ORAL HISTORY: Gene Strull

About Gene Strull

Gene Strull grew up in Chicago and became interested in electrical engineering at an early age while watching his father tinker with various electrical equipment. He began studying electrical engineering at Purdue in 1947, later attending graduate school at Northwestern, writing his dissertation on semiconductors. In 1954, Strull began his career at Westinghouse in the Materials Engineering Department, later moving to, and taking charge of, the Molecular Electronics Division. In 1981, Strull became general manager of the Advanced Technology Division, and in 1987 he became Vice President for Technology. Strull officially retired from Westinghouse in January 1993, having a facility named after him, but he stays active in the technology world.

In this interview, Strull discusses his career as administrator at Westinghouse and the various projects and committees he was involved with. Topics such as the lunar Apollo TV camera, work with NASA, tube lab in Baltimore, microwave chip project and various work with the IEEE including conferences are touched upon. Strull also talks about his move from Pennsylvania to Baltimore, and the atmosphere at the Baltimore plant. The structure of Westinghouse is also covered, as well as patents awarded to Strull, and his interest in defense work throughout his career.

About the Interview

GENE STRULL: An Interview Conducted by Sheldon Hochheiser, IEEE History Center, July 21, 2009.

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Interview

Interviewee: Gene Strull

Interviewer: Sheldon Hochheiser

Date: 21 July 2009

Location: National Electronics Museum, Baltimore MD

Background and Education Statement

Hochheiser:

It's the 21st of July, 2009. I'm Sheldon Hochheiser. I am here with Dr. Gene Strull at the National Electronics Museum in Maryland to talk to him about his career and about the Westinghouse Defense Electronics Division. Good afternoon.

Strull:

Good afternoon. I started my college education at Purdue in 1947 in electrical engineering.

Hochheiser:

Now were you a local Indiana boy?

Strull:

No, I grew up in Chicago.

Hochheiser:

And how did you find your way to Purdue?

Strull:

When I've known since I was about 13 that I wanted to be an electrical engineer. Not exactly sure why; my father was a window display man, but he fooled around a lot with things electrical. He could always wire anything, and he built radios in the very early radio days, and there were always some electrical things around the house. And so I was always interested, and I'd heard about Purdue somewhere, and decided to go there. Started in September of 1947. The dean of engineering welcomed all the incoming freshmen and he said get a good education, because half of you are going to make your living in ten years from something that hasn't been invented yet. Now, remember, it was just after World War II, with radar, with the atomic bomb. Plastics were coming in. Little did he know, because shortly thereafter the transistor was announced by Bell Labs, so he was an instant prophet.

Hochheiser:

[Laughter]

Strull:

I was a power major. I didn't know I'd spend most of my life—well, I like to say I spent half my career working for a living, and half my career worrying for a living. But before I got into management I did most of the things with transistors and integrated circuits that marked my career. Anyway, when I graduated Purdue, I went, took some interviews. I was single at the time. My parents lived about 7 miles from Northwestern. There were a number of job offers, but I wasn't really ready to go out to work, and since I was only about 7 miles from Northwestern, I decided to go there at spring break. Because everybody was interested in electronics and radar, a power major was of great interest to them, and I was assigned an assistantship in the high voltage laboratory. But when I started looking for a thesis topic, I got into solid state. Changed my major, and spent my master's and doctor's—my dissertations in semiconductors.

Hochheiser:

What specifically was your dissertation on?

Strull:

Well, I was way, way ahead of my time. It hadn't happened yet. Two-sixes. I did my master's and doctor's in cadmium sulfide, which hadn't quite arrived yet. We started with germanium. We moved to silicon. Gallium arsenide, and several number of three-fives came next. Two-sixes never really arrived. But it turned out that my advisor had a former student who was working for GE X-Ray on cadmium sulfide as an X-Ray detector. We also had in the physics department of Northwestern Dr. Rudolph Frerichs. He came from Germany after the war, and he was the man who developed the method for synthesizing cadmium sulfide. So I had knowledge and a ready source of cadmium sulfide. What happened was that the high voltage lab, [was equipped] with a half-million volt one ampere 60 hertz generator, and a million-and-a-half volt surge generator. You couldn't work alone at the high voltage lab. The man I was working with had just gotten married, and he wanted me to come in at 2 a.m. to help him with his dissertation so he could finish. His wife was after him. So I told my advisor I didn't want to do a thesis in high voltage. He said, well, power and light go together. And he told me about cadmium sulfide, and he says it's also a rectifier and a light detector. I said that sounded good. So he took me to GE X-Ray in Milwaukee and I obtained cadmium sulfide crystals, and fell in love with semiconductors, and changed my major. At that time, I met my wife-to-be, who was a math major at Northwestern, and we've been married 57 years. She got her BS; I got my MS at the same time. She wanted me to stay and my advisor wanted me to stay for a doctorate. She taught high school math while I got my PhD at Northwestern.

Hochheiser:

Who was your advisor?

Strull:

John A. M. Lyons, who later went to the University of Michigan, which was his alma mater.

Starting at Westinghouse

In July of 1954 I started with Westinghouse in Pittsburgh in an activity called the Materials Engineering Department. We were making early germanium devices, and one of my first assignments was to try and make a power device out of germanium. And I came up with a really great germanium power transistor. Then Detroit loused me up. They went from a 6-volt to a 12-volt electrical system, in around '55 or '56. The transistor I made was great for radio for a 6-volt system, but it wasn't worth a darn for, [Laughter] a 12-volt system. Germanium eventually gave way to silicon, because of the

better temperature, higher voltage. The thing that plagued me when I was trying to get double the operating voltage out of the germanium is what eventually led to its demise. Anyway, I started with Westinghouse in the Materials Engineering Department, and we were making diodes also for early T.V. It was all selenium at that time.

Hochheiser:

Mm-hmm.

Strull:

And they wanted a power diode for television to get faster turn-on, because then it was a vacuum tube, the 6J5s, I think, they were used in early television. In 1955, Westinghouse realized that they had semiconductor work being done in six different locations. The power devices were done where power was important, in East Pittsburgh. There were power devices in Buffalo used for welders. There were some small signal devices just being made in Elmira, New York, in the Electronic Tube Division. Anyway, they started a division called the Semiconductor Division in Youngwood, Pennsylvania, about 40 miles east of Pittsburgh, and I was a charter member of that operation. Now I'll finish that off, but let me jump ahead to Baltimore.

Defense Division and Tube lab Statement

Baltimore was the defense operation of Westinghouse, with a very storied history. In fact, I wrote a history that is in the museum,

Hochheiser:

And I was given a copy of that to use in my preparations, where it was extremely useful.

Strull:

Well, anyway, the electronic—the Defense Division started in Massachusetts in 1938. With the war on the horizon, somebody had the brilliant idea—there was no Pentagon then. The brilliant idea that being near the government in Washington would be a place for defense, and the Defense Division was established in 1940 in Baltimore. There were people brought from Pittsburgh. In fact, the early radar work had people who were doing that. In fact, a very sad story, a Westinghouse radar saw the Japanese planes—

Hochheiser:

[interposing] Right.

