to do the STS-1 preflight interface checks between the extravehicular mobility unit and the vehicle. I was not down there initially, but my boss was down there, and our NASA project manager was there. I think they wanted to kiss this thing good night and be there when it was put away. It just kept getting delayed and delayed and delayed day by day by day by day. Seemed like for at least a week, ten days, maybe two weeks. Then finally they said we can't stay

down here anymore. I was in Houston, and they said you come down and manage this interface test, which we affectionately called the V1103 test, because that's the procedure number at the Cape [Canaveral, Florida].

I was down there with a couple of other folks. Even the day by day delays at the very end became hour by hour delays. They said okay, you're going to get to run your test, but we're at the base of the pad in a van. It just kept getting delayed. It was like 10:00, 11:00, 12:00, 1:00. At about 3:00 a.m. somebody banged on the van and they said, "Okay you're on." So we went up. We had an astronaut. I don't remember who it was. A Cape Crusader. We went through the whole checkout and com checks. Everything worked well.

One of my remembrances was being up on the swing arm on the pad and standing there looking at this vehicle that looked to me like the Washington Monument. It had been on the pad forever. Then, I realized that a week or ten days from now, it wasn't going to be there. It was actually going to launch. This was in the days of the white tank, the external tank, before we went to the orange tank. So that was getting ready for STS-1.

Since there were no planned spacewalks, we always had contingency spacewalks as possibilities, but we didn't expect to have to do that and didn't. I think we knew the first four flights were developmental in nature. There weren't going to be any spacewalks in the first four.

Story Musgrave, who we had worked with really closely in the development of the EMU, had been assigned to the crew of STS-6. Speaking for myself but I think all of us had this feeling that that was going to be the flight with the first spacewalk, because it was just natural. Story was on the crew, and he had done all the development.

Lo and behold, NASA management came out and announced that we were going to do the first EVA on STS-5, which really surprised us. So we got ready for STS-5 and the two EVA

crew members were [Joseph P.] Joe Allen and [William B.] Bill Lenoir. We were really excited about it. I remember our offices were in Building 7 right opposite the astronaut offices in Building 4. We had great big letters in the windows, "Go for EVA."

Then we had one of those things that happens at NASA if you're around long enough. We had technical problems in both suits. Both life support systems. In one system, the fan would not spin like it should. In the other system, the backup oxygen supply in what was called the secondary oxygen pack, the pressure had shifted slightly, a couple tenths of a psi. We didn't know why. We wouldn't have done a single person EVA in any case.

But it was technically a real bummer for us, because you had all this pride, and it was your system, and it was your time. It was a bummer. We took the signs down right away, and got a lot of egg on our face. Our pride was hurt. I did a leadership talk a couple weeks ago over at JSC. One of the questions I got from the audience was actually from a Hamilton guy, but one who had not been around then. He was asking me about overcoming challenges, or downers. His question I think may have been related to the *Challenger* and *Columbia* accidents.

He asked me something like if I had ever experienced anything personally on our hardware like that, and I said, "Yeah." I shared this STS-5 story. It was a humbling experience. It probably reinforced to all of us, just like *Challenger* and *Columbia* did, that it's a tough thing, what we're trying to do. It's really a difficult thing, and you can't take anything for granted.

So the recovery of the pride—not total recovery, I think that took quite a while—was we had to understand what happened and fix it so it could never happen again. We had two different problems. It was a very intense failure investigation. We had the head of human spaceflight for NASA from Headquarters involved. You get a lot of help when things like that happen.

To the team's credit and even now it strikes me how challenging it was, we fixed both of those problems and successfully did the first EVA on the very next flight, on STS-6. I don't remember how much time went by, so that was a real high. We went down to the valley, and then it was maybe not quite to the top of the mountain, but when Story Musgrave went out that hatch the first time, there were a lot of happy people. Story was the first one out the hatch. Then [Donald H.] Don Peterson went out behind him and they did the first Shuttle EVA. The pictures of Story way back in the payload bay, they were around for a long time and I still see them every once in a while. Obviously now we've done so many EVAs that we're back in the mode of—and I encourage the younger people not to do this—but you tend to take it for granted, until you think about how little you have between you and the harsh vacuum of space.

WRIGHT: Well, it was from June to November, those two missions in 1982.

SANZONE: June to November, wow, I wouldn't have even guessed, five months.

WRIGHT: Regarding STS-5, did you feel like you lost the confidence of the astronaut corps?

SANZONE: My immediate answer is no. I know that Joe Allen and Bill Lenoir had to be very disappointed—every astronaut wants to do an EVA, but this was the first EVA—and to be that close, in the airlock and suited up, and not be able to do it. But I don't ever remember feeling like we've lost their confidence. Now part of it was we had worked with Story for years developing the suit. Well, now he was going to be the first guy doing the spacewalk, and he wasn't going to do an EVA if he didn't think things were right. So I never really thought about it

till you just asked me. But he [Story] probably did as much to boost our confidence back as anybody could, because we were in it together.

