ORAL HISTORY: Ted Foster

About Ted Foster

Ted Foster was born in Lynchburg, Virginia in 1941 and from childhood was interested in science and technology. He graduated from the University of Virginia in Charlottesville, getting his degree in electrical engineering in 1963. For graduate school, Foster received a fellowship from Westinghouse to attend Johns Hopkins University full-time while a Westinghouse employee. At Hopkins, he worked on solid state electronics, and received his doctorate in 1967. After graduating, Foster went to work at Westinghouse, starting in the Advanced Development Department, and quickly moved on to work with optical signal processing and SAW devices. Foster worked on many projects – including thick film technology, surveillance radar systems, and Very High Speed Integrated Circuits (VHSIC) – and had many positions, moving from project leader to manager. Although Foster spent most of his career at Westinghouse Baltimore, he also worked at Pittsburgh as manager of the electronics portion of the research lab, although he returned to Baltimore when Northrop Grumman bought his division. Foster retired from Westinghouse in 1999 and became Assistant Dean of Engineering at the University of Maryland, Baltimore County.

In this interview, Foster discusses his long career at Westinghouse and the many projects he worked on. He talks about his decision to enter graduate school and his route to Johns Hopkins, along with the prescribed program of study he had there through his Westinghouse fellowship. Foster also discusses how he became a manager at Westinghouse, and the at times informal leadership he held over groups. The important transition of radar systems to solid state in military electronics – and Foster's role in the process – is also covered. The troubles at Westinghouse and the eventual sale to Northrop Grumman are also discussed, as well as the reasons Foster felt it was time to retire in 1999. Foster also talks about the atmosphere at Westinghouse Baltimore, and the many people he worked with during his career.

About the Interview

TED FOSTER: An Interview Conducted by Sheldon Hochheiser, IEEE History Center, 17 February 2010

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Interview

Interview: Ted Foster

Interviewer: Sheldon Hochheiser

Date: 17 February 2010

Location: The National Electronics Museum, Baltimore, Maryland

Background and University Education

Hochheiser:

This is Sheldon Hochheiser of the IEEE History Center. It is February 17th, 2010. I am here with Ted Foster, who spent much of his career at Westinghouse in Baltimore, to talk about his career and about Westinghouse. If I could start with a little background. When and where were you born and raised?

Foster:

I was born in 1941 in Lynchburg, Virginia and went through high school in Lynchburg. And then I left Lynchburg in '59 to go to the University of Virginia in Charlottesville.

Hochheiser:

Were you interested in technology and science growing up?

Foster:

Yes. It was always interesting to me but I had a fascinating experience that got me more interested. When I was in the 7th grade, I visited an uncle in West Virginia who was a ham radio operator. And at the time, being very young, I hadn't seen anything like this, and I was really fascinated with the glowing vacuum tubes. I didn't know what to make of it. I was so fascinated by it that I came back to Lynchburg and got my license as a ham operator. And, fortunately, my father decided to get his license too as a way of supporting me. And so we built a ham rig and I operated it through high school. When I went to college we weren't allowed to have an antenna outside, and by that time I'd lost interest in ham radio. I was more interested in the technology. Some hams are interested in talking and they want to talk to as many people as possible. That's not me.

Hochheiser:

Right.

Foster:

I was more into the technology and once I was through high school and I'd built the rig and all of that, those days were over. So I went on from there to study engineering. Engineering was the obvious thing to study.

Hochheiser:

Right.

Foster:

Nothing else really seemed to matter. Engineering was clearly it.

Hochheiser:

So you went to the University of Virginia into the engineering school there?

Foster:

Yes. I got a scholarship and I finished in 1963.

Hochheiser:

Did you go there from your ham background planning on electrical engineering?

Foster:

Yes. In those days when you were admitted into an engineering school it was generally understood that you decided which program you wanted to enter, not just engineering in general. And I already knew it was going to be electrical engineering.

Hochheiser:

What was the curriculum in electrical engineering like at the University of Virginia in the late 50s, early 60s?

Foster:

Well, fundamentals of electricity, physics, chemistry, statics, dynamics , thermodynamics, mechanical drawing and lots of math. Electrical engineers also had to learn about power. So, you know, DC and AC power and DC motors and generators and AC motors and generators. Those things aren't taught any more in the basic electrical engineering program because they are too specialized. So, a lot of that, plus basic circuit design, solid state physics and a good dose of liberal arts.

Hochheiser:

Right.

Foster:

That's sort of the nature of University of Virginia - that's it's a more liberal approach to engineering than, say, Virginia Tech. Virginia Tech was known as an excellent engineering design school. And University of Virginia was known as being a little bit broader in its perspective.

Hochheiser:

And is that why you chose Virginia?

Foster:

Yes. I think, but, you know, I visited Virginia in the fall of my senior year and fell in love with the architecture and the Thomas Jefferson legacy.

Hochheiser:

It's beautiful.

Foster:

And I decided this is where I'm going. I didn't visit any other schools and I didn't apply anywhere else. I just decided, this is clearly for me.

Hochheiser:

[Laughing]

Foster:

And then in the end of my junior year, I got a call from a professor who said they were starting a new honors program and they were inviting a classmate and me to join it. But because I would be entering it only in my senior year and it would be a 2-year program, I wouldn't be able to graduate with honors. But I would be one of the first two students to go through this program. So, instead of going to classes, I was tutored by this professor every day. He would assign me homework and he would tutor me for an hour or so. I sat in on some classes informally but I was no longer taking classes as a regular part of my curriculum. That experience was very influential because I learned how the

professor thinks. It was his clear methodical way of looking at things that I don't think I would have received in the classroom; you get it through that personal contact.

Hochheiser:

What was the professor's name?

Foster:

His name was Dr. Cliff Siegel. I considered him to be the best faculty member in the department and I was very pleased to have the opportunity to be tutored by him on a personal basis.

Hochheiser:

Did, did you join IEEE - or rather one, either of, its predecessors - while you were at the University of Virginia?

Foster:

Yes, I was in the student chapter - but then when I graduated, and went on to graduate school, it didn't seem relevant for a while. I joined again later. But was not active for many years. I reactivated my membership later because I was at UMBC and the dean asked me to get involved with the engineering accreditation process. To be an evaluator for accrediting engineering programs you have to be a senior member of a technical society. So I applied for senior membership and learned how to do evaluations for accreditation of electrical engineering and computer engineering programs.

PhD at Johns Hopkins

Hochheiser:

At what point did you decide that you wanted to go on from Virginia for a PhD rather than entering the workforce?