Strull:

—approaching [Pearl Harbor], but Private Lockhart couldn't get his lieutenant to believe in this newfangled technology. He thought they were coming in the other direction, because some B-17s are due to arrive the next day. And otherwise, the history of the war could've been vastly different thanks to Westinghouse. Anyway, in about '56, '57, Harry Smith, who unfortunately passed away a few months ago, and was really an outstanding figure in Baltimore, came up with an idea for pulse Doppler radar. The first application was to be an air-to-air missile, the BOMARC missile, and it was to have pulse Doppler radar. It needed a special tube. The tube was being made in Elmira, New York, for use in Baltimore, and it used to be five stops on three airlines from Baltimore to Elmira. You'd have to fly Alleghany and then Capital and then Mohawk. And it was really [Laughter] quite a chore. Nobody wanted to do it. And there were all sorts of excuses. My wife's mother is sick, and she has to go take care of her, and I can't go to Elmira tomorrow. John Hutchinson was the Westinghouse VP of engineering at the time; he had on the staff a man who came from Lockheed, George Sziklai. And he had an idea to put a tube lab in Baltimore. It was the first instant of a components operation in an electronic defense systems environment. He hired Ross Kilgore, who was at the Signal Corps in Fort Monmouth at the time to run the tube operation. He brought with him a man named Jerry Klein, who worked for him at Fort Monmouth to do microwave tubes, and we decided to do imaging tubes at the same time. When I say we, I don't mean me, I mean Westinghouse, and a man from RCA named Dr. Arthur Jensen was hired. The three of them started this tube lab, and it worked out very well. They could test the things, they made them in Baltimore, and it greatly accelerated and enhanced the program. This led to a whole series of special-purpose tubes that were really important to Westinghouse systems.

Hochheiser:

So this way they were designing and then manufacturing tubes specifically designed to fit in these defense, these military projects?

Strull:

That is correct. About the same time, Westinghouse under, really, George Sziklai's auspices were beginning to peddle a program to the Air Force, really ahead of TI. TI got a lot more credit, and Westinghouse didn't, because we were a power company, and a number of us wanted us to do small signal devices, but the corporate leaders really wanted power to come out of semiconductors, rather than signal devices. We were peddling a program called Molecular Electronics. It came from a concept started by Von Hippel at MIT called molecular engineering. And what he felt was, instead of doing a lot

of things by trial and error, you could use spins, charges, and fields, and come up with things. He was thinking of magnetic materials, special alloys, and electronics, called molecular electronics, would be a version of that. The Air Force was very interested, and in March of 1959 we got a contract called Molecular Electronics, Dendritic Approach. There was also a different way of growing germanium at the time that Westinghouse pioneered, in long thin ribbons. It didn't go anywhere, but it got the Air Force excited.

Moving to Baltimore from Pennsylvania

Hochheiser:

Now, some—had you by this point moved to Baltimore from Pennsylvania?

Strull:

That's just exactly what I was getting to.

Hochheiser:

I guess I figured out where you were going.

Strull:

I had to give you this background.

Hochheiser:

Okay.

Strull:

When they came up with the concept for molecular electronics and wanted to peddle it to the Air Force, it was, of course, important for the Defense Division to be involved. So the concept that Westinghouse gave to the Air Force was to have people from the defense operation in Baltimore, and the people from the semiconductor division in Youngwood, be involved in this new program. By this time I'd been at Youngwood a couple of years, and I was approached in July of 1958, and [they] said, boy, Gene, we've got a great opportunity for you in Baltimore. But you'll still work for us, and you'll be there a couple years and you'll come back to us. That was in '58. So in July of 1958 I made my first trip to Baltimore, but I had an Air Force contract actually that I was working on for power devices in Youngwood, and my boss at the time didn't want me to go to Baltimore because he'd be stuck with this program, so we arranged a schedule where I'd spend three days a week in Baltimore, two days a week in Youngwood, 'til January of '59. I had just bought a home two months earlier. We had a three-year-old

and my wife was expecting. It was—you do things when you're young [Laughter] it was not the easiest personal time. But every week I drove back and forth from Youngwood—from Greensburg, actually, where I had moved, because it was 60 miles from the Greater Pittsburgh Airport. Only on Thanksgiving and Christmas weekends did I fly, which was lucky, because on the Thanksgiving weekend, there was a 13-hour delay on the Pennsylvania Turnpike. But anyway, in January of 1959 I moved my family and established residence in Baltimore, starting an operation that would make special devices for the Defense Division. There was the Air Force contract, but pretty soon we found there were a lot of devices that the defense group could use that they couldn't buy anymore. Early on, the only game in town was the Department of Defense, and a lot of early semiconductor companies took contracts with the Air Force. But then when commercial activities started growing, they quickly dropped it. So having an in-house activity was extremely important, [Laughter] It really made my career, I had a great career. I've had the best retirement in American history, since I've now had 55 years of some sort of continuity since I started in Pittsburgh, which is not very common. Anyway, there were all sorts of politics between the semiconductor division and the defense group. The semiconductor division wanted things they could market commercially. Defense needed things for defense, and defense at that time—well, at the time, Westinghouse was a $2 billion operation. The defense operation was about $150 million, whereas Youngwood was $12 million, and losing money. So that it turned out that Westinghouse Defense prevailed, and I was transferred administratively to Baltimore. That was '61 or 2, I don't remember exactly.

Hochheiser:

But you were actually working full-time in Baltimore from '59?

Strull:

Oh, I was working full time in Baltimore from January of '59 on. My boss was 250 miles away. I was just approaching 30 years of age. It was a great business experience for me.

Hochheiser:

[Laughter]

Strull:

To you know, have that freedom. So actually we made a lot of things that Baltimore needed. About the same time, '62, the contract was going pretty well. Westinghouse decided to go into the integrated circuit business. They were called microcircuits. They

were called solid circuits by TI. They were called molecular electronic devices by Westinghouse. In 1962, Westinghouse decided to form a division called the Molecular Electronics Division, and because they saw defense as an important customer, they decided to locate it in Baltimore.

Molecular Electronics

You have a question?

Hochheiser:

Yes, about the origins of the term molecular electronics

Strull:

[interposing] It—molecular electronics came from the term coined by Von Hippel of MIT.

Hochheiser:

Right.

Strull:

Molecular engineering.

Hochheiser:

Right. But that's just before solid—integrated, the first integrated circuits.

Strull:

It was about the same time.

Hochheiser:

Did the meaning of the term change once integrated circuits came on the scene?

Strull:

Yes.

Hochheiser:

Okay.

Strull:

We had it for—

Hochheiser:

That's where I'm confused, because of the chronology when the term arrives and when integrated circuits arrive, just a little tiny bit after.

Strull:

Well, about the same time we were starting what was called molecular electronics by the Air Force, they really liked the term.

Hochheiser:

Yes.

Strull:

TI had peddled their solid circuits to the Air Force.

Hochheiser:

Right.