The press can separate you or try to separate you, but one of the great things about NASA that I've always felt is it's a team, and it's a family, and sometimes you have a family member let you down, but you don't throw him out of the family, you try to bring him back in and help him. So we had a lot of people come together. We were very confident that we had found the problems and that the fixes were going to work.

I suppose we had enough confidence that we had gotten to the point of going out the hatch, except for these two things. Everything else seemed to work, so it was recovery. It was like flunking a test but taking the next exam. Maybe you have to take the course over again but you get an A or a B in the course. So I never felt that we lost the astronauts' confidence, but I never really thought about it either. It'd be interesting to ask them. Maybe you have.

WRIGHT: No, we haven't. But if we can, let's walk back a few years, because when Story Musgrave came on as an astronaut representative, he had already been an astronaut for a while. I believe he had done some work through the Skylab program. Then I remember in our previous conversation you had mentioned that when you first got here it was very interesting that so many of you had no experience at all, and you were pulling all this together. But now you were designing—as you have mentioned, you call the EMU itself a spacecraft. You were designing now with people who had had experience in space. Tell me about the differences of working through those processes of working with experienced people but yet on a whole new era. How much were you able to bring from Apollo into what you needed for Shuttle? But yet how much did you have to change to make it work?

SANZONE: Well, I think the interesting thing is that the people who were super young in Apollo, in their 20s, were now the same people in their 30s, 35, 40. Trying to think how old I was when Shuttle started. It was basically the same people, because my personal experience with people that worked and work in the space program is, it's not a job, it's a passion. It becomes your life. You never really think about leaving it. It's like breathing. It was many of the same people, although they were ten or 15 years older now, and had a lot of personal experience.

We brought younger people on. We hired younger people. I know we didn't give them as much freedom as we had. It just wasn't allowed. But the technology that was used in Shuttle from a life support system standpoint was very similar technology. The cooling systems, the heat exchanger was virtually the same, but was a little smaller, but the same technology was used. The same chemical was used. In the early years the same chemical was used to absorb carbon dioxide. We had a little more knowledge about batteries, so things could be a little bit smaller. But we had this integrated system now.

Probably the biggest change was in the suit. In Apollo the suit was all fabric. Had a zipper in the back, and you crawled in and you pulled the zipper up, and it blew up like an anthropomorphic balloon. The shape of a human. We strapped on this life support system. But in Shuttle the life support system, what we call the primary life support system, and the display and control module, were actually bolted onto the suit, and were semi-permanent. From an astronaut on orbit perspective, they were permanent.

We could take it apart in our labs. They couldn't take it apart on orbit, like they could separate in Apollo. The upper portion of the suit under the white fabric was called the hard upper torso [HUT], and it was fiberglass. It was like armor. Fiberglass armor if you will. In the

Apollo program the suit had a big zipper down the back. You unzipped it and you crawled in and pulled the zipper back up. In Shuttle the EMU separated basically at the waist, and you had pants, or what we call the lower torso assembly, that you put on first, and then you had the hard upper torso with the life support system bolted on and the arms bolted onto the shoulder bearings in the hard upper torso. The astronaut would literally put the lower torso on and then he would stand under this, what we affectionately called the short extravehicular mobility unit. He would crawl up through there and stick his arms through the arms of the suit, and then once he was settled in there he'd pull the lower torso up and make a waist connection.

I think the first big change that was made was back in the development days—it turned out to be very difficult for astronauts, particularly Story, to get into this hard upper torso. You were crawling through a tunnel. He had big shoulders. You had to see it to appreciate it. He would screw himself into this thing. It became obvious pretty quickly that we needed to make a significant change to the hard upper torso, so the biggest change was they actually shortened it. It was down like to your waist. They pulled it up maybe to your mid-stomach. It made this tunnel shorter that you went through. They made some changes in the scye bearings of the suit to be able to get your arms out through them.

The challenge was once the astronaut was in the suit you wanted everything to be as compact and as compressed as possible so that he could maneuver. You didn't want his arms to be sticking way out. You wanted the arms to be by his side as much as you could, so it was all a very big tradeoff. That was really the first big change that was made in the early days. By the time Story flew we had this redesigned hard upper torso.

As I said, most of the other technology was somewhat similar to Apollo. We had obviously advanced from Apollo electronics and communications systems and warning systems

that made Apollo seem a little bit crude. Generally speaking there were a lot of similarities—the things we measured, the temperatures we measured, and the pressures. I think the glove technology improved pretty substantially and continued to improve throughout the whole Shuttle program so that when you think about what astronauts were able to do with Hubble, it would have been virtually impossible with Apollo era gloves, and even real early Shuttle gloves. They were just too bulky to be able to do those kinds of things. So there was a lot of technology development put into the gloves by the folks at ILC.

WRIGHT: One of the differences between the Apollo and the Shuttle era is the fact that when the Shuttle began it was planned to have women as part of the astronaut corps. Was that taken into consideration?