Foster:

Interesting question. I remember that day in particular. I was in the hallway and one of my instructors came up to me and said that I really should consider going for a PhD. I don't think the thought had occurred to me before. I was clearly heading for industry.

Hochheiser:

Yes.

Foster:

I didn't even think about a PhD. And from that day on, I just sort of went down that path. But if he had not said that, I'm not sure I ever would have thought of it. I still remember it these 45 years or so later.

Hochheiser:

What was his name, If you recall?

Foster:

No. I remember his face but I don't remember his name —

Hochheiser:

[Laughing] That happens.

Foster:

He was not a full faculty member. He was an instructor in one of the power laboratories.

Hochheiser:

And how did you come to select Hopkins for grad school rather than someplace else?

Foster:

When I was in my senior year I decided to interview with some companies to see if they [had] any programs for supporting graduate students. When the Westinghouse interviewer came to campus he mentioned that Westinghouse had a program in which 30 or so students would be hired and sent to graduate school. And he said "why don't you apply?" So I did. I came for an interview in Baltimore and I learned that they were not selecting thirty but only two. So I thought, okay well that's that, you know [Chuckling], I went away thinking that was dead. Then I got a call one day that I'd been

selected for this fellowship. They were offering to pay me a full salary and tuition and my job was to go to Hopkins and get a PhD. And when I finished, I would have a job. And I thought well, you know, I can't turn that down —

Hochheiser:

[Laughing] Yes.

Foster:

In the meantime I had applied for and received a National Science Foundation fellowship to go to Harvard or MIT. I had been accepted to both schools. So I went to my instructors to get their advice. And my mentor, Dr. Siegel, said I should take the Westinghouse offer. And other people said “take the Westinghouse offer,” all except for one other highly respected professor who had been on the faculty at Harvard and he said "take Harvard because it will affect your whole life.” And sometimes I look back and wonder if I had taken his advice, how would life have turned out differently. But, anyway, it was nice to have the reassurance of a full salary and a job waiting at the end of graduate school. NSF fellowships had to be renewed every year. And if your grades weren't good enough, your fellowship may not get renewed.

Hochheiser:

Right.

Foster:

The Westinghouse program was at Hopkins. It wasn't like “come with us and go to Harvard.” It was —

Hochheiser:

Go to the local first rate university. [Chuckling]

Foster:

That's right. But Hopkins wasn't as well known for engineering as the other schools. And I also knew that I would come out with a somewhat lesser reputation because Hopkins is great in medicine, but engineering was not known to be its strength at the time. But, anyway, it turned out fine.

Hochheiser:

How did this arrangement with Westinghouse influence what you studied in graduate school?

Foster:

My Westinghouse manager said "we need PhDs in solid state physics or solid state engineering. That's the up and coming technology and we want you to go study that in particular." So it was clear; the curriculum was pretty much laid out. This program, I guess, was an agreement between Hopkins and Westinghouse. You come here and take these courses and do your research, write your thesis and you get your PhD in solid state engineering. I didn't know anything about solid state. I think it was my weakest area in school. But I said “oh well, that's where the need is, I think I can learn it.” So I went to Hopkins and started studying solid state physics and engineering, even though it would not have been my choice. As it turns out, it was a good decision because solid state was the future. And so people decided that for me without me having the vision to know that.

Hochheiser:

And what did you do your thesis on?

Foster:

The interaction between ultrasonic waves in crystals and drifting electrons. I had seen a paper written by Don White at Bell Labs about how it seemed possible to amplify ultrasonic waves in a crystal by applying an electric field across the crystal. And that sounded like a great idea because you wouldn't have to convert ultrasonic waves into an electronic signal to amplify them. You'd do it all in the ultrasonic medium. And so I decided to go into that field. And while I was doing my research, I accidentally discovered a phenomenon that I had not predicted. And I took it to my faculty advisor and asked if it would be an appropriate thesis subject. He agreed. So, by accident I discovered something that allowed me to write a thesis and finish in four years, whereas, if I had tried to prove what I thought I was going to prove I might not have succeeded or would have taken another year. Who knows how long it may have taken? But I was just lucky, I stumbled across a phenomenon interaction between drifting electrons and phonons and it was worthy of a thesis.

Hochheiser:

Who was your thesis advisor?

Foster:

Dr. Jan Minkowsky, who was a survivor of concentration camps during World War II. He was tough as nails. Nothing fazed him because of his history. And he was a really excellent mentor. He has since passed away. I worked in the Carlyle Barton Laboratory which was funded, in general, by an Air Force contract. So the equipment was there, paid for by the Air Force grant. Another grad student, Don Dernburg, was already working in a laboratory on a contract and I was just able to join his lab. I used the same equipment and I pursued my research while he was pursuing another subject, using the same equipment. That meant I didn't have to build the equipment, it was already there. I just got to run my experiments and go in my direction simultaneously with him doing his. And we got our PhDs on the same day in ‘67.

Hochheiser:

How much contact did you have with Westinghouse while you were being paid by them to take your doctorate?

Foster:

The first summer, part of the summer, I went to the Westinghouse education center in Pittsburgh where all new engineers go. It's [a] sort of indoctrination into Westinghouse. The second summer I did laboratory research halftime to learn something about lab work. And the other halftime I studied French and German because French and German were both requirements for a PhD. I had had one summer semester of German at UVA and then I finished learning enough German and French to pass the language exams. And after that summer I didn't go back again except for a once- a-year review. I'd go in and tell them how I was doing and they would say, "keep going and then come back when you’re finished." So there was just that once a year contact.

Hochheiser:

So it was '67 you finished your PhD.

Foster:

Yes.

Going to Westinghouse, SAW Devices

Hochheiser:

And now you actually come to work for Westinghouse.

Foster:

Yes. I went to work in what was called the Advanced Development Department, which was working on advanced concepts. That lasted for about a year but then there was a reorganization. Dick Linder who later was the president of the Defense Center, at that time was manager of a department called Equipment Design. He folded in all of the Advanced Development people into his Equipment Design department. And I was put into a group doing advanced development. I remember one day I was in the lab standing in front of a vacuum system doing experiments in thin film transistors and Dick walked up to me and said "I'd like you to work on optical signal processing." I had no idea what optical signal processing was. It was like, change careers, drop what you're doing. “Optical signal processing is coming along and we think it might be important; we'd like you to learn about it.” So I started studying up on this new thing called optical signal processing.

Hochheiser:

About when are we talking about now when you - ?

Foster:

Well I would say 1968 to '69.