Strull:

So they had a contract. We had a contract. And we continued, and they continued. But because the company really liked power, they wanted us to make power amplifiers for phonographs and other power applications while TI was doing the right things that would lead to integrated circuits and computers. So it was Westinghouse's cross to bear that we were mainly a power company; that modified the direction we were to go. I'll digress a little bit. When the Molecular Electronics Division was formed, the Wall Street Journal carried an article that said I would be in the Molecular Electronics Division. I'd had a lot of publicity for a young guy. I was on the front page of the Wall Street Journal in 1959 when I made what was called the first molecular electronics device. So "boy", the offers I got. [Laughter] My wife didn't know why I stayed with Westinghouse, but I enjoyed what I was doing, and I cared about the country and defense. Anyway, in 1962 they decided to form a division called the Molecular Electronics Division, and they built the building in '63 that is now called the Gene Strull Technology Center. I was honored by having it named after me when I retired. But at that time, it was Molecular Electronics and that division made some early integrated circuits. It's located about two miles from this museum, or, in other words just up the road.

Hochheiser:

Right.

Strull:

And we continued making these devices for defense. Now, when I was told I was going to be in this new division, Harry Smith, who was at that time engineering manager of the Air Arm Division, called me in, and he said, we really need (he had great vision) the devices for our system. We're going to continue to have an in-house facility in spite of this new Division. We want you to head it, but if you want to, go there. I said, no, I know the people involved, they'll screw it up.

Hochheiser:

[Laughter]

Strull:

And I'll take it over. I said this in May of 1963, and it came to pass.

At the time integrated circuit activity was just getting started nationally. In fact, there was a wonderful paper somebody at Motorola gave many years ago. He said there are about as many free world integrated circuit designers in the United States as there are professional athletes on teams. So what we really ought to have, if TI does better than Motorola, they've got to put up some of their designers, and we could have free agent drafts, and he made a whole thing on how small the industry was in the beginning, everybody knew everybody else.

Hochheiser:

Sure.

Solid State Device Research Conferences

Strull:

I knew Bardeen, Brattain, and Shockley. We went to the same meetings.

Hochheiser:

Mm-hmm. Were these IEEE meetings?

Strull:

Most of them were, under the auspices of the IEEE's Solid State Device Research Conference. As a matter of fact, [it] has a lot to do with social history as well. The Solid State Device Research Conference started in '50 or '51. I was still in college.

Hochheiser:

Right.

Strull:

The first one I went to was in 1955, which was held at the University of Pennsylvania. At that time, we had a stag banquet, and for a number of years—in fact, twice I was the MC at the stag banquet, which is like a players all-American. We told, you know, raucous jokes and, and wonderful songs related to the industry. Like, to the tune of My Bonnie Lies Over the Ocean. [singing] Some people make a transistor/some people haven't as yet/well those who encase them in plastic/will find that their junction's all wet.

Hochheiser:

[Laughter]

Strull:

Because the early hearing aid integrated circuits were in plastic.

Hochheiser:

Right.

Strull:

And were "creamed" by moisture. And then it went on, bring back, bring back my junction to me, to me. There were a whole series of songs like that, that made up this stag banquet. [It] was a wonderful industry because you didn't have to sell anything. You just had to have something, and the government was excited, and you'd get a contract, and that would carry you for the next year. It was after that that you started having to make something.

Difficulties and Strull in Charge

Anyway, the Molecular Electronics Division, an important part of the Baltimore history.

Hochheiser:

Right.

Strull:

By 1967, they had lost $12 million. GE lost $20 million over the same period. It was difficult for an Eastern establishment, union-driven company to succeed in this new technology. Another thing was the Eastern establishment universities. Harvard and MIT thought it was not seemly for their professors to work in industry, whereas Stanford

encouraged it. That's what led to Silicon Valley. Motorola went to Phoenix. There was talk about lower humidity, and there was some of that, but it was mostly the attitude, because electronics really started in Boston around Route 128, called Electronics Highway.

Hochheiser:

Right.

Strull:

Companies like Transitron and others, but again, the universities didn't cooperate with these people. There were operations on Long Island, but they were plagued by the same thing that plagued GE and Westinghouse. I could spend eight hours on the semiconductor industry, but I'll continue with Baltimore.

Hochheiser:

Okay, so you were up to about 1967?

Strull:

Now, it so happened, nothing to do with it, but it was—well, it did have a lot to do with it. Westinghouse sent two people to Harvard, 45 to 55, those that were going to be corporate officers, to the AMP that Harvard started at the end of World War II. They had started something during the war to train officers, [which became] the Advanced Management Program. Several years after that, they started something called the PMD, the Program for Management Development. That was a 16-week program, and it was for those traditionally 35 to 45. I was 37. Westinghouse sent two people a year to each course. There were about 125,000 people in Westinghouse, so if you got picked to go to one of those courses, you kind of were going to have a good career, if you didn't blow it somewhere along the way. In January of '67, I was sent to Harvard. In October of '68 a committee of 12 people, mostly vice presidents, but Harry Smith was on it, who wasn't the vice president then, and I was on it, to decide what to do with the Molecular Electronics Division. The components part of Westinghouse did not want the burden anymore. They were losing a lot of money, and they thought they would sell it. We met—we went over all the numbers. The numbers looked like you're going to be even worse in 1969, and Westinghouse was not going to keep this division. We met for three days or four days, and late on a Friday Harry Smith got me aside and said, I want the Molecular Electronics Division. You spend the weekend, and you come in Monday and get it for me. A little boy came home all out of breath, and his mother said, why are you

breathing so hard? He says, mom, you'll be so proud of me, I saved 50 cents. I ran home behind the bus. She said, that was dumb, if you ran home behind a cab, you would've saved $20.

Hochheiser:

[Laughter]

Strull:

The best offer Westinghouse had for the Molecular Electronics Division was $6.7 million. Using the principle of the little boy, I proved Monday morning that it was worth $8.4 million if we kept it. Because I'd just recently been to Harvard, I was believed. I had credibility. So the money Westinghouse spent to send me to Harvard bore really rich dividends, because the site where the Molecular Electronics Division was is now where Westquest 1 and 2, the major headquarters of defense are located. They're building a third building. There was 80-some acres, and the 80 acres and the building would've gone for $6.7 million. Depending on certain estimates it's been worth between $2 or $3 billion, our keeping it. But anyway, I took the building over, and then I really learned about some wonderful people, because there were over 1,000 employees, and we had contracts and obligations we had to finish. And these people knew when they finished the job they were on, they'd be out of work. But I talked to them. I told them I had great plans for the facility. At that time it had 137,000 square feet. It's now 435,000 square feet.

Hochheiser:

So now were you in charge of the facility at this point?

Strull:

I was in—I was put in charge.

Hochheiser:

Okay. So after you helped Harry Smith keep the division —

Strull:

[interposing] But the prize I got was to make it work.

Hochheiser:

[Laughter]

Strull:

And to succeed.

Hochheiser:

Yes.

Concentrating on Defense Work

Strull:

Now, the following year the defense division was given $7-plus million to close it. Because of the obligations of contracts and—oh, there were all sorts of interrelationships with Siemens in Germany and Mitsubishi in Japan, cross-licensing, things of that nature. And if we closed it for $7 million we were whole. Well, I managed to close it for $6 million, so I gave Nick Petrou, who was the boss at the time, an extra million dollars in his bottom line, which—

Hochheiser:

Wait, you closed the division?