SANZONE: Well, I skipped something that you reminded me of with your question. It's very significant. From a suit perspective in Apollo every astronaut had his own space suit. Virtually every astronaut. Every astronaut who was going to fly had at least three. He had a prime suit, backup suit, training suit. Those suits were custom-made, had their names sewn on the front. When Shuttle came along, NASA recognized that this is going to be a long program with a lot of astronauts, it's going to include women, and we can't afford to have a space suit or two or three for every astronaut in the program. When the request for proposal went out, the Shuttle suit was to be very modular. Sometimes people say, "Well, how many suits did you make?" We didn't really make suits. We made 20 left forearms and 30 upper right arms. The best way to understand it is to think of all these parts being in bins.

We would literally measure an astronaut like a tailor would, and then go to a bin and get the lower left arm that we thought would come closest to his size, and then the upper left arm, and we'd bolt those things together. Then we had some ability to do some tweaking to let it out a little or pull it in a little. Same thing with the lower torso.

Even the hard upper torsos came initially, I think, in five sizes if I'm not mistaken. Extra large to extra small. We had extra small, small, medium, large, and extra large I think. Somewhere along the line I think the extra small got dropped, maybe way downstream. But part of the request for proposal said we had to fit between the fifth percentile female to the 95th percentile male. That's a whole bunch of folks. So we didn't have to fit Wilt Chamberlain. But it was a lot of folks. Throughout the whole program the management of the logistics of all these parts was a major challenge, when you saw how many different parts you could pull in different sizes to comprise ultimately a suit with a life support system.

When the astronaut would go on board Shuttle, the public couldn't tell the difference. It was a white suit. He got in and did his thing. The women themselves weren't a challenge other than that most of them were smaller, so they were part of this fifth to 95th percentile thing. That was different. That was very different. I don't remember any particular issues with women per se any more than a small male maybe. Even then it wasn't an issue. It was just how you put the thing together.

WRIGHT: Mix and match the parts. Interesting.

SANZONE: I'm glad you asked me about the women because I had totally forgotten about that. We had people whose expertise was more in the life support system side, and then we had people

whose expertise was more on the space suit side. My experience had always been more on the life support side, so I didn't mess very much with the guys who were doing the suit stuff, because they were expert at what they were doing. They had their own challenges like those kinds of things.

I'm sure the pure suit guys could recall other suit issues that came up over the years that they had to deal with. I think they were happier with the metal connectors that we had rather than zippers. I didn't worry about suits at all in Apollo, because we weren't the prime contractor on the suit, but I know there were a few suit guys that maybe would wake up at night worrying about zippers and hoping that they would hold and not fail and not stick.

WRIGHT: On the integration of the life support system for Shuttle, I believe I had heard that [Harold J.] Joe McMann said his boss didn't want to see hoses anymore.

SANZONE: That's true. Yeah, that's true.

WRIGHT: Can you share how you all were able to create the integrated suit?

SANZONE: Well, I talked about the hard upper torso, this fiberglass. It actually had passageways built into it conformally to the body that basically tied the display and control module on the front of the suit to the big engine in the back of the suit. We had controls for the pump and the fan and the different communications modes that had to be integrated. Now obviously it seemed to be easier to integrate it with external umbilicals. It was an easier thing to do, but not as easy for the astronaut to deal with. Most of the heavy-duty design stuff like that actually occurred in

Connecticut, so I wasn't personally heavily involved. We had some really smart designers. They just took the challenge that they had, but it worked.

Joe McMann would, I'm sure, remember many, many more problems in the development stage than I would. From the times that I dealt with it it was a pretty reliable system. I don't remember particular challenges, but time has a way of helping you forget what some of those challenges were at the time.

WRIGHT: We digressed. I'd like to go back to your feelings when Story did come through the airlock. Was that a sigh of relief or one of jubilation?

SANZONE: Yeah, I think it was more jubilation. At least that's the way I remember it. I'm sure it was combined with a sigh of relief after what we had gone through with the prior flight. It's like, and I'm guilty of it myself, when I go to the Cape, and I am listening to the countdown, and there's so much I don't know about all these systems that are clicking along. Every single one of them has to work. Hamilton made several systems that were part of the prelaunch and those systems, you just hold your breath. Like auxiliary power unit startup—you just go, "Oh, I hope it works." You have all these thousands of engineers from different companies and different systems all at the same time holding their breaths from step to step, because they know how challenging it is for all this stuff to work at the same time.

I'm sure that we were holding our breath as we went through each step. When they said, "Turn the fan on," I'm sure we were thinking, "Oh please," because that's where we had had the problem. When they did the secondary oxygen pack regulator check, it was, "Oh please be in the right band." I'm sure there was relief, but I think it pretty quickly turned to elation.

This is a little bit corny. I'm not sure I recognized this at all on STS-6, but maybe years later. When that hatch opened and that astronaut comes out, it's almost like the Shuttle is giving birth to this astronaut. Particularly when they had the white thermal garment over the hatch, and it would flap open, and out would pop this little astronaut in a white suit.