Hochheiser:

So it wasn't long from your arrival that you moved off into a whole different area.

Foster:

Right. And after several years of study, we concluded that it did not seem practical, that you would always find a digital approach to signal processing that would be as good. And that you could not justify a whole new technology to do something that was not

really significantly better than alternate approaches. So [in] about 1971, after we had worked on it a couple of years, we wrote some papers summarizing our results. Some of the consulting engineers with lots of experience took a look at all of this and I think they decided "okay, that's enough investment in that area. Let's give up and move onto other things."

Hochheiser:

Right. You had demonstrated that it was not an economically viable alternate approach.

Foster:

Yes. Whereas, when we started we thought it might be fantastically better.

Hochheiser:

But you don't know until you try.

Foster:

Right. And I don't think anybody ever built any practical optical signal processing devices, at least within the next decade or two that I was aware of. We were trying to do a fast Fourier transform optically. If you can do very fast spectrum analysis using the Fourier transform that results from the geometrical aspects of optical signal processing, it seemed like that would be wonderful. But now, of course, fast Fourier transforms using digital technology are inexpensive. But in those days it was a big deal.

Fortunately, not too long after that I got to use my research work for a useful project. Around 1970 or '71 there was a contract to upgrade the electronics including the pulse compressor in the FPS-27 radar. In those days, the idea of using surface acoustic waves for pulse compression was new. I had read a few papers on surface acoustic waves and I was familiar with the Bell Labs work in ultrasonics. Most of their work was in bulk acoustic waves, not surface waves. We developed a 13-bit Barker Code pulse compressor using surface acoustic waves that turned out to be very successful. We put it in production for the upgraded FPS-27 radar. We wrote a number of papers and spoke about it at the Ultrasonics Symposium. No one had ever used surface acoustic wave devices for production, so they were impressed.

Hochheiser:

So now what's the chronology? Were you working on the SAW devices and the optical signal processing roughly at the same time?

Foster:

About the same time. I cannot recall if we had written off optical signal processing at the time we decided to do the SAW device. It could be just about the time we were writing off one -

Hochheiser:

- and the FPS 27 opportunity came along -

Foster:

- and I collaborated with two other engineers, one of whom was really a filter designer.

Hochheiser:

Right.

Foster:

And so I guess I worked on that largely full time for about a year or so before other opportunities and challenges came along.

Thick Film Technology, Vietnam War Contracts

Hochheiser:

And was it after the SAW device project was finished that you became a supervisor? Or was there something in between.

Foster:

In the west building there was a laboratory called the Hybrid Electronics Lab. We were just beginning to make hybrid subsystems like low noise amplifiers subsystems that would go into systems like the FPS-27. Thin film technology was the only thing that people had been using up until that point to make the circuits. Thin film circuits were not as cost effective as we needed. So we decided to start investigating thick film

printed circuits. We investigated the properties of printed gold, mainly gold transmission lines, the impedance properties and then, of course, the mechanical properties. And over a period of several years we developed a very cost effective technology for printing circuits and resistors and capacitors and conductors, although I think we later went on to add bulk capacitors and bulk inductors. I was very much involved in that activity. We were writing papers because the industry had not used thick film microwave technology for anything.

Hochheiser:

Right.

Foster:

I was informally leading a group. And about '72 or '73 my supervisor at the time, Wally Hoff, who later became number 2 at the Defense Center, won the Westinghouse Lamme fellowship.

Hochheiser:

Right.

Foster:

He went to Cambridge, England for a year. Before he left, he asked me if I would take his group while he was gone for that year. So, I inherited from him a number of signal processing engineers and ongoing contracts. The Vietnam War was going on. We had contracts with the Army at Aberdeen Proving Ground.

Hochheiser:

Right.

Foster:

There were several contracts to develop systems that would really help the soldiers on the ground. One was a very advanced mine detector that would detect not only metal mines but plastic mines that appeared as voids in the earth. One of them that Wally Hoff had pioneered was called an Improved Position Locator which was really a back-mounted compass that was stabilized so that it was a good compass, and a distance

measuring device which consisted of a coil on each of your ankles. It measured every step that a soldier took and resolved that into north and east components by using the compass signal. So, a soldier could walk wherever and know where he was and also could reverse his position and come back to where he started. It was like a poor man's GPS in those days. I inherited that contract, which was also being conducted for Aberdeen Proving Grounds. And Wally had another job which was to control dogs in the battlefield. We would mount electronics on a dog so that you could tell which way the dog was pointing and you could give the dog instructions and tell him which way to go. When Wally came back at the end of a year, we split the group and he took the signal processing half of the group and I took the microwaves half of the group. I was still not a supervisor - I was a group leader, but in those days a supervisor position was hard to get because they were very limited in number.

Hochheiser:

Yes.

Promotions and Solid State Radar

Foster:

The next promotion was to fellow engineer. I was doing a supervisory job but they gave me a fellow engineer title because that's all they had. I continued from that point on supervising groups, but on the microwave side.

Hochheiser:

Right.

Foster:

At that time there was a revolution in military electronics occurring - converting radar systems to solid state. The power amplifiers all the way through the entire transmitters were being converted to solid state. And, fortunately, we had some fantastic engineers and we were leading the world in solid state radar transmitters. We won all the development contracts that came out, like from Rome Air Development Center and others. And we kept building higher and higher power radar transmitters, mainly UHF, and finally got the contract to convert the SPS-40 transmitter to all solid state. That was, by far, the highest power solid state radar transmitter in the world, 240-KW. And in 1978 I became section manager. I was responsible for four groups, one of which was

developing solid state transmitters. One was the Hybrid Electronics Facility and one was doing high power solid state modulators for tube transmitters. So, basically, I started managing in about '73. Informally. And continued that until I retired in 1990.

Hochheiser:

When you're working on these conversions to solid state radar, was this largely upgrading existing systems or developing entirely new systems or some combination of the two?

Foster:

Well, the targets of opportunity were existing systems if you could convince the government radar program manager that his system could be more reliable by converting the transmitter to solid state. We targeted the SPS-40 because that was known to have a very unreliable transmitter. And you could get the statistics on how often the ship was in port having its transmitter repaired. We were able to get development contracts from the SPS-40 program office. Prior to that we had been building solid state drivers, which is one stage before the final amplifier. We had some good success at L-Band with the TPS-63.

Hochheiser:

Right.