Strull:

Oh yeah we—yeah, we closed—all right. Molecular Electronics was—

Hochheiser:

I'm confused.

Strull:

—a commercial division.

Hochheiser:

Ah.

Strull:

With commercial contracts.

Hochheiser:

Okay.

Strull:

There were a couple of government contracts. There were obligations to various equipment vendors. We had to provide integrated circuits of various types. We had things we were doing with Mitsubishi and for Mitsubishi, things we were doing with and for Siemens, and we had to grind all these down, which we knew—

Hochheiser:

All right. So what you were doing were closing all of the commercial—

Strull:

[interposing] Commercial activity.

Hochheiser:

So then, going forward the division would be devoted just to the defense work.

Strull:

That is exactly correct.

Hochheiser:

Ah, that's what I didn't understand.

Strull:

See, what you don't want to be is partly commercial and partly defense, because the way government accounting works, where does the overhead go, and who do you put it on, and the government would want the commercial to bear most of the burden, when it's all defense, you might have a fight between whether the Army or the Navy pays it, but somehow Westinghouse would get the money.

Hochheiser:

Okay.

Strull:

So we had to wind down the commercial operation. We were given $7 million to wind it down. We wound it down for 6 million. So we got an extra million dollars on our bottom line.

Lunar Apollo TV Camera

At the meantime we were doing more and more things for the defense that they couldn't get any other way. Like the lunar Apollo TV camera.

Hochheiser:

Yes.

Strull:

Westinghouse had the contract to make the camera, the astronauts—and it just had a great deal of publicity.

Hochheiser:

Right.

Strull:

The timing is—

Hochheiser:

Right, it was the 40th anniversary celebration just this week.

Strull:

[interposing] Now, in the camera chain for the camera, which had to work on a very low power budget, there were 22 integrated circuits in the camera chain. We could only get five commercially, no matter how we tried. So we had to make the 17 in-house. They were all things that had never been made before, and the whole world was going to be watching, but it proved the value of having an in-house facility. There was no other way to get them.

Hochheiser:

Did your operation then both design and produce the chips?

Strull:

Yes, that is correct.

Hochheiser:

And how closely did you work with the people producing the other parts of the camera in this process?

Strull:

Well, the camera came from the Electronic Tube Division in Elmira.

Hochheiser:

Okay.

Strull:

And was still there.

Hochheiser:

Ah.

Strull:

But of course we worked closely with them. Stan Lebar was the program manager, and everything had to work together. There was a very important government program at the time called the Defense Meteorological Satellite, DMSP, a tactical weather satellite, one of the early military applications of space, knowing your weather early. Of course, Eisenhower would've loved it, before D-Day.

Hochheiser:

[Laughter]

In-House Manufacturing

Strull:

And there were a number of integrated circuits in that. The vendor decided he was going out of the business, and we screamed at him we had a high priority rating, but we couldn't get the parts commercially. We made them. If I go into the seventies, middle-seventies, we made only perhaps one, one-and-a-half, maybe 2 percent at most, but closer to 1 percent of all the components we used in Baltimore. Integrated circuits, special tubes for imaging, special tubes for radars, acoustic devices, filters, various other items. However, on a system-building basis, 80% of the systems used at least one part we made in what we then called the Advanced Technology Division. So if you take the ludicrous situation of there being no second source, 80% of the systems would have failed. Now, this was as little as five parts on the Defense Meteorological Satellite, 12 parts of the quarter of a million used in the AWACS radar. A couple of hundred in this, one of those, and a lot of sensitive areas that we can't go into. But we made a number of things that we couldn't get any other way, and we still do.

Hochheiser:

Now, how did this work? Did the people working on a project like AWACS come to you and say, I can't source this material? How did you get involved and know what pieces your division needed to make?

Strull:

The model of our division was we made those things that nobody else could make, those things nobody else wanted to make, and those things we didn't want anybody else to make, that gave us a technical advantage. But it was a question of both our selling and their coming to us. A story I'm famous for: We had made an operational amplifier that we really thought was pretty good, but by the way, it's very hard to be an in-house facility. No project manager wanted to deal with us. Because you can't deal fixed price in-house. If you go buy a part from TI and they quote $50 a part, even if it costs $1,000 a part, they have to sell it to you for $50. But if you buy in-house, it is different, otherwise you could play games with costing rates, and play games with CPFF and fixed price, cost plus fixed fee. If I said $50, and it cost $1,000, I've got to charge him $1,000. So it was always a risk. We had to collect actual cost. Anyway, we wanted to sell this op amp that they were buying. I'm not even going to mention the firm. They wanted to buy it from a commercial firm. They came to us—oh, they said how much is it. And I said, we priced it out, it came to $150 apiece. He said nah, I can buy it from Brand X for $75 apiece. And I said, I can maybe get it down to 120 or 130, but I can't touch 75, you'd better buy it from them. He come back two months later, he said I'm ready to give it to you if you can do it for 75. I said, I thought you were getting it from them. He said they're not shipping. I said, "I'll tell you what, I'll not ship it for $60 apiece."

Hochheiser:

[Laughter]

Strull:

So we really got a lot of the business that we got because other companies let down projects all the time. It was a difficult, difficult challenge at the time. When we were selling the original molecular electronics program, Nick Petrou, at the time, was general manager of the Air Arm Division, and we went to Philadelphia to talk to the Advisory Group on Electron Devices, along with the Air Force, on this new program. And at that time an incredible yield for a transistor was 30%. And when I said I was going to put 20 equivalent circuit elements on a single chip of silicon, people on AGED said you're crazy, you know, 30%'s a good yield. Thirty, you know, point three to the 20th power, you're not going to make anything. It didn't go that way, and we knew it wasn't going to go

that way. Now these same people, oh, we were with you at the beginning, Gene, we remember when we talked to you in Philadelphia. Kind of funny. But it turns out we now can put a billion—

Hochheiser:

That's right.

Strull:

—equivalent circuit elements on a chip. There were some great, great innovations that made that possible. One of the things people don't know much about is the pellicle. A pellicle is a transparent membrane that goes over the master plate that you use for the photolithography in making integrated circuits. And what it is, it stands off about a 16th of an inch from the master plate. So that dust falling on it is out of the focal plane of the image. So in a very, very clean room you make your master plate and put on the pellicle, but then you can handle it. You still go into very clean rooms, but you don't have to be as super-clean as you would've been if you didn't have the pellicle. There were other innovations that make it possible to now do what was unheard of. When you see the things that can be done. In the summer of 1950, I was invited along with two other EEs from Purdue to go to Chicago to see one of three electronic calculators that IBM had. In the entire IBM they had three electronic machines. Everything else was gears and punch cards. And this great electronic machine that IBM showed us in 1950 had 5,000 tubes in it. And it was just a punch card reader. But it did it faster than dropping pins into slots. That's how far the industry has come. Now let's see, I want to give you some continuity.

Hochheiser:

Right. So you were talking about the seventies.

Strull:

We're in the seventies, and we're making more and more things for the radars we make, for the EW we make, for the sensor systems we make.

Hochheiser:

But is it generally that the production people are coming to you when they discover there are things that they can't source elsewhere?