I'm sure it was elation. It wasn't so much the recovery from STS-5 to STS-6. I know there was some of that, and I know there was some trepidation, hoping this thing works. It was really more the years, literally years of development. Here it is, this is it, this is the NBA final, game seven. You're out there. I think the fact that we knew Story, we had worked so closely with Story. His daughter even worked as an administrative assistant with us in the summer. I think some of it was even happiness for Story, that it was the culmination of all this work, and the irony of him actually getting to be the first guy to do the Shuttle EVA after he wasn't assigned to the first planned EVA flight and then we had the problems.

I don't know if I told you before, but actually I talked to Story about that, after STS-6. As you know, Story is pretty deep. He said, "Tom, the tide goes out, and the tide comes in." I never really forgot that. You just do your best and things will happen. They'll take care of themselves, and they'll be what they'll be. So yeah, we were pretty happy after STS-6, that's for sure.

WRIGHT: Through the design and development process, how important was it to have an astronaut be side by side with what you did?

SANZONE: I think it was probably more important than we thought it was at the time. It wasn't something we started out by saying we've got to have an astronaut to help us. You have all these engineers, and they think they have all the answers.

You asked me a few minutes ago about astronaut confidence. I think there was equal to the expertise and experience the fact that he not only represented the Astronaut Office to us, but he represented us to the Astronaut Office. If he had confidence in the hardware, he could convey that confidence to his fellow crew members in the office. I think that's something that I probably didn't recognize at the time, but obviously recognize later. There's nothing like having a guy who's been there and has that kind of experience. He had a lot of votes. There wasn't much that he suggested that we didn't end up implementing.

There have been other astronauts that have worked with us over the years. There's always been an astronaut at any particular time assigned to follow the EMU. But when you're going through the real development stage and building the hardware and taking inputs like—that HUT change was an expensive change, but it was pretty obvious that we needed to do it. It wasn't obvious until Story got involved. We had put people in there. But it became obvious that it wasn't just going to be difficult for him. It was going to be difficult for other people. We didn't want it to be difficult for other people. So yeah, he provided a lot of value to the whole design process.

I keep saying that most of the design activity was occurring in Connecticut. I honestly don't ever remember anybody knocking any of Story's comments. I just don't ever remember hearing, "Oh, he doesn't know what he's talking about." He had a lot of credibility. Then I think we also had this team approach where it wasn't an "us versus them;" it was us together making this thing be the best it could be. It was very rewarding having him involved.

WRIGHT: Talk some about the changes or advancements in the technology that you used. Before we talked about you used graph paper and slide rules. There were not fax machines. The elements of design changed as much as the design itself.

SANZONE: I guess probably the biggest change was everything was so much more computerized than it was in Apollo, not the least of which was monitoring the performance of the hardware. I'm a big [car] race fan. If you go back and look at races that were occurring 50 years ago, those were race drivers, and they drove race cars. Now today you look at today's cars, and they're so much more elaborate, and have so much more technology, but they're still race car drivers that are driving them. From that aspect it was similar.

I guess what I'm trying to talk to is, as important as the technology was and the development of the technology, most of the success came about in both programs because of people and their drive and determination. That never changed. That was a constant. The tools that they dealt with going from a slide rule and graph paper to a computer and strip chart recorders, that part of the technology certainly changed. But the people aspect didn't.

I still see the same—what used to be referred to after the Apollo program as the Apollo spirit. I still see it with the young people who work at NASA. I think that's what makes NASA such a special place. It's hard to put into words, but you talk to people and interface with people who work there, and they look each other in the eye, and they know what you're talking about, and it's just yeah, yeah, yeah. I'm not giving you a real good answer to the technology question.

In Apollo we used a lithium hydroxide chemical to absorb carbon dioxide. For years in Shuttle we used that same technology, lithium hydroxide canisters. Then we got thinking about

how when we get up on Space Station, to bring all this lithium hydroxide with us is a lot of weight and a lot of cost. So the experts went off and designed a system that we call metal oxide. There is an oven on Station and instead of carrying up pounds and pounds and pounds of lithium hydroxide chemical, we have this metal oxide system in the suit that can be baked out in an oven and then reused without having to use the chemical and carry the chemical up.

Those kinds of technology advances allow us to do things that we wouldn't even be able to do. You just wouldn't be able to bring up enough to make it cost-effective. Hamilton Sundstrand is now involved in many systems on the [International Space] Station. I didn't mean to jump to Station, but oxygen generator assemblies, water processors, and the ultimate integration, taking urine and turning it into water that can be drunk. We always used to bring our oxygen up with us in tanks, so now they have the ability to actually generate oxygen on board. So those kinds of technology advancements, we couldn't be doing the kinds of things we're doing now without them.

WRIGHT: When you look back at STS-4, the first step with the suits was whether or not they could get in and get out.

SANZONE: Your memory is better than mine.

WRIGHT: Had to refresh mine before you walked in. Then you had the not-so-good experience with 5, success with 6. Then afterwards they began to expand more what they could do with the EVAs. How did that impact how you guys did your jobs in Hamilton? What did you have to do to adjust to future expectations of what could be done during EVAs?

