ORAL HISTORY: William Gretsch

About William Gretsch

William Gretsch was born in Brooklyn, New York in 1933. He studied electrical engineering at Bucknell University, and after graduating went to work at the Glenn Martin Company. After a year at Glenn Martin, Gretsch went into the Army for six months of active duty – and 7.5 years of reserves – in the Signal Corps. After active duty, Gretsch went to the Aircraft Radio Corporation, and while working there he attended NYU for his Master's. In 1961, Gretsch started working at Westinghouse Baltimore assigned to the Typhon project. Over the course of his career at Westinghouse, Gretsch became part of management – working as supervisor, manager and engineering manager – and participated in many important projects such as AWACS, Apollo lunar TV and airships. Gretsch retired from Westinghouse in 1995.

In this interview, Gretsch talks about his education and career, focusing mostly upon his years at Westinghouse. He discusses the many projects he was a part of, particularly AWACS, for which he served as manager of development and engineering, and was one of the 'four horsemen' of the project. Gretsch also talks about becoming a manager and the changes that involved, as well as his style of management and the challenges of juggling projects and working directly with customers. The organization and atmosphere of Westinghouse is also discussed, as well as many of the colleagues Gretsch had over the years including Earl King, Dave Mooney, Johnny Pearson and Wayne Fegely.

About the Interview

WILLIAM GRETSCH: An Interview Conducted by Sheldon Hochheiser, IEEE History Center, 13 April 2010

Interview #543 for the National Electronics Museum and IEEE History Center, The Institute of Electrical and Electronic Engineers Inc.

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It is recommended that this oral history be cited as follows:

William Gretsch , an oral history conducted in 2010 by Sheldon Hochheiser, IEEE History Center, New Brunswick, NJ, USA at the National Electronics Museum, Linthicum, MD, USA

Interview

Interview: William Gretsch

Interviewer: Sheldon Hochheiser

Date: 13 April 2010

Location: The National Electronics Museum, Baltimore, Maryland

Background and Education

Hochheiser:

This is Sheldon Hochheiser of the IEEE History Center. It's April 13th, 2010. I'm at the National Electronics Museum in Baltimore with Bill Gretsch. Good afternoon.

Gretsch:

Good afternoon.

Hochheiser:

If we could start with a little bit of background, when and where were you born?

Gretsch:

I was born in Brooklyn, New York, in 1933.

Hochheiser:

And where were you raised?

Gretsch:

I was raised in Brooklyn and out on Long Island in a little town called East Williston through grade school. And then I went to high school in Morristown, New Jersey.

Hochheiser:

What did your parents do?

Gretsch:

Well, my dad started out as a banker. In the Depression he was fortunate to have a job with Chase Bank. He had helped train one of the Rockefellers there. That was an interesting story. My mom was a housewife.

Hochheiser:

Were you interested in technology and science as a kid?

Gretsch:

Well, yes, I guess so. I was a photography hobbyist and interested in that. The technology was pretty simple back then, crystal radios and so forth, but I was interested in it.

Hochheiser:

How did you come to choose Bucknell rather than some other college?

Gretsch:

Oh, gracious. That's a long story, but I'll make it short. I was trying to get an appointment to West Point, and I was the third on the list for our district, and second, and then first. Then I went to get the physical, and I flunked because of overbite. And so at the last minute I had to scramble around because I had only applied to one other school. I scrambled around and my dad - well, one of our neighbors had connections at Bucknell. I went up there and liked it. And fortunately at that late date they accepted me.

Hochheiser:

Did you go to Bucknell with a particular course of study in mind?

Gretsch:

Yes, I went with engineering, electrical engineering, in mind. One of the main reasons was that everybody said that if you took electrical engineering and you flunked out, you could then go to other engineering. And [if] you flunked out of that, you could become a physicist. Of course all these people do not appreciate that assessment. I wanted to be in electrical engineering, and I started out in a class of 28 EE majors, and I graduated with a class of 14. So I got a lot of individual attention there.

Hochheiser:

What was the electrical engineering curriculum like at Bucknell when you were there?

Gretsch:

It was largely oriented around power and power machinery and so forth. There was a course in radio, one course, but that was it.

Glenn Martin Company, Military

Hochheiser:

What led you from Bucknell to Glenn Martin Company rather than some other opportunity?

Gretsch:

Well, times were good then, and so we had a lot of recruiters come to the campus. And Glenn L. Martin was in Baltimore and close to where I wanted to locate. I went down there and interviewed, and they had some interesting projects, and so I picked them.

Hochheiser:

And then after a year, you went into the service?

Gretsch:

Yes, yes. I was fortunate. I got the six months active duty for training program. So I was able to go six months active duty and then seven and a half years of reserves in the Signal Corps, where I got some additional electronics experience, so that was good.

Hochheiser:

Were you a member by this point - or at Bucknell - of either the AIEE or the IRE, the [IEEE] predecessors?

Gretsch:

Yeah, I was an IRE member in college and then kept that up all throughout my career as the organization evolved. And I always enjoyed the publications. I was sufficiently overwhelmed by some of them in my early career, but then found them to be terrifically valuable.

Hochheiser:

So you spent six months active duty in the Signal Corps.

Gretsch:

Right.

Aircraft Radio Corporation, NYU

Hochheiser:

And then when you got out, what led you to Aircraft Radio Corporation [rather] than going back to Glenn Martin or something else?

Gretsch:

Well, that was also geography. It was interesting. I went to high school in Morristown, New Jersey and Aircraft Radio Corporation was in Boonton, nearby. They were a pioneer in aircraft radios and made, I'd say, Cadillac-class radios for private planes that were very high-performance, and they had a real nice bucolic location in the countryside with a campus, full of smart people. When I was on leave from the Army, I interviewed with them, and when I got out they offered me a job. I really, really was quite fortunate then.