Strull:

We kept our ear to the ground, and we knew what was coming up, and we had a little bit of our R and D. Not a lot, but we tried to make things that we thought would be

needed. We knew the direction that the industry was going, and we tried to be one step ahead. Many, many times we were able to do things that nobody else could do, ahead of the game. And that's why it's still there, and it's been enlarged. The integrated circuits were followed by integrated microwave. There were a number of government programs.

Government and Military Programs

Hochheiser:

Well, about when were these?

Strull:

Well, the first solid-state program was called the VHSIC [pronounced vis-ik] program, which stood for Very High Speed Integrated Circuits.

Hochheiser:

And about when was this?

Strull:

Let me work it out. I guess it must've been in the late seventies what, '79? Something like that. It started out being called Very High Speed Integration. And some senator thought it was something to do with school busing, so the Air Force changed the name to Very High Speed Integrated Circuits, from Very High Speed Integration.

Hochheiser:

Okay. And were these for microwave use?

Strull:

No. These were for computers, radar chain and camera chain circuits, and things that DOD would use. It worked, they gave out several awards using 1.8 microns, which is nothing today, but was a very, very good dimension 40—well, it was 30 years ago.

Hochheiser:

Right.

Strull:

Over 30 years ago, it was leading at the state of the art. The program went very well, and then several years after that they started a program called Microwave Monolithic Integrated Circuits, MIMIC.

Hochheiser:

Okay. Well, first, now did these VHSIC circuits that you were making, did those end up in specific military products?

Strull:

They went to various military programs. We couldn't just do it for Westinghouse. None of the vendors could do it just for—

Hochheiser:

Okay. So under the terms of the contract, you were developing this technology for use by?

Strull:

DOD.

Hochheiser:

By DOD so then what—?

Strull:

[interposing] Contractors.

Hochheiser:

Okay. Was this the first time you undertook a project of such nature that was going to be feeding not just to Westinghouse products but other DOD contractors?

Strull:

No way, way back when, over the years, we made—in the radar area, there is a device called the TR tube, the transmit receive tube. You want a switch, you put out a very, very high power, and you have to keep the very sensitive radar detector out of the circuit, otherwise it'll burn out. So you have a switch. When you transmit, you short out the detector diode, and when you are receiving the signal, you put the detector diode back in the circuit. Now, you've got planes on the carrier deck. Big signs in the wardroom, turn off your search radar before you land. A guy forgets, and he burns out all the radar detectors. Westinghouse pioneered something called a radioactive igniter, where we would use a bit of tritium foil to partly ionize the gas, so that we could block the device faster, and keep the device from causing fratricide with your other radars. This was state-of-the-art, and the DOD asked us to make it for other firms.

Hochheiser:

Okay. And this was about when?

Strull:

Oh, this was the sixties actually.

Hochheiser:

Okay.

Strull:

Then, when they heard us bragging about it, a Hughes vice president said, I don't care what it costs we're going to make our own. [Laughter] But they weren't very successful, and we did make it for them for—we made a number of things for other contractors over the years, when DOD made a request.

Hochheiser:

So it sounds like you had, if you will, two revenue streams. One where contracts directly from DOD, and one where internal things with—

Strull:

revenue streams from internal things we made for Westinghouse systems.

Hochheiser:

Right.

Strull:

We had our own DOD contracts where we're trying to be ahead of the state-of-the-art, and we did have a revenue stream for making things for other defense contractors.

Hochheiser:

Now I have a better understanding of what the division is doing. Okay. So if we can circle back, you were talking about the VHSIC chips in the late seventies.

Strull:

Yes. There [were] six contractors originally Westinghouse, Hughes, Honeywell, TI, IBM and TRW. National Semiconductor was a subcontractor to us on that, along with Harris and Control Data. There were some major teams with—

Hochheiser:

Right.

Strull:

Let's see. TRW, Mainly and Westinghouse.

Hochheiser:

That can be looked up.

Strull:

Oh, I think that's all in the book anyway. Some of that's in the book. But at that time the commercial industry was passing (in terms of minimum feature size) what DOD was doing. They started a VHSIC 2. Unfortunately, we did not win that. But we kept doing things we needed for our in-house programs.

Hochheiser:

Yes.

Strull:

We had a number of other programs that enhanced our capability.

Upgrade and Promotion in the 1980s

Hochheiser:

Now you're saying that by the early eighties, the commercial—

Strull: By the early eighties a very interesting thing happened. As we got into 1980, I was asked to do a strategic plan for the division, because it turned out that the industry was moving so fast we needed more equipment, and we weren't mainstream like radar, and there was a hesitancy, and I was asked to appear in Pittsburgh before the corporate fathers. They were going to give me a half an hour. I spent three hours, and they listened, and I got more money than I asked for so we could actually upgrade the facility so that it could continue—

Hochheiser:

So was this major equipment you needed to—

Strull:

Yes.

Hochheiser:

—to keep pace with the, how manufacture had moved?

Strull:

Exactly, because when I started, the very first germanium I had were half-inch diameter wafers. Then 1-inch. Two-inch seemed incredible. Silicon was worse, it was much, much harder to make, and it was a long time before we got 2-inch silicon, and all our equipment was based on that. Then 4-inch started to be available. And then 5-inch, and 6-inch, 8-inch. Now, most of it's a foot. There's even talk of 16-inches. In fact, there may be some 16-inch out there, but 8-inch is pretty much common these days for—

Hochheiser:

But by the early eighties would it be 4—?

Strull:

By the early eighties 4-inch.Well we had to get to 4-inch. And that was a major upgrade in equipment to handle the larger silicon. It turned out that 4-inch gave you more than four times as much in terms of yield, because even if the edges of a wafer are bad, and there's a sweet spot in the center. So when you double the size of a wafer, you get more than twice as many, and when you go to 8-inch, it's even more than that, because you have much more [of] a sweet spot.

Hochheiser:

Okay. So, you got this major increase in—?

Strull:

In equipment so that we could keep pace with what was being done in the industry.

Hochheiser:

Did this increase also lead to any change in the group in terms of organization or hierarchy?

Strull:

In 1981 it—oh, it was kind of interesting. At one time everything that was in the advanced technology facility was under my control, but then later on the component manufacturer became the Advanced Technology Division, and I was named the general

manager, but there was also a space division, so half of the people who reported to me were now in another division. [Laughter] So I had a major promotion but at half the number of people.

Hochheiser:

And this was, this was about when?

Strull:

Eighty-one

Hochheiser:

So anyways you have a promotion, but, now, how many people did you have under you?

Strull:

Well, at one time I had close to 1,000. Later on I had about 350 as the Space Division and the Advanced Technology Division were formed and separated.

Microwave and Committee Experiences

Hochheiser:

The other place you were going from the VHSIC chips, you were starting to talk about microwave?

Strull:

[interposing] Talk about microwave, yes.

Hochheiser:

Microwave.

Strull:

I've had experiences beyond belief. I was a NASA advisor for 20 years, from 1968 to '88. So I was a NASA advisor when Apollo was launched. I got a VIP invitation to Apollo 12, so I was in the stands when Nixon was in the stands. The pre-launch parties were like something out of a Hollywood set. And Von Braun was there, and spoke to us, and we got all the autographs of the astronauts. It was a really, really quite a time. Because I was a NASA advisor, when the shuttle first flew tethered on the 747, I was invited to that, so I was out at Edwards watching that. I had incredible experiences there.