SANZONE: One of the things that we dealt with was we had to be able to do an EVA on every single mission, what's commonly called contingency EVAs versus planned EVAs. The most common concern that they trained for was if the payload bay doors would not close. You couldn't re-enter with payload bay doors open, so they had tools and winches on board where two astronauts could go out, do an EVA, manually close the payload bay doors.

I remember my boss saying one time that the human nature tendency was to worry about the planned EVAs, because we're going to go out. We have to do all these things, such as we've got to service the satellite. But my boss said the most important EVAs we have to be ready for are the contingency EVAs. Because with the EVAs to service satellites, if they were to be a failure for some reason, you'd lose a satellite. If you had a contingency EVA, payload bay doors for example, you'd lose the crew and the vehicle. So we had a mindset of preparing for every mission in the same way.

I know if you walk the halls over in Building 7, they have the great big photographs, it's one after the other of the first spacewalk, the first female spacewalk, the first satellite servicing, the first satellite retrieval, first, first, first, first, first. We probably had 20 different firsts and then we ran out of firsts. I remember we even had the first contingency EVA. I can't remember what the problem was, but the guys went out.

So I don't want to say it was routine, but our facility in Building 7 on the third floor in Crew and Thermal Systems Division was a processing facility that was constantly churning. Multiple shifts. For each mission we had to train the astronauts in vacuum chambers and turn the hardware around and get it down to the Cape. The logistics job became tedious, or challenging. We had a guy responsible for logistics just keeping track of everything and where it's going to

go and what's coming back when and what you do with it. The logistics really is the thing that I remember the most.

WRIGHT: When you began increasing the time of training with the pools, how did that change from what you had done previously?

SANZONE: I'm trying to remember when the NBL [Neutral Buoyancy Laboratory] was actually built [1997]. Over my career we were in several different water tanks. The first one was like a great big tub out in the "back 40" at JSC, called the WIF, Water Immersion Facility. Then we went to the Weightless Environment Test Facility, the WET-F, Building 29. Then when Station was coming around, they said we've got to have a much bigger facility.

The suits that we used for water tank testing, wherever it was, were identical design, but generally downgraded suits. We would never fly a suit that was in the water tank. So virtually every suit would start out pretty much as a flight suit or training suit, and then through wear it would get downgraded some. Then we had what we called WET-F suits. We did have some challenges with suits that were exposed to the water all the time. There was concern about degradation in the materials. So we had to refurb[ish], retest each WET-F suit after 40 hours of use, 40-hour maintenance they called it.

After it was in the water for 40 hours it had to be taken out and gone through. I remember there were some significant challenges with suit degradation in the water, but as I said earlier, the suit guys were worrying about most of that, and I was worrying more the flight hardware stuff. But they definitely had some challenges with those suits and overcame the challenges. When you stop and think about it, every challenge that came along was overcome,

because we never got to a point, not just in the EMUs but in anything at NASA, where we are, "Okay, we just can't solve this problem. We're going to stop now." It's the old [Eugene F.] Gene Kranz thing, "Failure is not an option." He was talking more about the ultimate failure. But even the small failures, it's just like, "Okay. How do you overcome them?"

It's just challenge after challenge after challenge and overcoming those challenges. I think that's where it goes back to the people. There was never consideration of, "Well gee, maybe we won't be able to solve it." That wasn't in the vocabulary.

WRIGHT: Well, a big challenge that the agency and the nation overcame was recovering from the loss of *Challenger* and the crew in '86. There was a downtime for the whole agency as things were looked at. There were opportunities -- to use that word -- to go back and improve, enhance. How did you use that time?

SANZONE: I'm going to back you up a month or two, because I've talked some about how we did all this processing of the suits over in Building 7. In the mid '80s NASA started doing contract consolidations and contract changes. The first significant one that I remember, not so much from a consolidation but from a change, was for orbiter processing at KSC. The orbiter had been built by Rockwell [International]. Everybody that worked on the orbiter at the Cape worked for Rockwell, and that's pretty much the way NASA had always done business. If you made the hardware, you were the guys that did the processing of the hardware.

So NASA had a procurement around 1984, I think it was. Lo and behold, Lockheed [Corporation] won the contract to process the Rockwell orbiter, which was a real surprise to everybody. That was really just the start I think, because the following year, the '84, '85

timeframe, NASA consolidated about 15 small contracts, generally small contracts and one relatively large contract into a single contract called the Flight Equipment Processing Contract. Well, the one relatively large contract out of the 15 was the space suit processing, the EMU processing. The other 14 or so contracts were like for food and medicine and clothing, something that we always affectionately referred to as the socks and jocks.

So NASA consolidated this contract and had a competition. Seventy percent of the value of the contract, or the time or the effort, was for the suit processing. Those other 14 or so contracts comprised 30 percent. To make a long story short, we lost that contract. We lost it to Boeing [Corporation]. Hamilton was still the prime contractor for the EMU as a manufacturer, but we were no longer doing the processing, just like Rockwell was no longer doing the processing of the orbiter at the Cape.