Hochheiser:

What did you do at this company?

Gretsch:

Well, I started out at the bottom in engineering, which then was environmental test of components. And I learned there about the physical limitations of components and materials and so forth. In college, of course, you learn a resistor is of certain value, and that's it. But in the real world everything is variable, and it's only good within certain ranges. So I learned through environmental tests. I appreciated the real-world limitations of components. And then I tested complete equipment, and then I graduated to the design section and designed receivers and transmitters.

Hochheiser:

Okay, and these are going into commercial private aircraft?

Gretsch:

Yes. And they were really, really well done. They were beautiful pieces of work, and we had an excellent manufacturing department, precision. It was good.

Hochheiser:

What led you to go back to school for your Masters at this time?

Gretsch:

Well, you know, I could see that I was going to hit a ceiling, and I wanted to be able to do more adventuresome things, more advanced things in my field. I knew I needed to learn more, so I went back to NYU. NYU was quite the hotbed in those days. Bell Labs was quite near where I was.

Hochheiser:

Right.

Gretsch:

And all the people at Bell Labs had to go to NYU for their Masters. It was required. So I decided -

Hochheiser:

This would have been the Bell Labs facility in Whippany?

Gretsch:

Yes, and over at Murray Hill too. So I knew that a lot of smart people were going there and the courses would be pretty good, and I managed to commute with some of them and went in a carpool with some of the guys who worked on the early transistors and were in the same section as [John] Bardeen and [Walter H.] Brattain and so forth. Then NYU was, you know, teaching the theory behind the transistors, Schrödinger's equations and all that kind of stuff, which people groan at now when they have to take. It's still an intimidating set of equations. But I really got a good, good experience, a good education at NYU.

Hochheiser:

And you were doing this at night while you were working?

Gretsch:

Yes. I'd commute into NYU. I'd leave Boonton and drive into New York, across Manhattan into the Bronx. They had a campus in the Bronx then.

Hochheiser:

Right.

Gretsch:

And so I commuted there. Being in the Army Reserves, I had to go away to summer field training every year. And one year I came from Fort Dix, left the bivouac in the field, went to my car, stashed my rifle in the trunk, changed my uniform to civvies, drove into New York, drove back and went out into the boondocks again at night, stumbling around in the dark. I think that was to take advanced differential equations or something like that.

Going to Westinghouse, Typhon

Hochheiser:

What led you to leave the aircraft company and move to Westinghouse in '61?

Gretsch:

Well, I got my Masters, and so I told my boss I just got my Masters. And he said well, you're the same guy today as you were yesterday. So I got the hint that it wasn't going to really make much difference and they weren't really - they were doing very straightforward radio design. I wanted to do things that were on the cutting edge, so I started looking around and interviewed a lot of places, and was fortunate to come down to Westinghouse, where I was hired on at Parker Road at the Typhon project, which was a neat project. It was cutting edge everyplace, so it was great.

Hochheiser:

What was the Typhon project?

Gretsch:

The Typhon was a ship-borne radar, a big active aperture, a phased array using traveling wave tubes for each of the elements, a huge thing. And it had a frequency diversity pulse Doppler mode, and it had a beyond-the-horizon type mode, a pulse mode. Pulse Doppler was just coming into the fore. Harry Smith and the team had just invented it, and there were experimental programs going on and so we decided we'd put it in the production system. So I was in charge of the FDPD receiver, Frequency Diversity Pulse Doppler receiver, and that was a neat project. To implement a Doppler filter bank we did

in analog the equivalent of digital signal processing, but instead of integrating in digital circuits as is done now, we integrated on capacitors, charging up the capacitors and adding the voltages. It was really an analog Fourier transform machine. We split the signal into in-phase and quadrature components using mixers 90 degrees out of phase. And we had analog multipliers. Nowadays, of course, we have digital multipliers. One board was a flip-flop, one whole board. We used crystal filters in the intermediate frequency stage of the receiver to filter the signals, and very low-noise tubes in the front end.

Hochheiser:

And it worked?

Gretsch:

It worked, but we lost the competition to our competitor up north, GE. And that system became AEGIS, which is a wonderful system. But we didn't win.

Hochheiser:

Who did you report to?

Gretsch:

I reported to Don Tolj, who was a receiver supervisor, and then he reported to George Desai - these guys were great managers. They knew how to motivate us, I'll tell you. When we weren't working six days a week, we'd work seven. We had a tough schedule and, like always in all the development projects, tough schedule, no budget, and we had to meet specs that were well beyond the pale. They motivated us well, and we had a great, great team.

Westinghouse in the '60s, East Building

Hochheiser:

Mm-mm. What was Westinghouse Baltimore like in the '60s?

Gretsch:

Well, I think the culture was the same as it still is now at Northrop Grumman. It was really a very supportive culture. You had freedom to fail and great support when you got into trouble. You had good mentors. Smart people surrounded you that you could always go [to] and get help. It was that the production people and the engineering people and the purchasing [people] all worked very, very closely together. It was really, really a super place to work, and it always was, my whole career.

Hochheiser:

Once Westinghouse lost the Typhon to GE, I assume that assignment ended.

Gretsch:

Yes, that assignment ended. A couple of my friends had migrated from the Parker Road plant where we were over to the East Building to advanced development under Wayne Fegely. John Stuntz was the big, big manager. My friends had migrated, and they told tales of how great it was. And so I accepted [an] assignment over there in the receiver group and worked for a great boss, Andy Seman, and Wayne. We really got to do some super work. The greatest thing an engineer can have is an interesting assignment, and we had interesting assignments. We always had to do something that nobody had ever done before.

Overland Radar Technology, Theory of Distortion

Hochheiser:

What assignments stick in your mind after all these years as particularly notable?

Gretsch:

Oh, heavens. How much time do you have?

Hochheiser:

I guess the answer to that is we have a total of about two hours for the session.