Hochheiser:

What were you advising them on?

Strull:

Electronics. There was a committee. I was a committee chairman for electronics, electronic components.

Hochheiser:

And then did this feed back into components that you were designing and producing?

Strull:

Oh yes. I was on a number of NASA committees. There were experiments on what experiments to carry along on the long—there was a long duration facility.

Hochheiser:

Right.

Strull:

There was what we were going to do in outer space. I was on a committee with Carl Sagan. I really had some incredible experiences. We wrote up a number of documents and papers. A big one on sensors that might be used—what would happen after the lunar camera, other cameras. I was on the Army Science board for several years. That was also quite an experience. I went to Korea. I was on the National Tunnel Detection Committee for two years, when the "bad guys" were tunneling under the DMZ in Korea, and I actually went to Korea in flak jacket and hardhat and crawled down an intrusion tunnel that the South Koreans had dug to stop, a North Korean tunnel. The Army let me fly a helicopter at Fort Ord. I was in the gunner's seat, the little plastic bubble on a COBRA, but I had the stick for 15 minutes with a real pilot in back, and that was, wow! Some of them I can talk about, some I can't.

Hochheiser:

Of course.

Strull:

I was on the Naval Research Advisory Committee summer study on high-energy weaponry-how do you protect an aircraft carrier. I was on the Defense Science Board on a committee chaired by Bill Perry, before he was secretary of defense. It was really a

VHSIC committee; it was on where was VHSIC going. I was on the National Research Council committees. I've done a number of things for the National Science Foundation. Since I've retired, I've been to Cornell, Stanford, MIT, Georgia Tech, Virginia Tech, Cal Berkeley. They look for grants and then we decide whether they get it or not.

Hochheiser:

Mm-hmm. I guess circling back around, um—

Strull:

I'm jumping around a little bit now.

Hochheiser:

That's okay, that's okay. If you don't mind that I'm going to circle back around.

Microwave Chip Project and Materials Lab

Yes. You started to tell me about the microwave chip project.

Strull:

Yes. Yes, because that became extremely important also, because of radar and electronic warfare, and what—it's a much harder material to work with, gallium arsenide.

Hochheiser:

Okay. So the microwave project, now, you're moving from silicon to—

Strull:

[interposing] To gallium arsenide

Hochheiser:

the three-fives.

Strull:

Yes, and there are other materials too.

Hochheiser:

Right.

Strull:

Indium phosphide and a few others that are being used, and that's all done at the advanced technology facility.

Hochheiser:

And when did that start?

Strull:

Well, we started doing microwave things—actually, believe it or not, the microwaves started before the solid state. One of the first projects I got when I came here in '59 was to make a better varactor diode for a microwave detector. So we always had a microwave activity. But with the exception of a couple of detector diodes, it was more tube-oriented. But then as we moved into the'70s or something like that, we started looking at gallium arsenide. Our research lab in Pittsburgh was always a materials pioneer. At one time, we grew the best silicon in the world, but we didn't make it a commercial venture. Maybe we should have. But we were growing really very good silicon.

Hochheiser:

And then did you continue to—?

Strull:

And we made very good gallium arsenide. Eventually other people supplied it to us.

Hochheiser:

But did you then continue to work—have contacts with the people at the materials lab at Pittsburgh?

Strull:

They are now in Baltimore, but we continued to have contact with them. Oh yes. Yeah. They were part of Westinghouse, we visited them frequently, and—

Hochheiser:

And, and worked together on projects?

Strull:

Yes, as we needed it, yes. And we the[n] received a lot of important material advanced programs. Silicon is very reactive when it's molten. Very hard to find a crucible that will contain it. And what Westinghouse pioneered was a concept called zone levitation. We

took a rod of not too pure silicon with an induction coil around it, and we actually melted—we had a molten zone—we had two solid pieces of silicon, and a molten zone in the middle, and we would actually drive it from one end to the other vertically and concentrate the impurities, and then we'd cut off the end, and we do this a few times, and we got much purer silicon then could be obtained by any other technique.

Hochheiser:

[interposing] Now was this in Pittsburgh?

Strull:

That was in Pittsburgh. Eventually we licensed companies who made it. So now it's made by other companies. The same with gallium arsenide and other three-fives. There were also special materials for acoustic devices.

Hochheiser:

Now, as we move into the eighties did your relations with the other groups in Baltimore change at all?

Strull:

As they needed us more and more, and as we delivered more and more, it became somewhat better so we could get more business but still there was always this worry about how much will it ultimately cost. [Pause]

Vice President, Technology Manager and Retirement

Hochheiser:

Looking on in your biography, the last position title, you had was vice president for technology at the Electronic Systems Group, and general manager of the Advanced Technology Group, now is this a—

Strull:

Yes.

Hochheiser:

—new title or a new position or—?

Strull:

In 1987—

Hochheiser:

Right.

Strull:

—I was made vice president for technology. It was a new title.

Hochheiser:

Okay. Did it mean a change in your responsibilities?

Strull:

Not really.

It was a way to reward me a little bit more.

Hochheiser:

I have seen that in many cases.

Strull:

Okay. Well, for example, a big perk in Westinghouse was the Greenbriar Physical, which only the top 125 people in the corporation got. And when I was given this new title, I was given a Greenbriar Physical, and a financial advisor. But I was always doing all the things. Whenever there was anything related to technology, I was always consulted.

Hochheiser:

As a longtime technology manager, how, how did you manage to keep up with the technology itself, with all of your administrative duties?

Strull:

Just able to do it. Technology came very, very easy to me. I retired January 1st, 1993. And I still have an office. I am still badged. I never dreamt that 16-and-a-half years later, with a different company. The most incredible, the finest thing that ever—well, when I retired, and Westinghouse named a facility after me. I was astounded. It was really, really hard to believe. A great many of the things I worked on were sensitive, because we were always ahead of the state of the art. So a lot of people—in fact, when Harry Smith told me he was making me a general manager he says I'll take some heat for it, because most of the people don't know what you've really done.

Hochheiser:

I guess that's part of the downside of working in state of the art sensitive DOD areas.

Strull:

Yes.

So anyway—and I did have some people [ask], why him? Three years later, I consulted for Westinghouse a small amount. They don't want former—I absolutely had to retire at 65, if I wanted my pension. It turned out that I retired at 63 and eight months. Westinghouse was in very deep trouble then. Westinghouse was having the trouble GE is having now.

Hochheiser:

Okay.