Foster:

We converted its driver to solid state, which was a huge reliability improvement, although we didn't replace the final transmitter tube until many years later. So we were proving our capability with targets of opportunity -systems that we already had that were unreliable and the customer was unhappy. We could convince them to convert pieces of it to solid state, always hoping that we would get the opportunity to convert the entire radar to solid state. As I said, we eventually got permission to convert the SPS-40, which was UHF. UHF transistors are much more efficient than those for any higher frequencies. So it's easier to make the conversion in UHF, around 450 megahertz. And at L-Band which is 1.3 gigahertz, transistor efficiency is dropping off.

Hochheiser:

Yes.

Foster:

In those days S-Band, 2.7 to 3.00 gigahertz transistors were really falling off badly, but we were beginning to push. I thought we could do something in S-Band someday and there are some S-Band systems that could be converted. In the meantime I think we did the driver for AWACS, which is S-Band. We made that solid state. So we were just doing pieces at a time, converting a piece whenever there was an opportunity. Looking for the big payoff, which was whole transmitters.

Hochheiser:

And you got there.

Foster:

Yes. The other thing that was happening a little bit later was that the television industry was converting to digital. And, as you know, now it's converted. But in those days there was going to be a mandate that everything had to go digital, which means you have to abandon all your VHF transmitters and build a whole new family of transmitters at UHF. So going after the whole industry of solid state broadcast transmitters was something that was targeted for a while. Then the government decided to put off the mandate for a few years. So the market went away for a while. It came back later.

Hochheiser:

Right. So by '78, or so, you had four groups reporting -

Foster:

Four groups, yes. It was called the Power Generation Section.

Hochheiser:

And by this point, were you spending all of your time managing rather than doing engineering directly?

Foster:

Oh yes. I think there were 45 engineers in the group.

Hochheiser:

That doesn’t leave any time for you to do any engineering [Chuckling] does it?

Foster:

Well no. No, not any design engineering. But those were very technical jobs we were working on. So I was closely involved with the people doing the work because you have to make decisions about things. And if you don't understand, you can't make a decision. Fortunately people were very patient and explained to me what they were doing. So I was able to go out and help get money to continue going down certain development paths. Even though we were in an equipment design department, we were trying to push the state of the art in some certain areas.

Hochheiser:

Right.

Foster:

We had a mission. We were going to convert radars to solid state. Well you can't do that without money and opportunity. So I would try to understand the technology well enough to help with the decisions and with getting the contracts, the opportunities to do it. Then I was part of the selling team, to see the SPS-40 program manager over and over, until we convinced him that we can actually build a solid state transmitter.

Hochheiser:

So you were going out. Did the customers come from the various military groups?

Foster:

Yes. There were also program offices within Westinghouse. You'd get with a program manager whose job it was to go after the SPS-40 transmitter. So he and I would go to see the SPS-40 program office in Crystal City. And he said, "I've got a real reliability problem." And, we said "we think we can solve it for you, let me demonstrate this solid state amplifier. If that works we'll demonstrate more power to you.” So you do it in pieces. And eventually, when you've demonstrated that it can be done, then by that time the SPS-40 program manager had sold the Navy on the idea.

Hochheiser:

Now so would there, in this case with the SPS-40, would there have been a specific Westinghouse program manager you worked with?

Foster:

Yes. Charlie Smith. Charlie was in charge of selling it, not managing it after it came in.

Hochheiser:

Right. He was in charge of selling it. Once it came in were you the one who was -

Foster:

Well no, because if you win it, then there's a program office here that matches the Navy program office. By that time I had moved on to other jobs. The program was won by my successors and the program office. They set up a program office to do the development of the transmitter, and then go into production.

Hochheiser:

In this job who did you report to?

Foster:

I reported to Hank Airth at the time who was an engineering vice president of that part of Westinghouse.

Management

Hochheiser:

How does one manage a technical group of this size and nature for success?

Foster:

[Chuckling] I hadn't thought about how one does that. Well, I think managing is more about leading than directing. My approach was [to] try to inspire people. To have them

able to work on the most advanced projects that were going to make a big difference. My job was to help get the funding and approval to do really exciting things. The leaders in each of these groups were excited to have the opportunity to do that. So we worked together to create for ourselves an interesting future, a future where we could contribute. If you're going to convert transmitters to solid state that's a big deal and, look, we're all in this together. My job was sort of inspirational. Of course, it has to do with putting the right people in the right jobs and sometimes taking people out of jobs who didn't fit. So I think that that was a large part of it, trying to understand why do people work. I think engineers work because they believe in the cause. I'd far rather be involved in work that everybody considered great and was worth doing than work to get a salary. So I was always looking for how to find the inspiration so that everybody was going [to] be really excited about what they're doing.

Hochheiser:

Right.

Foster:

And I remember very vividly, I was in an environment where there was a factory part of our building and every day at 3:30 when the bell rang there was a big group of factory people running down the hall trying to escape as fast as possible. You could interpret that as trying to get to the parking lot to avoid the traffic jam but you could also interpret it as "let me out of here, I hate it and I can't stand one more minute." And I thought let's try to not live life that way.

Hochheiser:

Who were some of the key people who worked under you in your group during these years?

Foster:

Well, in the solid state group, the transmitter group, Al Morse, who became eventually a consulting engineer, and recently retired. Al was an outstanding designer of the most advanced power combining circuitry for combining lots of transistors in parallel so that they wouldn't kill each other and so that you could get all of the power out, without significant efficiency loss. Ken Lee was the supervisor of the group, whereas Al was the fellow engineer. So in a sense we were a partnership. Ken would supervise the group, Al

would do the technical leading and I would just sort of run interference for them. Certainly those were the two most outstanding people in that group.

Hochheiser:

Right.

Foster:

In another group, the one that developed high power radar modulators, Ed Hooper was the senior technical person and Ed Piechoviak was the group leader. And between them they were leading the industry in solid state modulators for high power radar transmitters. It was exciting to be at the forefront of that technology too. One other group was the hybrid electronics facility. Mike Kline was the person who ran that group for many years. And later in my career when I got another assignment to do something which I guess we'll talk about later, I recruited Mike to come over and take on this new assignment with me.

Hochheiser:

Yes.

Foster:

Because he was a real go-getter. He thrived on making that hybrid electronic facility succeed. It was a prototype facility that was actually a factory. It was producing production equipment in parallel with the real factory. When they needed a solid state amplifier that was hybrid they'd buy it from us. We had technicians and engineers working there and we were a miniature factory that was supplying production equipment.

Surveillance Radar Systems, Matrix Organization

Hochheiser:

So then you left the solid state program. When would that be, in the early 80's?

Foster:

'82.

Hochheiser:

'82, and then you moved on to surveillance radar systems.