Gretsch:

Well, my first assignment was ORT, the Overland Radar Technology receiver. I knew that it was coming along, and I worked on some other things, but I was a hardware designer

for that. And then I had to have an operation for my eyes, so I was out for a few months until I could come back and see well again. Well, I came back and the contract had all come in, so we went to work on that. That was the predecessor of AWACS - it proved the theory. We had a receiver that was really super on that for the time. We had a vacuum tube in the front end, a ceramic tube, and that's what we used in the low noise front end. We had some transistorized circuits. We used the crystal filters in the IF, which were made up in New England by a guy who ran a crystal filter company, who was a musician by background so he understood acoustics and sound and all that. That's the way crystal filters worked, by propagating sound waves thru the crystal.

Hochheiser:

Right.

Gretsch:

And so we worked with him, and one of my jobs was to get the filtering right in it. To explain a little bit about the radar, you have to have - can I gesture?

Hochheiser:

Please.

Gretsch:

All right. In a radar you've got good signals here, and then you've got all these nasty signals out there you don't want to pass in. You have to get rid of the nasty ones, so you want a very, very sharp filter to get rid of the nasty ones. The trouble is if you make a sharp filter, then the transient response goes on forever. When you bang it with a big signal, and the filter rings. And then that ringing causes false signals to appear in additional time slots. And so you have to have a filter that has no ringing, but it's got to have sharp skirts to get rid of the nasty signals. I'd learned at NYU about Butterworth filters and Chebyshev filters and how you optimize filters for time response as well as frequency response. And so we had some interesting filter work done in that. The other thing we were tackling there, which we tackled for a few years, was a problem of distortion and trading distortion off for low noise. When you lay out a receiver you've got all these stages, and the first stages are very low in signal level, and they're very susceptible to noises that are in the circuit. Then when you get to the end, the signals are very big, and you don't care about noise, but you do not want them to distort or they will create false signals. So if you take the little signals and you try and make them

big, you get intermodulation distortion because amplifiers are not perfect. We were using transistors then, and we had no real good theories about where the distortion came from, so we were fighting that.

Fortunately, about the same time, Herb Grauling won a contract for an instrument landing system that had similar requirements.

Hochheiser:

About when is this?

Gretsch:

This was in the '60s. The instrument landing system from FAA had to have two channels, and you steered the airplane by the difference in the signal between the two channels, so you couldn't have any distortion in that. Herb had some funding, so I got a chance to work on the theory of distortion in transistors and ended up developing some useful rules of thumb, and some accurate theory and equations and so forth, which was published in the IEEE. I just looked it up last night, and it's still being cited nowadays.

Hochheiser:

That's great.

Gretsch:

So that's nice to know.

Hochheiser:

Yes.

Gretsch:

Anyway, the paper was called The Spectrum of Intermodulation in a Semiconductor Diode Junction. Now isn't that a mouthful? But we were able to make the signals going through the receiver be large enough to overcome the noise, but not so large as to distort. And we were able to design the circuits and all the semiconductors to not produce intermodulation or fault signals.

Hochheiser:

And was this receiver designed for a specific larger project, or was it more of a development type thing?

Gretsch:

Well, a lot of the things we did were development because we did the first ones of everything, you know. So that receiver was designed for the instrument landing system. Then the ORT receiver used that technology as a predecessor to AWACS, to prove high PRF radar could be implemented. In our group we did a lot of the advanced receivers.

Digital Filtering, RMS Radar

I went to a symposium in Chicago on digital filtering in which I learned how to implement a fast Fourier transform in digital circuits that would do filtering just like a physical filter, and with more flexibility. The filter bank in ORT would have been huge and impractical, so we wanted to filter digitally. To do this we needed an analog to digital converter (A/D) that operated at faster speeds and with more bits than was within the state of the art. We got a technology program to develop the critical circuit in the A/D, a sample-and-hold and Frank Fialkowski in my group developed it. Irv Kaplan, who headed up the digital processor group, got another project to work out the digital processing. Frank Fialkowski, Johnny Pearson and I went to Seattle to convince Boeing to let us change our approach. Harry Dost was the Boeing Program Manager of Westinghouse. Johnny had figured that by changing to digital processing we could cut our bid greatly, and Boeing let us change. This later proved to be a big boon to us in the fly-off against Hughes, which we won.

We earlier developed radar which was called the RMS radar. Now that's not what you think. It's not root-mean-square. It stands for Reuter, Mooney and Stull: Hal Reuter, Dave Mooney, and Kiefer Stull. They were the three gurus behind it. For that one, the technology was so different. We made the receiver out of pieces of solid aluminum with little compartments in them so you wouldn't get any feedback from the front to the end, and each little compartment was like a little resonant filter cavity. Because it was solid aluminum the resonant cavities would not vibrate and create false signals. Now we use PC boards and the filters are digital filters which cannot create false signals from vibrating.

Hochheiser:

Right.

Gretsch:

It goes all on a chip. You don't have to worry about that. But in those days you had to really make things tightly shielded and buttoned up and so on. One of the stages of that receiver had to have a filter. For that filter - of course here I was pretty green out of grad school and so on. I'd taken all this stuff in class, but I'd never really done it. I said oh, a filter's got to have Ls and Cs, inductors and capacitors. Well, I'll make myself an inductor. Okay. Here is a copy of the inductor right there. I looked up the equations. I wound a couple of turns of wire, and I put it in the circuit with a capacitor, and by golly, my filter worked. I said, you know, this stuff I learned in school works. So from then on I said okay, I'm going to start using all these equations and so forth with much more confidence. But that filter was a neat achievement for me; and I saved the copy of the inductor all those years because it was kind of like a big 'aha.' I mean these things really work.

Colleagues and Organization

Hochheiser:

Who were the people you worked most closely with in this lab?