Strull:

Even more remarkable than Westinghouse naming the facility was that Northrop Grumman has kept it for 13 years. For which I'm most appreciative and most honored. But I've been loyal to them, and doing some things for them. But in 1946, '47, '48, right after World War II, Westinghouse came up with an incredible commercial innovation, the Laundromat. People had the washing machines. I remember my mother with the wringer, and they hung the wash on the line. There were no dryers. Even a washer was an innovation. And when the Laundromat came out, it was really something. To help appliance dealers help their customers get appliances, like Laundromats, they started a small financial arm, Westinghouse Financial. It was like GMAC for washing machines. Fast forward to the eighties and junk bonds, and Milliken. And we had a CEO who decided this was a way to make a lot of money. Anyway, a number of bad bets were made, and the Westinghouse stock went from 39 to 9. And we were a hairsbreadth away from bankruptcy. And the financial advisor that I had said, take your money and run. When I retired, I was the oldest executive in Westinghouse. Everybody else had gone earlier. Even though I had 16 months to go, there was nobody older who qualified for the executive pension or had this grade of management. GE, being larger, had a financial arm too, and they were a big bank, and that's why their stock went from 40 to 12.

Hochheiser:

I know that.

Strull:

They were just a little behind. Westinghouse got it earlier, 'cause we started earlier and were smaller. So—but anyway, I consulted a small amount. I was allowed to consult six days a month, but I came in four days a week, I was so used to it.

Hochheiser:

[Laughter]

Strull:

But I kept up with technology. I still do. I still get ideas. I've put in something like 20 patent disclosures to Northrop Grumman. I have 21 patents, but many of the best things that I did, I couldn't patent.

Hochheiser:

[interposing] Patent because they were done for—

Strull:

Yes, other—or—

Hochheiser:

[interposing] —DOD highly secretive projects.

Strull:

So, but I do have 21 U.S. patents, and I have a number of disclosures, and I've gotten patent awards from Northrop Grumman. I'm just very fortunate, I get ideas every day. I don't feel, intellectually, I've lost a nit. I know that's terrible, but that's just—

Hochheiser:

It's not terrible, I think it's wonderful. [Laughter]

Strull:

But…

IEEE and Committee Involvement

Hochheiser:

Another question. You know I'm with the IEEE.

Strull:

Yes.

Hochheiser:

So I would like to ask you, now, when—did you join IEEE back when you were a student?

Strull:

Yes, I joined the IEEE—

Hochheiser:

Or I guess.

Strull:

[interposing] It was AIEE.

Hochheiser:

It wasn't IEEE yet, right.

Strull:

I joined the AIEE at Purdue, as a student member. And then I guess I was in graduate school, I joined the IRE.

Hochheiser:

What led you to join and what ways, if any, did you participate back then?

Strull:

I became a member, a senior member. I was very fortunate; I became a fellow at a very tender age.

Hochheiser:

I know.

Strull:

In '67, I was 37; in fact, I was at Harvard. I went to New York for the ceremony from Harvard, By that time they'd merged.

Hochheiser:

That's right; in '63 they had merged.

Strull:

And in ’90 what year? ’91. I won the Frederick Philips Award. And at that time it was a 4 troy ounce 18-carat gold medal. They’ve now done away—the gold medal with a $2,000 check and the gold medal was worth, at that time, about $1,500. It’s worth more today. They have stopped the gold medals except for the higher awards. But mine is a nice, heavy hunk of gold.

Hochheiser:

Through your professional career at Westinghouse did you continue to remain involved with IEEE?

Strull:

I was an editor of the electron device journal for many, many years. I chaired some committees. We started in early—I don’t even remember now, let’s see. In the sixties we started something that was integrated circuits, early on. I was on the standards committee. I was on a couple of medal committees. You could probably better answer this [Laughter] I don’t even remember all—

Hochheiser:

And indeed, there’s a list in your membership record at IEEE.

Strull:

Okay.

Hochheiser:

What was Westinghouse’s attitude towards your active participation in professional activities?

Strull:

They had no problem with that, because I had a great many committees. Oh, for a number of years I was, for many, many years I was involved with the Solid State Device Research Conference. And there were six meetings a year in New York before the meeting. Well, let me say a word about New York, and let me talk about how things have changed, because it’s history. I joined Westinghouse in July of 1954.

Hochheiser:

Right.

Strull:

I started working on July 15th, 1954. I had submitted a paper, really my doctor's thesis to the National Electronics Conference in Chicago, and Westinghouse sent me to give that paper. And I then wrote a paper that was accepted for the—I think it was in 1955, the big convention was March of '55 in New York. The AIEE conference. And I got a call from my boss, and it turned out that he was on a committee for the Solid State Device Research Conference, and he said, I can't go, and it was the following Monday. He said, why don't you stay over in New York and go to this Solid State Device Research Conference meeting. So I got involved. I wasn't even employed by with Westinghouse a year; I got involved with the Solid State Device Research Conference. And he had me continue that, so for about seven years I was involved with the—I was program chairman. I was the stag banquet MC [Laughter]. Had a lot of involvement with that over the years. When I went to Harvard, and I came back and I was given much more managerial responsibilities. I let some of that slide, because I was getting a little bit—but 'til '67, but Westinghouse was always very good about letting me do things that were involved with committee work. But what I was going to say about the—when I first became a formal committee member on an IEEE Committee, the West Coast was so far that we had a separate West Coast committee, and once a year we'd meet together. But most of the activity was in the East. The first time I went to the West Coast, I was still in Pittsburgh. The flight was Pittsburgh, Cincinnati, Dallas, El Paso, San Diego, Los Angeles. There were no jets.

Hochheiser:

Yep.

Strull:

And they're 13 hours. When I first started working on committees, I was in the Semiconductor Division in Youngwood, and I lived in Greensburg, Pennsylvania. Was about 55, 60 miles to the Greater Pittsburgh Airport. What I would do, the Pennsy [Pennsylvania Railroad] had a stop in Pittsburgh. I would get on the train in Greensburg, and take the sleeper to New York. Now I'd fly back, so I could not be away two nights.

Hochheiser:

Mm-hmm.

Strull:

But for a young engineer, now, at this time I'm 26 years old, I get on the train in Greensburg about 11:30 at night. I go in the club car, and all of these businessmen, everybody was in a suit, nobody [Laughter] in fact, in fact everybody traveled in a suit.

Hochheiser:

Right.

Strull:

Even though there was no air conditioning. I've got another story about that. And I was with—and here I'm a young kid, the Club Car had a big crock of cheddar cheese to go with the drinks. It was a real business education, the months I took the train to New York with businessmen of all sorts, who were very happy to talk about what they were doing. Flying is great, but you do miss some of that. Now, in those days, in a DC3, which sat up on its tail wheel, in Washington National, you could get airsick before you ever took off. It was—must've been 100 degrees in the plane. You were sitting at a bad angle. [Laughter] And of course there were no hijackers. There was no coach at the time. [Laughter] Yes. A whole different experience. Well, where do you want me to go now?

Baltimore Plant

Hochheiser:

How was the Baltimore plant in general, as a place to work? In terms of colleagues, in terms of social activities—?

Strull:

Incredible. I came to Baltimore from the Semiconductor Division. My boss was still in Pittsburgh, and I went back there time to time for meetings and he visited me, but there was a spirit—it was like the Marine Corps. The esprit de corps was unreal. The people I met were—are still—unfortunately, many of them have passed away. I've still got some very, very good friends who are still around. [Laughter] And there was nothing like it. When I had a choice to make in '62, and when I'm transferred administratively to Baltimore, I could've gone back to Pittsburgh, but Baltimore was a whole different world. And I was always very patriotic, and I liked being involved with defense. I met some wonderful, wonderful people, and they really cared, and—yeah, it was a great place. Everybody—everybody really cared.