Foster:

Yes. The way we were organized was that the program offices that were in charge of various radar systems had an engineering component. Lou Meren was the engineering manager of that division. He assigned me to be the engineering manager in a particular portion of that business which was called Air Force Surveillance Radars and included the TPS-43 which was a backbone radar of our business. The TPS-70 was coming along, as was a radar system for a European country. We were supporting development of new radars like the TPS-70 plus existing radars that had been in production for a few years; the TPS-43 was going through an upgrade, and, again, it was back to interacting with the customer to convince them that you can build an improved system.

Hochheiser:

Yes.

Foster:

We had lots of international visitors who would come in and I would give them a presentation about our new radar systems. I remember one particular Japanese visitor who had jet lag and he asked to be allowed to stand up during the presentation. So he stood up during the entire presentation because he knew if he sat down, he would fall asleep. He was just trying to stay awake long enough to listen to what we were saying. That was 1982. I think we had four different radar developments going on at the time. There was an engineering manager reporting to me for each of those radar developments.

Hochheiser:

Yes.

Foster:

Their job was to go to the design departments to get the design engineers for their project. So at that point my job also involved helping to sell these new radar systems to international customers.

Hochheiser:

And it's now primarily international customers rather than US customers?

Foster:

Well they were US radars.

Hochheiser:

Right.

Foster:

And we were upgrading them for the US government. But there was an agreement with the US government that if you can find foreign allies to also buy radar systems at the same time, it increases the total pool of development money. It was part of foreign military sales. So we were selling to Argentina, Turkey, and other allied countries that were buying the same systems that the US government was buying.

Hochheiser:

Yes.

Foster:

So it was like a parallel sale. You sell to the US government and you sell to its allies. And so you never know what the day would have in store. One day you come to work and you find that there's going to be a contingent from Argentina today. Can you speak to them? You have to have your presentation ready, because you don't know from one day to the next who's going to be there. They show up and you're called on to come in and tell our customers about our new radar systems.

Hochheiser:

Were there language problems or did these visitors speak English?

Foster:

On rare occasions they would have an interpreter. And so you would have to speak slowly and wait for the interpreter to finish the sentence. Other times they spoke English. But I didn't speak their language ever.

Hochheiser:

Right. I'm just curious - you're dealing with international customers, people whose native languages aren't English, how do you communicate?

Foster:

Well, they are in America to buy an American radar. So they know that they've got to bring along translators or they've got to understand English well enough to get along. So by the time they got to me they had already faced that problem.

Hochheiser:

And who did you report to in this position?

Foster:

Lou Meren. Dick Koehler was the program manager of the Air Force Surveillance Radar Department. Lou Meren was engineering manager for several product lines. There was also an Army radar product line with another program manager and engineering manager.

Hochheiser:

And about how many people did you have in the organization under you at that point?

Foster:

Well, solid line, only four or five managers or so.

Hochheiser:

And did they each have people under them?

Foster:

Dotted line. That is, they would go to the functional organization and recruit engineers for their project. The way the matrix organization works is that there were a lot of local group supervisors and section managers like I had been in those design groups. The engineering manager went to the design groups to recruit transmitter engineers and receiver engineers and some signal processing engineers. And the supervisor allocated people and managed them and the engineering manager oversaw this process because he was working with the engineers and their supervisors in parallel. It was a cooperative arrangement where you didn't have to have those people reporting to you directly.

Hochheiser:

I see.

Foster:

And the matrix organization still works very well, as far as I know. Westinghouse was very proud of its matrix organization. And they now call it the Home Room. The Home Room manager is responsible for the technology and the well-being of all the people in the group. And when a program manager wants something done, the Home Room manager takes on the responsibility of leading engineers to accomplish it. And the program manager or the engineering manager from the program office is still in charge, sort of, but it's a shared responsibility. Because he can't take on the direct leadership of all those engineers. Some program offices do that more formally. They move the people into the program office. But, even then, their Home Room supervisor is still responsible for them. And when they finish that assignment, their next assignment is the responsibility of their Home Room manager. That process worked very well and still works very well, as far as I know, but I've been gone ten years.

VHSIC, MMIC and a New Radar Factory

Hochheiser:

And then from there you moved onto the VHSIC project?

Foster:

Yes.

Westinghouse had one of, I think, five government contracts to develop a VHSIC (Very High Speed Integrated Circuit) chip set. TRW had one, IBM and Honeywell had one. I forget who the other one was. But we each had roughly $50 million contracts to develop a VHSIC chip set. The government was taking the initiative to develop high speed chips because industry was not going to do it. So I became manager of the VHSIC program without any knowledge at all of the subject. I mean it was really amazing how little I knew about the subject. [Chuckling]

Hochheiser:

Yes.

Foster:

I didn't understand the language and technology of integrated circuits. I had never been involved with that technology before and I was overwhelmed by it. The first day on the job I learned that we had 75 government customers who were going to come in three weeks to do a program review because the VHSIC program was high profile. There was a community of government reviewers who would go from one company to the other for periodic reviews. And so, 75 were going to be coming the third week of January for a day and a half review. I was supposed to give the summary initial presentation, 45 minutes [Chuckling] and so I remember how overwhelmed I was. I had to organize a day and a half worth of presentations for 75 customers and I had to try to avoid sounding like a complete fool. And [Chuckling] that was just very scary. Fortunately, a lot of really good people were on the project. And so I would call them in and say, "tell me about this, or that." And they would tell me and I'd forget most of it instantly because I had no context to remember it. I think I lost 90% of what they said. But they were very good people. And we were able to pull together a very successful review in three weeks and I gave the [Chuckling] opening presentation, of course, with lots of coaching from my subordinates, and it went quite well. But it's certainly a good example of learning under pressure. And the learning didn't end then.

Hochheiser:

Yes.

Foster:

The review ended and I still had to learn what it was all about. I had that job a couple of years. And it was a wonderful experience. Our subcontractor was National Semiconductor, so I'd go out once a month for a review in Santa Clara. And, of course, AI was learning every minute. Their job was to produce a VHSIC chip set. Our job was to design it. So we had an east coast design team and a west coast production team. That was an excellent learning experience, to work with a commercial semiconductor house and learn their culture and their technology.

Hochheiser:

Yes.

Foster:

Wally Hoff was my manager at that time, too, because he was in charge of the entire Westinghouse signal processing activities, including VHSIC. So, fortunately, I was able to continue learning from Wally in that job too, while managing the VHSIC contract, which was a subset of the larger set of technologies that Wally was in charge of. I did that from '85 for two or three years.