Gretsch:

Oh, gracious. There were some great guys. In the first place I worked with some of the system architects. We had great system architects. These guys were brilliant - Dave Mooney was one, and Bill Skillman. I used to go over with my hat in my hand asking what the spec on noise is, and what's the spec on distortion, and filtering and transient response because we can't do it all at once. And the architect would say well, you know, I've got to have this much, and I've got to have that much, and your filter's got to be so much. You'd say man, those requirements are tough. So we would go back and forth, and they'd say well, I can trade off a little bit somewhere else in the system. We will let a little noise pop up there and so on. These gurus were great in terms of really understanding what the hardware people were having trouble with. The architects were very good.

When a system first came in, we drew a block diagram for it, which is maybe obsolete nowadays because it's all on a chip. But we took every stage; we drew a little box around it and then Tom was assigned the first stage, and Harry that one, and so on. Then the

stable local oscillator, the STALO, was assigned to another group, and the transmitter group designed the transmitter. It was all divided up, and then the organization for the program was structured around that block diagram. Like they say in architecture, form follows function. So our organization and our work breakdown structure, and our money flow and all, followed the block diagram, so we could keep everything all organized. These system engineers were great at the tradeoffs on these block diagrams. The interfaces would be designed together. The architects would put it all together into a system requirement spec and say well, the radar can now see a certain size target a certain number of miles all that kind of stuff. They were great to work with.

Then the other folks we worked with, I mean I worked closely with, were the other equipment designers because we really had to be able to give and take. It was collaborative. We were all in the same boat, and if I was hurting for making a requirement, somebody else could maybe give a little and vice versa. It was a great cooperative kind of environment. And the same - if I was ahead with my money, then with my allocation for money, I could free up some money to give it to somebody else who was in deep trouble and so forth. Same with manpower. If I needed some more help, some more designers, somebody would lend me some and so on. So we had a great collaboration. Then we worked closely with purchasing because, as I said, when I started out everything depended upon little components, and little components have to do what you want them to do within certain ranges and so forth. The purchasing department had to go and find them for us. And we'd maybe temporarily get a part from Radio Shack, but that wouldn't be mil-spec and we had to go back later and replace it.

Hochheiser:

Right.

Gretsch:

So we'd have to get one that would really be okay. The purchasing department was really great at going and finding things. We worked like this with them because lots of times we would get on the horn and go out to a vendor and help them build the part, so it was neat. We worked with purchasing, and of course manufacturing because everything we did had to be built by somebody – a real person with special skills. The first model was built by a model shop. There we got eyeball to eyeball with the guy running the lathe and the drill press and so on, and making the PC boards, wiring, building chassis, etc. Sometimes we would make the PC boards ourselves, and then we would install them in the chassis, so we worked very, very closely with the model shop.

The next stage was, of course, production, and all that stuff had to be all according to Hoyle as far as production standards and so on. Things are so great now. I've been retired since '95, but I bet they're even better because the tools now - the tools I had at the end of my career to make sure that we could design stuff that could be produced were great. The computer-aided design wouldn't let you do something that was verboten in the factory. In the beginning there were no rules. What did they used to say about Jack Kennedy's father - he excelled at games for which there were no rules? Okay, well, that's where we were. We excelled at games for which there were no rules. If we could build it, then the factory had to do it to our way. And we gave them many a headache, I will say. And of course we collaborated with program management. At that point, that was before I was in program management.

Hochheiser:

Right.

Gretsch:

Program management was always the bogeyman, you know. They were always mean. Get it done faster. Don't spend as much, you know.

Hochheiser:

And how long were you in this position?

Gretsch: I don't know. About 20 years, to the early '80s, I guess. Yeah.

Becoming Management, AWACS

Hochheiser:

Now at some point when you're in this area, do you become a supervisor?

Gretsch:

Yes. I was supervisor of a group and then -

Hochheiser:

About when did that happen?

Gretsch:

Maybe after ten years. I have forgotten all that now. Approximately.

Hochheiser:

So after about ten years of doing this on the bench, you're now a supervisor.

Gretsch:

A supervisor. Then I became a manager, and I inherited the transmitter, the receiver, and the STALO development groups. So we put together that part. Of course you always got special assignments too.

Hochheiser:

Right.

Gretsch:

During this period, one of my special assignments was for the AWACS brassboard. I was one of the four horsemen on the AWACS brassboard. That was a term which we never used again, although everyone said it was a successful way of doing things. We divided up the system into four pieces: the computer, the antenna, the receiver /processor and the transmitter. There was a horseman in charge of each one of those, and I was in charge of the digital processor, the receiver, and the STALO. The concept was that if you were one of the horsemen, you got all the money for the complete project in that area, and you got complete schedule responsibility. That was purchasing, design, engineering, factory, everything, so you were responsible for the whole thing. So you really had an integrated thing for your part of the system. That worked out pretty well. We were able to manage that very well.

Hochheiser:

When you were one of the AWACS four horsemen, about how many people did you have working under you?

Gretsch:

100, 150, something like that. For those who know about AWACS history, at that point everybody in the defense center worked for AWACS in one way or another. I mean it was just so big.

Hochheiser:

Yes, everyone mentions it, right.

Gretsch:

Right. So it could have been 150 direct, full-time. But everybody else had something to do with it.

Hochheiser:

How did you manage people for success of [the] project and for success of the people?

Gretsch:

How did I manage them? Well, you really have to get to know them and get to know what turned them on and what motivated them, and what they really wanted to do. About everybody was highly motivated to do the best they can and they could in their area. But that often produced conflicts with other groups, between the other groups inside their own technology and so forth. So you really had to know a lot about what they were doing, and you had to be able to give them some technical advice when you knew something that they didn't. Most of the time they knew more than you did, and you had to recognize that. You really had to realize you had people working for you who knew a lot more than you'd ever know. But you had to know enough to be able to understand their problems and help them solve them. You had to give and take and so on, and you had to be able to inspire them to work their tails off because all these things had tough schedules.