Hochheiser:

Do you think it was because it was defense work that led to this spirit?

Strull:

That was some of it, and it was because we were really working at the forefront of technology, had a lot to do with it. I'm not sure this is appropriate for your audience, but I've always liked to say technology is like sex. When it's good, it's great. Even when it's bad, it's still pretty good. [Laughter] But we were always at the forefront of the technology. I was very fortunate. I never forget a joke. You know, you—somebody never remembers a joke? I remember every joke I've ever heard. And this happened to me more than once. It's 10:00 at night. We're screaming at the customer. He's screaming at us. We've got a launch coming up, and we don't have the payload, and, you know blah, blah, blah. And somebody makes a remark or tells a joke, and it's like dancing on a grave. Ten minutes later, I tell the story, it's just the right timing, it's just the right thing. Everybody laughs. We part as friends. We get it done. We get the extension, and everything is copacetic. And that has as much to do with my successful career as some of the inventions. Hey, there were times that it was really tough. There were times that we were near the edge of disaster when we lost some programs we should've won. As a matter of fact, in almost every case when Westinghouse lost a program we felt we should've won, the eventual winner blew it. We had a very, very fine record. It's unfortunate after the debacle in the mid-eighties with finance, and we had to sell off so much of Westinghouse, the only piece left of any value was defense. And when a new CEO decided he wanted to buy CBS, defense was the only thing of value.

Hochheiser:

So then that was sold.

Strull:

That was sold. But we've done well by Northrop Grumman, I really believe. And it was—in fact, Northrop Grumman is a, quite a success story. Because at one time there were a lot of mergers in the defense industry, and Northrop was going to merge with Lockheed Martin. And DOD wouldn't let us. But they've done very well on their own.

Hochheiser:

Right.

Strull:

There were a lot of people who thought that might not be as successful a firm, but there was a very positive article in either Thursday or Friday's Journal on Northrop Grumman.

Cold War and Administration Changes

Hochheiser:

Your career paralleled the Cold War.

Strull:

Oh yes.

Hochheiser:

In what ways does the ebb and flow of the Cold War and the change from administration to administration,—in what ways, if any, did that affect the flow of work here?

Strull:

All right, let me see if I can phrase this properly. When I came here Eisenhower was president, and as a matter of fact I was really, really excited when I heard about Gary Powers when the U2 was shot down. Because I was so afraid that Eisenhower, not wanting to appear militaristic wouldn't—well, like I'm afraid the present administration is selling the CIA and DOD and other things short. And I was really afraid that Eisenhower, not to appear militaristic, first military president since the post-Civil War. So when I found we did have an active spy program to get at what the other guys are doing, I was greatly comforted. Kennedy seemed appropriately—you know, he wasn't going to let the country go off the tube. Although he gets more credit than he should get for the Cuban Missile Crisis, because if we'd had one lousy plane help the Cubans when they were going in—you know, we sort of told them to go after Castro, when the good Cubans landed, they had no help at all. And so it would've given Obama something more to apologize for. But we didn't give them any help, and yes, he did act during the Cuban Missile Crisis, but we shouldn't have gotten to that. Johnson, of course, was really not a non-defense president.

Hochheiser:

Yes.

Strull:

Oh, I'm going to say something, since I have an audience.

Hochheiser:

Please.

Strull:

We won the Tet Offensive. Absolutely, positively. Unequivocally. The liberal press caused us to lose it. The Viet Cong couldn't realize the press they were getting. They were just about ready to fold their tent, when we found that we were calling them victors. And much as I admired him—Walter Cronkite when he turned, it was the wrong time. We really were doing well, and the aftermath was pretty sad. But let me get back to your question—

Hochheiser:

Which is basically how did all of these political changes—

Strull:

[interposing] Yes.

Hochheiser:

Affect the work here in Baltimore?

Strull:

Well, because we had such a long, long lead time, because we were making the next generation radar for the next generation aircraft, there was one instance where it really was—I'll get into that. But for the most part, when we were making things for—at one time we were doing mostly Navy work, radars for Navy aircraft. That shifted to Air Force. In fact, every defense contractor has an on-site DOD office.

Hochheiser:

Yes.

Strull:

Either Army, Navy, or Air Force. For many, many years we had a NAVPRO, the program office, which stands for Navy Program Office, monitoring Army, Navy, Air Force, Marine, FAA—all our programs were monitored for the government by the NAVPRO. But later as more and more of our programs became Air Force, the NAVPRO became the AFPRO, and now we have an AFPRO. But because of the long lead-time, there wasn't much effect through Nixon or through Ford. Jimmy Carter wasn't in long enough, didn't do a lot. After Bush it was—the reason that Clinton had such an excellent budget is because he cut the hell out of DOD, and he is responsible—I don't know how political I can get, but he's responsible for a lot of the trouble we had in Iraq, because we so neutered the

equipment base during his tenure that it wasn't really there, and it wasn't built back. And because of what was inherited in terms of DOD and the whole climate, that it didn't get built back fast enough. But at that time—for example, we were working on radar for the next generation Navy aircraft, the aircraft, the radar and other elements were cancelled – that really hurt in '91, '92. Now that was still under Daddy Bush, but there were more cuts to come.

Hochheiser:

We have managed to cover everything that I wanted to ask you about. So if there's anything that you'd like to add that I could've asked you that I didn't, I'd certainly be happy to have you do so.

Strull:

I'm trying to think what would be of interest to historians. Sometime in the 1800s, I forget what year it was, when the head of the patent office resigned. Maybe it was after the steamboat. He decided everything that could be invented had been invented, and there was no need for his office anymore. And we haven't even started. There are so many things we still can do with technology.

Hochheiser:

Yes.

Strull:

And I am really, really awed at what I [Laughter] can do on my home computer. You know, I started in an era when in graduate school we had comptometers. The whole building shook when they—especially when they divided. [Laughter]

Hochheiser:

Yes.

Strull:

As they did successive subtractions 'til you had a remainder. And I saw the industry really come up from scratch, and it's kind of exciting when I see what can be done. There's more in the phone I'm carrying than there was in—

Hochheiser:

[interposing] In the mainframes you worked with—

Strull:

Yes.

Hochheiser:

—[Laughter] earlier in your career.

Strull:

That's right. That's right. No, we started off, we were doing some things and there were still punch cards, and then there was mag tape, and but well, I'll sum up this way. Having started college just before the transistor was invented, and spending virtually my whole working career in integrated circuits and electronics, I saw the whole industry, the whole thing materialize and mature, and it's truly very exciting to have been around to see all of that happen. Actually, I'm 80, so we went to the moon a half a lifetime ago, for me. Kind of scary because the first 40 years seemed to take a long time. The next 40 didn't take any time at all. But I've been involved with technology. I came here for a two-year assignment, and spent my whole career here. Now, I've been retired for over 16 years, but I still am doing things that excite me. I'm still doing things that I think contribute nationally. I hope they do. I'm told they do. And I appreciate the opportunity to share these reminiscences.

Hochheiser:

It's been a pleasure to listen to you share them.