At that time there was a growing understanding of the importance of microwave integrated circuits using gallium arsenide for the future, because radar systems at S-Band and especially X-Band depend on gallium arsenide, not silicon. So I started using my experience with silicon integrated circuits to influence the local operations in gallium arsenide. The Westinghouse Advanced Technology Lab was working in that technology but wasn't making fast enough progress. We realized that we needed progress faster than they could make it with the investment that was being made. We had to find out what other companies were doing with it and how to make this technology available. And so I was asked to take some program responsibility for gallium arsenide MMICs (Monolithic Microwave Integrated Circuits) at the same time as VHSIC. Companies were developing their own versions of VHSIC chip sets and that technology didn't need too much more push from us. But gallium arsenide microwave integrated circuits were just in their infancy and they really needed a big boost. And we needed them badly for the radar systems we were going to be involved with, which were mostly in X-Band and above. So I started working on MMICs around 1987 or '88, taking a lead in trying to get the efficiency up to something that we could use.

Hochheiser:

Yes.

Foster:

Well that was the time in '87 or '88 when the predecessor for what's now the F-22 fighter was being developed for the Air Force. There were two competitors, Lockheed Martin and Boeing, and their radar was being defined along with the whole plane. The question was whether it would be a passive electronically scanned array (ESA) or an active one. What do I mean by that? We use the term "passive" to mean that the power is generated in the transmitter and is distributed to the radiating elements by a manifold and it uses phase shifters to switch the phase of all the signals going out from the radiating elements. The problem with that kind of system is that there is a 3 dB loss on transmit and another 3 dB loss on receive, so you lose three-quarters of the power that you generate. That loss was acceptable for the radar for the B-1 bomber because it's a big plane, with lots of prime power and a large enough antenna that you can afford to lose the power. But in a fighter, the radar antenna has to be much smaller to fit in the nose and the prime power available is much less. So the radar design became a contest between the tried and true technology which is passive phase shifters, the B-1 technology, versus putting amplifiers in transmit/receive modules on the antenna. You don't lose 3 dB going out and you don't lose 3 dB when the signal comes back. The echo goes immediately to a low noise amplifier which sets the noise figure. So it became clear to the systems engineers who were doing in-depth analyses that the only way to build the radar that would work would be to use transmit/receive modules at every one of the radiating elements. Well, there are roughly 2,000 radiating elements on an antenna and each one requires a microwave assembly that normally costs $10,000 to build by hand. So that's $20 million per radar just for the transmitter and receiver. That ignores everything else, like the antenna. Clearly unaffordable. So we knew that if we were ever going to be able to build modern radar, the opportunity to change the whole paradigm in how radars get built, then we had to prove to ourselves and to the customer that we could build 2,000 modules cost effectively for every radar system. And there were going to be hundreds and hundreds of radars. So it required a design that could be manufactured and a manufacturing process that would be highly automated and error free. Motorola had demonstrated how to build high quality, complex electronics in high volumes with essentially zero errors using Six Sigma. No inspection - you don't inspect quality in, you just build quality in. So we had to have a culture transformation. And we had to find where we were going to get the gallium arsenide MIMICs we needed. The power amplifier was the biggest challenge. And we had to be able to assemble all of those MMICSs and other components into a transmit/receive module and produce them at a price of roughly $400. We had to reduce the price from $10,000 to $400. And we had to learn how to produce them about 40 times faster than we ever had before. I was given the job of getting us in that business. So in 1988 my job

became manager of antenna modules. And I was also manager of the Microwave Design Department. My biggest challenge was to take a portion of the department and focus on affordable transmit-receive modules. There were lots of other things going on in the department, but those were, in general, well-led self-sustaining groups and I don't think I had to invest much time in those - but the one that was going to make the difference for the future was the group that was designing the solid state transmit and receive modules. And then I was also in charge of building a factory to produce them. It was interesting that the engineering department was given the responsibility to build the new factory, instead of the factory management.

Hochheiser:

Yes.

Foster:

Because the factory was known as old-school-build-it-by- hand and not willing to change their culture. Not nearly fast enough to win the contract for the F-22. So we ran very fast to build an automated factory that would build the modules and we worked in parallel designing the modules themselves. The factory technicians were under the direction of engineers within the factory and that was pretty revolutionary for the time.

Hochheiser:

Right.

Foster:

The lab was the show piece of the entire complex. I remember one day when there was a presidential election and Dan Quayle was the vice president running for re-election. He visited Westinghouse on election day. He came around to the new factory and I have a picture of me from the Baltimore Sun and Dan Quayle is leaning over a microscope in my lab and Dick Linder and the CEO of Westinghouse were standing behind me. We were showing off this new factory that was going to be the future of radar systems.

Hochheiser:

Yes.

Foster:

We were very proud of it. I brought Mike Kline over from the Hybrid Electronics Lab and said “Mike, I want you to help me build this factory of the future.” Our partner was Texas Instruments. They were already building modules like this. They had their own design which we didn't agree with. And Texas Instruments was trying to become the leader in this technology. We realized that we had to also build these modules or Texas Instruments would become our supplier by default. And we would lose the business to them.

Hochheiser:

Yes.

Foster:

We had a cooperative arrangement where Texas Instruments and Westinghouse created dual factories that were similar to each other and we shared the production. Then that factory went on to become the factory for the radar for the Joint Strike Fighter which is coming up. Now it's a very modern factory that produces all parts of the radar system. And it's now the basis for most everything they do in radar, including some ground-based radar too. You can use those same modules in X-Band, tank-mounted or Jeep-mounted radars. I'm proud that we got to be pioneers in converting over to a technology that's now the central technology in their radar business. Those were interesting days.

Engineering Manufactuing Advisory Council

Hochheiser:

One other thing I noticed from your resume from those days is that you represented Westinghouse on the Engineering Manufacturing Advisory Council of Westinghouse.

Foster:

Yes. That was an organization of engineers and manufacturing managers across the corporation. We would come together every few months to compare best practices across different Westinghouse divisions. Some members were from defense but most were not defense. I remember giving them a presentation about our manufacturing challenge - that we had to produce these modules and how we were doing it - and they were really impressed. We were suddenly labeled as the leader in advanced

manufacturing within Westinghouse. They weren't doing anything like that. The use of statistics and Six Sigma was something I was trying to get them to do and I think they never concluded that they needed to do any of that. But for us it was essential - if we didn't do it, we would not ever succeed. Fortunately there were good pioneers who had done that before. There was an American who went over to Japan after the war, Edward Deming.

Hochheiser:

Edward Deming, yes.