Hochheiser:

How did you personally find the transition from being the guy on the bench doing stuff to being the guy supervising other people doing stuff?

Gretsch:

Well, I found it interesting. It was interesting and fun, and I felt rewarded - satisfied or something - because I was able to do more through other people. Able to accomplish more through other people than I would ever do by myself, because the folks I had working with me were so good that together they could do much more than I could if I'd spent a lifetime in each of their specialties. So I really liked doing that and enjoyed it, but it was hard work. It was a lot of hours.

Hochheiser:

On the AWACS project, did you work much directly with the customer?

Gretsch:

Well, at that point, no. I mean I made briefings. I'd give briefings and write reports and so on, but I didn't really eyeball-to-eyeball unless there was a formal meeting. Later on I worked a lot with customers.

Hochheiser:

We'll get to later on.

Gretsch:

Okay, okay, good.

Hochheiser:

I'm just trying to figure [it] out. We're talking about this stage in your career and what's the scope and the nature of the things you're doing at this point.

Gretsch:

My customer was the program and that's who I worked with the most.

Hochheiser:

Okay. Who was the program manager you were working with?

Gretsch:

Well, the program manager or the assistant program manager. It depends upon the project.

Hochheiser:

Okay.

Gretsch:

But yes, that was interesting. I actually wrote some papers and published them in IEEE on program management because I observed that there was a feedback operation, a feedback process, and it followed the same equations as feedback that was written in whatchacallit's (Harold Black's) paper in the '30s. I don't know if you remember. Anyway, what happens in big program management is that there's an action going on. The program manager samples it at the output, and there's a time delay. And then that gets fed back to the corrective action at the input. Okay, well, if you know anything about a feedback, if there's a long time delay, it gets out of phase - they get oscillation. And so the program bangs back and forth between the stops, overreacts, underreacts and so forth. So you need to put damping in that, and you need to really make sure your sampling point for the data is real. It was a real interesting way to look at the way program management.

Hochheiser:

So managing a program is much like a negative feedback amplifier.

Gretsch:

Exactly right, yes.

Hochheiser:

Very interesting. So who did you report to?

Gretsch:

On the AWACS brassboard, Johnny Pearson. And you maybe have heard lots of reference to Johnny. Johnny was just a prince of a guy, a really good engineer and a prince of a guy, and a good manager, and a combination of grandfather and team driver. So I reported to him. On occasion I reported to the program manager directly.

That was kind of beginning before we got all organized and so on. But then I became a horsemen and they had it all structured, so I reported to Johnny, so it was interesting. Like all programs, AWACS waxed and waned. They had phases and so forth.

Juggling Projects, Tail Warning System and F-15

I still had my job as manager of the technology group, of the advanced development group, and I did that at the same time. So then I would go back to that full-time. At one point I was the engineering manager of the WX200.

Hochheiser:

Which is?

Gretsch:

It's a predecessor of the F-16. I got called back to AWACS and George Michaels, he's a terrific guy, took over the WX200. I had other special assignments back and forth. It was interesting. You had to wear two hats. At one point you were in a program, and the next day you'd be doing the technology and so forth. It was one of the strengths that we got to learn. For each of those programs, we got to develop technology and ways of doing things and there were lessons learned about program management and all that. On each one we learned something, and we applied it to the next one. We learned that way. You develop relationships among all these different technology groups, and that applies to the next one. We just built the capability, and we were very fortunate. We won a lot of things, and we were growing like crazy back then, so I hired a lot of good guys.

I worked with a fellow named Earl King who was in personnel. I don't know if people have talked about Earl, but Earl was just a great guy. He would go out to colleges and look for the bright guys in the field I was looking for, and we would interview them. I'll never forget one time - now you can tell the time period then. Earl was relating to these college kids, so he had fixed up his office. Now, Westinghouse was pretty square. He had an office with beads hanging down, and he had a big, big picture of Helen Reddy on the wall with colored spotlights on it and so on. These kids would come in and interview with him, and they'd say man, this is a groovy place, not knowing that after they were hired they would get out with a bunch of square technology guys. Earl was terrific, and he managed to get some great, great people for us. One of the saddest things - I'll jump ahead. One of the saddest things in my career is that at the end we had to let a lot of people go. Before Northrop Grumman rescued the company, we went through a real tough time. A lot of those brilliant people were let go. But we built it up,

and then the peace dividend came along. We won the Cold War. The funding dried up, and all those folks went out and became insurance salesmen or something. I don't know. That's life.

Hochheiser:

Jumping back, I guess we're back in the '70s . You're juggling, you're going back and forth. You have the AWACS project.

Gretsch:

Yes.

Hochheiser:

You've got your ongoing responsibilities in other special projects.

Gretsch:

Yes.

Hochheiser:

I'm thinking it must have taken an incredible amount of juggling to keep it all straight.

Gretsch:

Sure. I mean that's why it was neat. It was really great. One of the special projects we had was a thing called a tail warning system. This was a system that we put in the back of a fighter, in the tail. It had antennas, and it looked for a missile coming after it. It was a little radar. It sent out signals. If the missile came at you, you dispensed chaff, and the chaff dragged the missile off to the side. We had to test that. It was really one of the first active aperture phased arrays in solid state technology. [Pointing to two artifacts] The two things were little T/R type modules, transmit/receive type modules. This little artifact here came back from our field trial. This is the turbine blade from a missile. The way the field tests were arranged, we had a little hut, and the Navy planes would come in and fire missiles at the target, and the target was our hut. We put an offset into the software so that the missile would miss the hut. Of course, whenever there was a trial, the guys were sitting there with their fingers crossed. But anyway, one of the fellows brought this

back for me as a souvenir, saying when a missile hits the ground, this is about all that's left. We made it, so that was an interesting thing, an interesting diversion.