That was a downer for us to say the least, because we had several hundred people and we badge-swapped those people over to Boeing. The reason I backed you up from the *Challenger* question was that contract was awarded or announced in December of 1985. So we were going to go through this transition that was supposed to be a 90-day transition to Boeing, which we all felt was going to be extremely challenging, to be able to turn all this stuff over and still keep the wheels turning of getting EMUs on board.

WRIGHT: Of course this was a time that NASA had predicted that the Space Shuttle flights would be—

SANZONE: Higher than we ended up with for sure. So we were in the midst of trying to transition, and the *Challenger* accident happened. We were in this emotional state of losing this

contract—a different level—and now we'd lost a vehicle and a crew. I was here for all the flights of Apollo from Apollo 7. I wasn't here for the Apollo 1 fire, so I didn't personally experience that, so for me personally *Challenger* was something very different.

We talk about the NASA family, to lose a crew, and I had talked earlier about the downer of STS-5 not being able to do an EVA. Well, this was on a totally different level. This is losing an entire vehicle and the crew. It was really an emotional, a very difficult time. We were laying people off and transferring people, trying to recover from the accident.

Having said that, it was the spirit of NASA. It's the "never give up" spirit. Everything got looked at. That's one of the things that happens when you have something like that. Some of the old-timers say—guess I'm an old-timer—but the real old-timers of Apollo, I've heard some of them say if it weren't for the Apollo 1 fire, we never would have gotten to the Moon in the '60s. It forced everybody to stop, to look at what was going on, and to make improvements that they didn't think they had the time to make. Well, now they had to make the time to do it. Ultimately it made the program safer and successful. I think with *Challenger*, there was some of that.

I don't know any more than anybody else who has read the accounts of what led up to *Challenger*. I do remember as a very young project manager, not really knowing what managing a program was really about, working for a very experienced NASA program manager, Harley Stutesman, and him telling me that you have cost, schedule, and technical. Those are the three elements of the program. You can only control two of them. The third one goes where it's going to go. It's just my own personal analysis; the schedule pressure was intense.

I'm really saying this more from what I've read. I don't remember feeling any more pressure than anybody else as far as processing EMUs. There was always pressure to support the

manifest. But as far as the overall program, the schedule was very tight. You couldn't mess with the schedule. Then the money was starting to be tight, so if you had cost tied and schedule tied, then the technical is the one that free-floats. Then ultimately that's what bit them, bit us.

It's a lesson that gets learned over and over and over again by program managers. Remember the old term, "faster, better, cheaper"? There was a corollary to that that was "faster, better, cheaper, pick two." That's really that same thing that that experienced program manager had told me. You can't do all three. Or it's certainly a very big challenge. It's better to maybe pull in a little bit on the other two and provide a little bit more to that other leg. But the schedule pressure was pretty intense. It was a difficult period.

WRIGHT: Did your job change around 1986?

SANZONE: Yeah it did. It very much did, because my immediate supervisor, guy who had been my boss for 17 years, Fred Keune—he was a great mentor and I was very close with him and his family and his kids, and I'm still close with his kids—but after the loss of that flight equipment processing contract he took it hard. He just decided he was going to do something else. I'm not sure exactly when he made his decision, because the contract announcement loss was in December, and then was followed very quickly thereafter by *Challenger*. I'm sure he saw this as it was going to be a long time before there's a recovery, and I've been doing this for 20 years, I think, 19 years, he had been doing it. He just decided he was going to do something totally different. He moved to Florida and got in business with his brother-in-law. Eventually, he came back to Hamilton years later, never in the space area but in some other areas.

So I became the site general manager, project manager. I'm not sure what title we used back then. Boy, when I think back at it now, it's like what a time. I had no desire to go anyplace other than NASA, so the thought of leaving didn't really even enter my mind. I was in it for the long haul. I was in it for as long as they were going to let me haul. Effectively I had been his deputy for a number of years, so I was more confident than I should have been. Because one of the things that I've learned—and I coach some other folks that become deputies or are about to move from being deputies to being the guy in charge—there's a very big difference between being the deputy and being the guy in charge.

In my own mind, I rationalized that I had been his deputy for a long time, a number of years. I knew the job, I knew what it entailed, and therefore it wasn't going to be that much of a change. I was wrong. The part that I didn't recognize was you're the guy responsible for everything. When you're the deputy you're helping. He's making decisions that you don't have to make. He might ask your opinion but ultimately he's making the decisions, so that was an enlightenment because you're affecting people's jobs and lives. The stress to get new business—here we were going from several hundred employees down to 25 employees with a plan to really zero us out within two years. They were going to go 25, 15, five and then zero, just to do a phase-in. I think I'm glad I couldn't see the future, because it was a tough number of years.

I'd always been blessed with having good people that I worked for and good people that worked for me, and that continued. I had a really fantastic group of people that would just do whatever it took. From that aspect it made it very rewarding. We worked unbelievable hours. I was also very spoiled in that I had always been able to work the technical side of the job and not really worry the business side. I worried budgets, but I'd like to use the word underestimate but

that wouldn't be a strong enough word. I really didn't have a clue what the business pressure was going to be like.