Foster:

And he showed them the importance of Six Sigma and then [Genichi] Taguchi got involved at that time. It was adopted by Ford and Motorola. I went to Motorola and visited their chief engineer and he told [me] what they did and I came back and said "we've got to do what they do" and, fortunately, we had some people who agreed with me. And we were able to make that transformation.

Westinghouse Baltimore Memories

Hochheiser:

Before we move onto your years in Pittsburgh, is there anything else from these several decades in Baltimore that we neglected to cover?

Foster:

No I think we covered it fairly well.

Hochheiser:

Then let me ask you one more question. What was Westinghouse Baltimore like as a place to work: atmosphere, camaraderie, social activities, anything that comes to mind?

Foster:

Westinghouse, in my opinion, was the best there was anywhere in the world in terms of technology. Occasionally I would think perhaps I should go to work for some other company. Then I would think, why would I do that? You cannot get any better work than

this anywhere in the country, in terms of defense. We led the country in the areas of technology that I was interested in. I felt that the people I was working with were always topnotch. There was always an air of cooperation. But I didn't have any real comparison; I never worked anywhere else.

Hochheiser:

Right.

Foster:

You're so busy you don't spend a lot of time talking to people in other companies. You don't even know people in other companies. So I didn't have a lot of comparison. But I had no reason to believe that there was any better opportunity anywhere in the country to go work. And looking back on it, I still think that's true. I remember [Chuckling] in 1977 or '78, I think, Dick Linder asked me to head the hardware design portion of a proposal to build a solid state phased array called Pave PAWS (Phased Array Warning System). The Pave PAWS system was in competition, and Raytheon was the main competitor. I think GE was also proposing. Raytheon was proposing to build it in a fairly conventional way. So was GE. And we had had some success in solid state transmitters so we decided that we were going to propose solid state. So I became part of a two-person selling team, Omar Jacomini, who was a consulting engineer, and I went on the road to convince the Air Force that they should build the Pave PAWS radar as a solid state phased array. We developed the transmit/receive module and demonstrated that it would work. We wrote a great proposal and the Air Force chose us in the sense that they thought we were the best technically, but Raytheon came in at $19 million less. The Air Force customer said he couldn't justify not going with Raytheon because their bid was $19 [million] less than yours. So we lost. Later we heard that at the first meeting with the Air Force Raytheon raised their price about $19 million. They found a way to underbid us and then to work the customer to get the price to be what it needed to be to get the job done.

Hochheiser:

Yes.

Foster:

We were just too straightforward and we bid what we thought it was going to cost, and we lost. My career would have been different had we won that job because I would have

had some major role in a really big phased array development program. That was an opportunity lost. Later in my career, I competed against Raytheon in other areas and lost again. I was always angry at them for what I thought was dirty dealing. So I was biased against going to work for Raytheon because I did not like them.

Hochheiser:

Right.

Foster:

Who knows if it was accurate? But it's just my perception.

Hochheiser:

Yes.

Foster:

So you asked if anything was going on during that time. In addition to running groups, occasionally I would get an assignment: take over this portion of a huge proposal – Pave PAWS. It was a $100 million proposal. And in those days that was a lot of money.

Hochheiser:

Yes.

Foster:

$120 million I think, But aside from the fact that we couldn't beat Raytheon, it was still a good place to work.

Hochheiser:

[Laughing]

Foster:

Raytheon is very good at Army radars. They are highly respected by the Army and so they win. They control a number of important Army systems, like Patriot.

Moving to Pittsburgh, Westinghouse Troubles

Hochheiser:

How did your move from Baltimore to Pittsburgh come about? You're the first person I've interviewed who spent any time in Pittsburgh after arriving in Baltimore.

Foster:

Well, in about 1989 the corporation was getting a little nervous about whether the research labs were being run in such a way that they were getting their money's worth. The labs were costing a lot of money and we never get very much worthwhile from them. So, the vice president at the research labs at the time, Isaac Barpal, decided that in order to have the research labs be useful, it had to have business unit people manage it on behalf of the business units. So they came to their electronics division, which was here, and asked them to send somebody. They asked me if I would be willing to move to Pittsburgh to manage the electronics portion of the research labs on their behalf. I realized that I would never get such an opportunity here in Baltimore. Because here, to become a general manager, you have to run a part of the business. And my background was not running businesses. My background was technology. The only opportunity I was going to get for a big promotion was this opportunity to manage technology, which I'd done most of my career.

Hochheiser:

Yes.

Foster:

Besides you needed a PhD, by definition. Well, there were practically no PhDs around. So this PhD that Westinghouse had paid for all those years earlier paid off because at the time there was practically no other PhDs to choose; maybe one or two, but they weren't interested in management. I was the only PhD around who was interested in management. There were some good managers around who could have done a good job but they didn't have a PhD. And so I went to Pittsburgh to try to improve the electronics research that was feeding into Westinghouse defense - microwave components, various solid state devices, and microelectronics. There were four or five groups already doing research that could pay off for Westinghouse, but it was not paying off.

Hochheiser:

So these are groups in Pittsburgh who might be able to connect to the work in Baltimore.

Foster:

They were already being paid to do it. Every division was being taxed to send money to the research labs, but not much was coming back. That was the perception. So the plan was for me to go to Pittsburgh to represent defense and see if I could make that research more productive. So I went up around the beginning of 1990. And I arrived there and took over five groups or so. There was another manager from another part of Westinghouse who came in to be the general manager of the part of the research labs that was doing work in chemical processes and energy-related technology.

Hochheiser:

Yes.

Foster:

There was a third general manager who was involved with industrial electronics, high power electronics and information technology. After I was there about a year or so the vice president decided to eliminate that position and split that division. So all of that general manager's electronics departments were given to me and everything that he was doing that was energy-related was given to the other new general manager. So then instead of having three general managers there, there were two. I then had nine departments and 220 people, many of them PhDs. And they were all doing what I considered to be really excellent work. It was fun to be there because I was involved with leading nine departments, all doing work that I thought was going to make a big difference for some part of the corporation. We would give presentations to the president of Westinghouse and the CEO and let them know what was happening and show them this is really going to make a big difference for Westinghouse.

Hochheiser:

Yes.

Foster:

But about that time Westinghouse was getting in financial trouble. They were in financial trouble largely because they had invested in real estate development, developing hotels, malls, shopping centers and there was a collapse in that market. Westinghouse had loaned lots of money to those developers, and when those developers went bankrupt, they couldn't pay back the loans to Westinghouse. The corporation was bleeding the operating divisions, including Baltimore, to stay afloat. And, about '95, a new CEO, Michael Jordan came in to take a fresh look at what to do with Westinghouse. He did a lot of analysis and concluded that we should concentrate in broadcast. Westinghouse already had a broadcast division and he bought CBS to add to it.