Another project we had in between AWACS developments was the F-15. We competed for the F-15 radar, which was a very, very big program. We built a model and had a fly-off with Hughes. I had become tapped to special assignments to be in charge of system integration for several of these systems. I would go up on the roof and run a shift where we would try and get all this equipment together and working. It was rudimentary software in those days. So this was a little souvenir of the F-15 radar development days. We lost that program to Hughes.

Hochheiser:

Right.

Gretsch:

But we learned so much from doing it because we used our R&D money and our IR&D, and we developed all this stuff. Then we got to use it, all this technology, in AWACS and the F-16 and so on. It's very interesting how each of these programs fed on each other, and we developed a technology over the years. Even when we lost, we gained. Don't tell that to the program managers you interview.

Hochheiser:

What role did you play in the F-15 program, and what is your perspective on why Westinghouse lost?

Gretsch:

I was in charge of the receiver and transmitter and STALO, that part of the system. And then I also got the tap to be in system integration - after all the stuff was designed and built, to put it together and make it work. So that was my role. I think the simple answer for why we lost was that the government was not going to give us both the F-16 and the F-15 at the same time because they didn't want to have all their eggs in one basket. And we knew that, but the government said we want you in there. We knew that we couldn't win everything because of the need for a broad industrial base for the country. So I think that's why we lost. But also in our fly-off, in our field trials, we didn't do perfectly. I bet Hughes didn't do it perfectly either, but we didn't do perfectly, so there was plenty of cause to reject us. Then there was a cost proposal and all that stuff, so a

lot of things went into it. I think at the bottom, if it really came to a tie, we wouldn't have won, but it was a great experience.

Apollo Lunar TV Project, Integrated Circuits

Hochheiser:

Jumping back in time a little, were you involved with the Apollo lunar TV project?

Gretsch:

Yes. One of my designers, a fellow named John Lenhoff, was a very, very good low-noise video circuit designer. John was on it, and I got involved in that program. John designed the front end for that camera, which was one of the first low-light televisions.

Hochheiser:

Right.

Gretsch:

Back then they didn't have handheld video cameras that operated in low light, and this thing would see in the dark. Of course it had to. John designed the front end, and I got involved in that. A lot of my folks supported him. It was a fascinating program in that all the components had to be - their origin had to be traceable back to the mine that mined the aluminum that went in the chassis, back to where they got the silicon to make the transistors. So we had a pedigree on every part on that, completely traceable. It had to be very reliable. Our part of it, although small, was a useful part of the program. We celebrated when we stopped work and watched the picture of the first step on the moon.

Hochheiser:

That must have been exciting knowing that you made those pictures possible.

Gretsch:

Yes, but the credit belongs to John and all the other designers.

Hochheiser:

Anything else from the ‘60 and ‘70s before we move on to the second half of your career?

Gretsch:

Oh, my. There’s so much. We worked a lot on integrated circuits in those days. The ATL, advanced technology lab - I don’t know what it’s called now - had an ability to build ICs. In fact, it was the premier captive IC facility in the world. It was completely dedicated to Westinghouse ICs, making them. So Sam Shepherd, in my group, set up near our offices a great big darkroom longer than this room. We tacked up a huge piece of film on one end, and we projected the masks from the other end. We cut out the masks from Rubylith, which is probably obsolete now. We used Exacto knives to cut out the little paths for the junctions and for the connections and the resistors and so on. We projected the masks on film on the wall, made all these masks like this, and then reduced them and reduced them, and reduced them, and reduced them, and we made the integrated circuits (ICs). Then we decided that was kind of awkward, and we tried to use computers. There was somebody up in New England who had a bunch of computers. Sam went up there and started to lay out the ICs on computers. Of course now we all have the software to do that. But it was really interesting using Exacto knives and so on. There were a lot of special programs we made ICs for that I won’t talk about.

Hochheiser:

I realize that there are some programs that even after this many years are still classified.

Gretsch:

Right, right.

Hochheiser:

You’re not the first person who said there’s this program, but I can’t talk about it. It’s the nature of the business.

Gretsch:

But I’ve got coffee mugs from all the programs on it, so -

Development and Engineering, AWACS and Quality

Hochheiser:

Okay, so then in 1979 you move on. You become manager of development and engineering.

Gretsch:

Yes.

Hochheiser:

And how did that change? I assume that was a promotion, or was that a lateral?

Gretsch:

I guess a promotion. That was for AWACS, Airborne Warning and Control System.

Hochheiser:

Okay, so the AWACS continued.

Gretsch:

Yes, it's still going on.

Hochheiser:

I know.

Gretsch:

Oh, yeah. I became the development and engineering manager for the Airborne Warning and Control division. So then for about five, ten years, I was completely devoted to the AWACS product line.

Hochheiser:

Well, but these are now broader responsibilities than you had.

Gretsch:

Yes. I was in charge of all engineering on the AWACS at that point. And I took over from a great guy named Hank Airth. Hank Airth had taken over from a great guy named Jay Fay who was the engineering manager early on [in] the program. Jay was the engineering manager on the production design, and Hank Ayres was engineering manager through System 19. I came aboard on System 19 when we were about to put a major enhancement in, which was called the Maritime Surveillance Capability.

Hochheiser:

And what was this?

Gretsch:

This was adding to the AWACS the ability to see and track hips at sea. So I came on board at that period, and System 19 - well, it's interesting that - I'll be philosophical here. Everything we did at Westinghouse was what I call short-run production. It was not like building cars where when you get to the millionth car you've got the bugs worked out. And it isn't like TV sets. When you get the ten millionth TV set, you get the bugs worked out. Here we had to work out the bugs, and System 1 had bugs, and System 2 had bugs. And by the time we get up to System 19, it was still very exciting. We had a tube in there called a klystron, really high power. It had 50 kilovolts in the power supply, and these things would pop like popcorn. We were using them like fuses, and replacements cost about $50,000 apiece. So this was a big problem in our production and also in the integration at Boeing and in the field, in that these things were state of the art and would tend to fail. Mean time between failure (MTBF) was not very good. I mean this is really hard to imagine now, but we turned out radars during the Vietnam War that had like three-hour mean time between failures. Three hours, okay? Guys would go out on a mission, and by the time they got home the radar would have worn out. The parts were not that good and so on.