Here I am running this Houston office. Guys in Connecticut are worried about profit plans. Everybody has a boss. I had been spoiled in that my primary effort over the years was in keeping my customer satisfied. I had bosses that allowed me to do that. They provided cover for me to do that. Some of the business took care of itself. I had one boss that I worked for in Connecticut, and he told me one time, because I was getting some pressure from his boss. He said if you keep your customers happy things will take care of themselves. Sounds simple.

That's what I always focused on. By doing that in a growth mode at NASA, you got more business, and the business grew. Once we got into *Challenger* and we're not flying, I greatly underestimated the pressure from above, "Well, we really don't care what happened, we've got to increase our profits by 10 percent this year. How are you going to go do that?" So I really had to grow up fast.

WRIGHT: Were you able to take training? Were they able to help you move into more of the business mind frame?

SANZONE: Hamilton was a great company to work for, but we were never really big on training. I think in hindsight that was a mistake, even when I was general manager. One of the first things to go is training. I've seen companies do it. I don't think this was limited to Hamilton. But my experience both from above and below is you tended to get thrown in the deep end of the pool. If you could swim, you survived, and if you couldn't, somebody else got thrown in the deep end.

I may have been a little too quick to knock training. I'd say from a formal standpoint not so much, but a lot of OJT [on-the-job training] learned from experienced people who I worked with and for, who were pretty darn good about sharing time, experiences. From that standpoint I actually got some very good training. I didn't get classroom training per se until later. There are things I learned ten years later and thought, "Gee, I wish I knew this ten years before. Oh, that's why we did it this way."

WRIGHT: So when did things start to change for you and for the company?

SANZONE: Well, up until 1986 except for that short period for Skylab where we did the ground support equipment maintenance and some of the training equipment maintenance and some of the approach and landing test stuff with masks, and then that modular integrated utility system thing for a couple years, except for that, the only thing we did was extravehicular mobility unit. Life support, space suits. That's it.

We were a field service department. Our headquarters was in Connecticut. We used their business rates, their cost rates. I'm going to step back a half step. When we competed for this Flight Equipment Processing Contract, after being—for me it was 17 years as a field service depot at NASA, which is one of the reasons I didn't get a whole lot of business training, because we were focused on doing this job, and somebody else in Connecticut was focused on the business aspect—we found ourselves unable, well, we knew we would not be able to compete on a pure service contract. See, we were servicing equipment that we had designed and manufactured, just like Rockwell was servicing the Shuttle. We knew we couldn't compete with the rate structure that we had from a hardware development manufacturer in Connecticut.

This was in ’85. We created a subsidiary company called Hamilton Standard Management Services [HSMS]. That was the buzzword of the day. Everybody had management services in their title. Well, the ultimate irony on that was we created it on paper. I think the thought was if we don’t win the contract we’re not going to go to this subsidiary company. If we do win it, obviously we will, and we have to. At the same time we were working on the proposal for months and months on this FEPC contract, our folks in Connecticut were bidding on another service type job in Houston to design early stages of Space Station environmental control and life support systems, and had a bunch of ground support equipment that had to be built.

Our engineering manager in Connecticut talked to my boss at the time and said we need to get our costs down to be able to win this thing, and I’d like to bid it out of this new HSMS company, because you guys are going to have lower rates. I don’t know how much thought my boss gave. I didn’t give any thought to it. He just said just go do whatever you want.

So we end up losing the flight equipment processing contract, we’re not going to institute this HSMS, and we get a call. Hey, you guys won this other contract that you bid out of this HSMS company. Which, oh by the way, you have no infrastructure now, because you didn’t win the FEPC job, and the guys that—this is my own whining here—the guys that bid it, bid it with the presumption that we had won this other contract, had a purchasing department, finance, payroll, all the stuff to run a business. The only thing they bid was the bodies. There was no infrastructure. I still remember talking to the business development guy in Connecticut.

Because now I had it [responsibility], because my boss was gone. It’s like, “Hey, now you’ve got to go do this job.” It was like, “Oh my gosh, right out of the barrel. Our rates are going to be crazy.” I remember him telling me, and I won’t even use his name, he said, “Our job is to win it, your job is to do it.” So the good news was we had lost a bunch of people to FEPC,

but we now had this, we called it tech demo. There's probably ten contracts called tech demo, but we had this Environmental Control and Life Support System Technology Demonstrator Program in Houston. It ended up being—just the ground support equipment was like over $5 million. It was big, it was really big.

Those were our first steps on the road. Then at the same time, and I can't even remember which happened first, about the same time, Rockwell came to us. At the time General Electric [GE] was the designer, the manufacturer and the supplier to Rockwell for the commode, the toilet system in the Shuttle. Hamilton had bid on that back in the '70s, '73, '74, something like that. Hamilton had bid on that and lost to GE. Well, you've been around long enough to remember how many times the toilet ended up on the front page of the paper with problems. Then the press and the late night TV would just—it was unmerciful. Well, as I understand it secondhand, GE executives made a decision that they didn't want to be in that business anymore. They were in the business of selling refrigerators. Every time they picked up the paper their name was associated with this toilet that had problems.