Hochheiser:

Right.

Foster:

That was in the summer of '96. And he decided to sell off the other divisions. So he sold the Distribution and Control business unit. He sold the power generation business to Siemens. They were headquartered in Orlando. And every time he would sell off a business the researchers would go with it. So the research organization was dwindling. Northrop Grumman had already come to Westinghouse to buy Electronic Systems and the Westinghouse CEO said it was not for sale. But when he went through all his analysis and decided to invest in broadcast and divest everything else, he announced that Electronics Systems was for sale. Northrop Grumman showed up first. They said “we're not leaving until we get it.” They started negotiating and when they left they had it. I was sold to Northrop Grumman, along with 130 people from the research labs. And other parts of my division were left with the other general manager, to serve the other parts of Westinghouse. These 130 people were now the Northrop Grumman Science and Technology Center -

Hochheiser:

In Pittsburgh.

Foster:

In Pittsburgh. So I was the director of that center. And I continued to do that for a while.

Returning to Baltimore

But it became clear that my manager at Northrop Grumman in Baltimore was not comfortable having a director in Pittsburgh making the decisions that really needed to be made here [in Baltimore].

Hochheiser:

Right.

Foster:

So it became evident to me that I was not needed there and I may as well come back home. And so I asked if they could find a place for me to come home.

Hochheiser:

What happened to the 130 people in Pittsburgh after you came back?

Foster:

I recommended one of my managers to take it over. He managed it for about a year. Then Northrop Grumman decided that they no longer could justify having their research labs in Pittsburgh. So they decided to make offers to some of the people to come here and others, no offer. They decided who the most useful people were and offered them a job in Baltimore. But some of the best people looked around and found other high tech jobs in Pittsburgh. So only about a dozen of those people came to Baltimore, although more than that received offers to move. About a dozen came here and are working on different technologies and the rest of them are employed elsewhere. They also moved some of the equipment from Pittsburgh to Baltimore, and I think they sold off the other equipment.

Hochheiser:

So what did you do? What position did you find back here in Baltimore?

Foster:

The position I came to was to head up a proposal for an aerostat-borne radar system. It had various names, but eventually it became known as JLENS, Joint Land Attack Cruise

Missile Elevated Netted Sensor. It was intended to defend the troops against incoming missiles several hundred miles away. There were two competitors, Raytheon and Northrop Grumman. Raytheon had been funded to develop an approach to solving that problem. The RFP specified a problem to solve and we proposed to solve it with a solid state UHF radar and an X-Band radar hanging under a tethered aerostat. The missile defense command in Huntsville wanted the technology that had been developed by Raytheon. And only Raytheon was proposing it. We weren't. So we lost to Raytheon.

Hochheiser:

That's tough.

Foster:

When we lost, I had to move on to another job. I was given an assignment to be in charge of two businesses, both in electronics. One of the businesses was infrared sensors for missile warning. If you are being attacked by a heat seeking missile you want to be able to detect the heat seeking missile and either deploy a decoy or shine a high powered infrared source at it to confuse it or defeat it. We were building the infrared missile warning receiver. And that's very, very difficult technology because if the receiver accidentally looks at the sun it would be blinded. So you had to be able to look for a very, very, small infrared signature of a missile and be able to exclude the sunlight. It required about a billion to one rejection. We had to use some very good filters which were being developed in one of [the] groups in Pittsburgh that I had been in charge of before. That receiver eventually went into production. And it is part of the DIRCM, Directed Infrared Countermeasure system in which the countermeasure is now a laser. Northrop Grumman builds that system to protect high value aircraft. Originally they used flares as decoys. Later they developed the laser to blind the incoming missile. The other business was infrared cameras for night vision surveillance. There were two or three different systems that we were building and some that we were competing to build. I was in that job until near retirement.

Hochheiser:

Right.

Retiring from Westinghouse, Going to UMBC

Foster:

I decided to retire in 1999 because my technology background was not a good fit for their current needs.

Hochheiser:

Because the nature of the operations had changed after Northrop Grumman took over?

Foster:

Yes. And because the people they needed were radar program managers or radar business managers. Well, I was not experienced as a radar business manager.

Hochheiser:

So when you reached the minimum retirement age it was a good opportunity to leave on good terms and move on.

Foster:

Yes. I was unhappy with not fitting their need, because I had spent my whole career working very hard at being productive. I no longer felt that I was contributing enough.

Hochheiser:

Yes.

Foster:

Fortunately for me, a local university, UMBC, was interested in my background. Wally Hoff wrote their president a letter of introduction for me. Coincidentally, the College of Engineering had extra money in their budget that year and they made me an offer to come as Assistant Dean in the engineering college. And I've been there ten years.

Hochheiser:

I think your current position is probably both too recent and outside the scope of the project.

Is there anything that I neglected to ask you about that you might be -

Foster:

No, I think you've been very thorough.

Hochheiser:

I try. [Laughing]

Foster:

The process of looking at the résumé and devising questions based on what you read there is a very good technique.

Hochheiser:

I never know, if sometimes there are questions that I don't know to ask -

Foster:

- and sometimes, you know, something you say would trigger a thought.

Hochheiser:

Exactly. So I always like to leave that open-ended opportunity.

Career at Westinghouse

Looking back how would you characterize overall your career here with Westinghouse?

Foster:

Well, I was always interested in doing things that I thought would make a difference that is technology oriented, that would be used and would be significantly different or profoundly different from what had been done before. Because, as I had said before, you really need to enjoy what you're doing, and you've got to feel challenged. And I only feel challenged if something that I'm doing is going to make a big difference. And because I worked hard, I was given some promotions. Northrop Grumman still does that. They look for people who are movers and shakers, who are going to make a difference. I was lucky that I had a chance to do it some, although I recognize now the

people they're promoting do it better than I did. I'm glad to see that they're promoting some very sharp people.

Hochheiser:

Okay. Then unless you have anything else you'd like to add, I think we're finished.

Foster:

Well I'll only think of things after I leave.

Hochheiser:

If when you read your transcript, you think of something that you would like to have spoken about, you can add it to the transcript.

Thank you for your time.

Foster:

It went well. And it went quickly too.

Hochheiser:

Well, I thank you very much for taking part. It's a pleasure to meet you and it was a pleasure listening to you talk about your career.