So anyway, the AWACS tubes used to really pop. Along with that, we had a lot of other things in the systems that would be big problems in manufacturing and integration and in the fleet. I got a report on my desk every morning on every AWACS everywhere in the world and what its health was and where we'd gone wrong with it, and what's being fixed and so on. Even after System 19 we had a couple hundred engineers working on straightening these things out because we had gone into production with a development, just following a brassboard, the first development model. We wanted it to be perfect, but life is not perfect, and things would break. So we would just pound away and pound away and pound away at fixing these problems. And if something failed, we

would just put a team on it and get to the bottom of it. We had a great, great program manager named Jim Allen. He used to say just don't fix the problem, find out the source and stamp it out forever. This was before anybody talked about total quality, but that was the idea about total quality. Jim was ahead of his time, and a great manager.

Hochheiser:

Right.

Gretsch:

You found the problem, stamped it out forever. Lots of times it was a circuit design - something met requirements but requirements should have been tougher. Lots of times it was something being stretched too much. Lots of times it was something faulty, a part faulty in its manufacturing. Sometimes it was a manufacturing process that had to be improved. We had told the factory to put these things too close together or something, or they put them too close together by mistake. And it was just a huge variety of incremental improvements. We ended up with between 50,000 and 100,000 change notices before I left the program. The cycle time to build an AWACS when I started was three years, and by the time I left we got it down to a year and a half. That big improvement was because we didn't have the failures anymore on the shop floor, and we weren't getting things back from the field and so on. So it was interesting, a lot different than advanced development.

Hochheiser:

Yeah.

Gretsch:

You [have] got to realize what happens. After you do your advanced development and you made one that worked, you try to make more that work. You've got to get it right, absolutely right, over and over.

Hochheiser:

Yeah. And moreover, you're getting all this feedback from the field, from the units that are actually out there being used by the military.

Gretsch:

Sure, yes, and we had great guys. ILS, Integrated Logistics Support, folks were out there right with them, and they would get a hold of the part that had failed and send it back to us right away, or have a thorough report. So we worked with the ILS guys like this. It was a really, really interesting experience because I started out in the physics side of things, and then advanced development, and now I was working with the practicality. It was super. Of course as a result of all that - everybody had that experience in the industry - the total quality thing came to the fore, the Japanese way of doing things. We developed a lot of computer-aided design tools so you would always lay out boards in the same way according to certain design rules. We got qualified for 9000, which is a -

Hochheiser:

Right, ISO 9000.

Gretsch: - quality thing. There's probably a more advanced version now, but we got qualified for that. We just drove our processes down to be repeatable. That was interesting. I was so lucky. I got to work on interesting problems, some of them my own making.

Customer Contact - Boeing and Europe

Hochheiser:

Now in this role were you now working directly with the customer? Did you have direct contact?

Gretsch:

Yes.

Hochheiser:

So that would be another change from earlier in your career.

Gretsch:

Right. I had a great relationship with my counterpart at Boeing. Robbie Robinson was the engineering manager there. Every Friday night at about 7 at night I would have a

long phone call with him. We'd go over what's happening in the week and so on. He would tell me what their experiences were. I would tell him what we're doing about it here and what our experiences were. And in order to get a change in - which was ambitious to fix a problem; they called them class one changes [when] it affected form, fit, and function - Boeing had to sign on to them, and sometimes the Air Force had to sign off on them. So it was really valuable to have a close relationship with Boeing. And Robbie was a great engineer. He would just come in and dig in with us. He had a great, great staff. He had some of the pioneers in pulse Doppler radar working in his group, and he had experts in antennas and receivers and all that bit, so it was great to work with him. And then I got to know the program manager at Boeing and so on through that experience and through the process of presenting a case to make a change to make things better. That was great. Boeing was really good to work with.

Hochheiser:

Did you need to travel to Seattle much?

Gretsch:

Yes. I'd go out there once a month. And Seattle's a nice town, nice place. And a little later on in [the] period I got to travel to Europe a lot.

Hochheiser:

This was when the AWACS was starting to go to our allies' forces in Europe?

Gretsch:

Right, right. NATO was buying them. The UK had a system called the Nimrod, which General Electric of England had developed, and it wasn't working, so we wanted to sell them AWACS. I spent a lot of time with the RSRE in Malvern, Radar Signals and Research Establishment, something like that, in England. And I traveled to Geilenkirchen, which was the NATO headquarters for AWACS. We would help them understand what they were buying and how they were buying it and how to use it and help work out the support of them. They always wanted to have improvements of their own, so we would have to design them. We had improvements that we wanted them to put in their fleet to do a better job in Europe. And then with the Brits we really had to convince them that they should give up on their native company, General Electric of England, and buy the airborne surveillance from the United States, and that was a political fight. It was also a

technical fight. So I supported that. As part of that, one of the things the Brits wanted was to make sure they had employment.

Hochheiser:

Yes.

Gretsch:

If they stopped the local employment through General Electric, they wanted to still have hi-tech employment. We committed to giving them a certain amount of production. Then they said well, but we want to be on the cutting edge too. We want to do some R&D. So I put together a team and toured with some of the really smart guys at Baltimore - Jerry Klein in microwave, and Ted Foster in T/R modules, and Bob Nix in antennas, and a couple others top experts. We toured all around England to visit the premier technology companies. We visited the university where they were doing advanced development in computers and so on. We made a technology assessment, and we tried to figure out how to give them the most we could and how to take advantage of teaming with them on other projects.