So Rockwell came to our vice president and said you guys bid on this against GE 15 years ago and lost, and asked if we would be interested in taking it over, because GE wants out of the business. Of course my boss, our vice president, said, "Sure, we'll do it." We took it over from GE, and we hired a few of their people, and we went through a transition. It was challenging, because we made a commitment to Rockwell—maybe I made the commitment. Anyway, we made a commitment to Rockwell that once we took it on, it would be ours.

You know the term Original Equipment Manufacturer, OEM, you hear used sometimes? We would effectively become the OEM even though we weren't literally the OEM. We weren't the original, and we weren't the equipment manufacturer. But Rockwell needed somebody

committed enough to not every time there was a problem say, "Oh that's GE, GE designed that," because GE was gone, they'd left the auditorium.

We made that commitment and for the first several flights we continued to have some issues. So we took some heat. I kept a folder on it over the years, because it was very humbling to go back and look at headlines in the paper. Within a relatively short period of time—I couldn't even tell you how long it was—we did something. We took an approach that I think paid off for us and ultimately for NASA very well, and that was my experience and our experience in Houston working on life support systems—we treated that toilet as if it were a life support system. We treated it the same way we treated our primary life support systems on the suit, that same kind of discipline. Within a relatively short period of time, several flights, maybe five flights, we got it to the point where we weren't having any failures. That particular thing, we did that to the end of the Shuttle program, Hamilton did the toilets in Houston. The toilet system was called the waste collector subsystem. That was the official name, WCS. The WCS was not a part of the Shuttle. It was a subsystem.

When the Shuttle would land the WCS would come off the Shuttle, and it would be sent back to Houston. We would do all the processing, some of it pretty nasty, but we would do the processing, refurbishment, prep for flight. We would ship it back to the Cape. There was one for each orbiter. We would ship them to the Cape. They would go into the [processing] flow at the Cape. That was a really successful program for us. Everybody was happy. GE was happy they were out of the business. Rockwell was happy that things weren't failing anymore. We were happy that it was a business and we had people working it.

That happened around the same time. Those were two programs that came out of the blue. Then what we did with our suit guys—the Boeing guys were doing the processing; our

Hamilton guys were responsible as the OEM, because Hamilton was the OEM. We had the engineering expertise. Any time there was a failure of a component, say a pump, Boeing's job was to say, "We ran this test and this failed." It wasn't their job to fix the pump or change the design, not that we had a lot of failures. The engineering aspects of the job were such that it became more obvious to NASA, I believe, that we really can't zero out this engineering workforce. So if you can hang on, things can get better, and we did that.

Then we had another thing. We had always been in Building 7, the Crew and Thermal Systems Division. As part of a contract renegotiation that we were going through with NASA, we were obviously going through give-and-take in the negotiations. My vice president at the time as part of this business deal committed to provide two engineers at no cost—he would eat the cost—to support the EVA Program Office in Building 1. We had never had anybody in Building 1. I think that agreement was for at least a year. It might have been two years, but it was at least a year.

We made a conscious decision that I never regretted. Where the tendency might have been to take two of our weaker engineers, because we're not getting a dime for them, and put them over there to fulfill this commitment, we made a decision to take two of our best engineers and put them over there. What happened was—and I'll use the year term—at the end of the year, those two engineers had done such a great job that NASA, the EVA Office, said, "You can't take these people back, we want these people, and we'll pay for them. Oh, by the way, can you send us two more?" We still, up until near my retirement, we still refer to that as the Building 1 model, because that group grew to over 15 people. Remember I talked about, satisfy customers and things take care of themselves? They did a very good job. They were very customer-

focused. The NASA people and the EVA Office, do what you and I do every day—you go back to a restaurant that you like and you tell your friends.

Those were three growth opportunities that happened around the same time, initially it was survive and then thrive. It was that way, so the business started growing again. We actually had some pretty impressive growth charts, when you look at them year after year. It's one of the things that I recognize particularly with success. [Walter W.] Walt Guy, who I know you know, coined a phrase, a very smart guy. He coined a phrase after STS-5. He was the division chief, so he was not a happy camper, and he was getting heat. He said, "Success is relative, failure is absolute." It's so true. I remember that not so much from the failure side as the success side. As you become more successful and growing the business, people don't see a change from yesterday to today. It's when you put a chart together over five years and somebody says, wow, I didn't remember that you were that small. You know what I mean? Some of our business reviews were almost fun, because that was happening.

Now with this engineering group, we developed a significant Russian interface group in Houston. The Russians were obviously responsible for their own space suit, but the EVA Office at JSC wanted to be sure that they had people on their staff who were not Russians who were knowledgeable of the Russian hardware and could convey a sense of confidence in the hardware. That grew pretty substantially. That Russian group grew pretty substantially.

WRIGHT: If you don't mind, because I know we're going to have another session. Could we pick up on the Russian stuff then?

SANZONE: Okay, great.

[End of interview]