Also, at the same time, NATO wanted to be in the game. Since they weren't developing their own, they weren't developing an inherent capability, so I put together a consortium of Italians, and Germans, and French. We worked up some proposals for the next generation of airborne surveillance for Europe beyond AWACS. That was really interesting to see because we had language - they all spoke English. I spoke English, so I was okay. But that was an exciting thing too, to see what the Europeans were doing. In some areas they were just so far ahead of us and in some areas they weren't. It was really great to be able to find the best in the world.

All during this period I had on my wall a biography of the chief engineer of the Russian AWACS. And I said to myself he's the guy I've got to beat. For Westinghouse it was no longer you had to beat Hughes or GE or anybody because we were preeminent. But the guy I had to beat - I had put together better systems, faster, that did more things and would not break and so on, and better than the Russians. So he was the guy I was out to beat. I never knew what happened to him.

Hochheiser:

Yes.

Gretsch:

I'm hopping around some. I'm sorry.

Hochheiser:

That's quite all right.

Gretsch:

Oh, I didn't talk about my little artifact here.

Hochheiser:

Well, go back and talk about it. I was expecting you to because now you're talking about England.

Gretsch:

When I was touring around England, they were real happy because they were going to get some employment and so forth, and they were happy with the team I'd put together. I went to a party in Manchester, in a hotel there, and they had baked a cake to celebrate, and this is the decoration from the top of it. Now this is 20 years old. This is sugar, which is now crystallized, and it survived in my basement a couple of floods and everything. There's the AWACS with a little dome on top and so on, put together by the chef at a hotel in Manchester. So that's another artifact.

Hochheiser:

Now since they were interested in employment, did that mean you needed to work with an English manufacturer rather than Westinghouse doing the manufacturing?

Gretsch:

Yes, just like as we did for NATO, we took parts of the system and divided them up and gave the Brits some things to build, and that worked out pretty well. They seemed to be happy.

Joint STARS, Contract Competition

Hochheiser:

Who did you report to in this position when you were managing the AWACS program?

Gretsch:

Well, it was Jim Allen in the beginning, and then Bill Adams took over when Jim moved on. Jim moved on when we were competing for Joint STARS.

Hochheiser:

Joint STARS?

Gretsch:

Joint STARS is an airborne surveillance system that looks at the ground. And it's operating now. It's very successful. It keeps track of all the moving traffic on the ground, and it helps direct fighters to interdict the bad guys on the ground. AWACS mostly worked against airborne and ships. But Joint STARS was a side-looking radar with a big long antenna on the side of it, and it had very high resolution, and it could detect things moving really slow and so on. So we were trying to win that.

Hochheiser:

Right.

Gretsch:

The incumbent was Northrop Grumman. We were competing against Grumman. Jim was a great program manager, so he tapped a couple of top management guys to run that proposal. I was doing the engineering for that. I built a model of the antenna to demonstrate that we could do it. Then Bill Adams took over for Jim Allen as the manager of Airborne Surveillance and Control up to the time I retired. Well, you always have two bosses. I reported to Bill for program stuff, but I reported up to a fellow named Kelly Overman from advanced development.

The hat I wore on that was for advanced development for airborne surveillance systems. The guy I directly reported to was Lou Meren who was the West Building engineering manager. So I had a bunch of bosses. During the latter part of the '80s we were competing for advanced development work for the next generation of airborne

surveillance and for the technologies that would support it. We managed to win the lion's share of all the contracts put out by all the government labs in airborne surveillance - of all the enabling technologies like computers and processors and antennas and other things, software and so forth. We were trying to position ourselves with the labs. It's really important to have the labs think well of you, because when a big program wants to get a contract going, they ask the labs who's good. The labs all evaluate your proposals for technical things.

Hochheiser:

So you're hearing now about the government labs like Wright and Rome?

Gretsch:

Wright,Rome, Hanscom and so on. Then MITRE, Langley etc. We were doing a lot of advanced development, including with Mac and Boeing. We were the best!

Hochheiser:

So you're looking for new development work at the same time you're dealing with the problems of the current system out there being used.

Gretsch:

Well, by late in the '80s we were getting AWACS under control pretty well.

Hochheiser:

So then you had more time to go and seek new cutting-edge business.

Gretsch:

And we didn't have to put all the engineering resources on the production system.

Hochheiser:

I understand.

Gretsch:

We needed to take care of our future because we could see that the bottom of the market was going to fall out, that the Cold War was over. We needed to position ourselves for the next generation, so we did that with all these development contracts and so forth.

AWACS Enhancements and Management

Another place for opportunities for us was enhancements to AWACS. There was an enhancement to AWACS that we, well, I identified it. My first day as AWACS engineering manager, I put up on the corner of my blackboard two or three things we had to fix. One was this tube I talked about.

Hochheiser:

Right.

Gretsch:

One was the fact that our computer was a pain in the neck. It would crash all the time. We'd have to reboot it and so on, so we needed a new computer. And we knew we might as well do new processing at the same time. Throughout all this period we were pinging away at the labs to get little development contracts and trying to advance the state of the art and that bit. Toward the end of this period there it all got put together into a program called RSIP. It's probably pronounced differently nowadays. That was an enhancement for AWACS that put a new computer in, a new processor in, and put a new man machine interface for control and troubleshooting and analysis of what's going on in the system. But the big thing is we made AWACS more capable of seeing very low cross-section, stealthy targets by putting in a whole new mode and changing the waveform and everything. It was really interesting because we started out being motivated by pulse Doppler, which is high pulse repetition rate, high PRF - a lot of pulses come along quickly. In this new enhanced mode, you see very small targets. That mode is what our competitor had used in the very beginning, and we licked them because we made our high PRF work. A big reason was because our system was reprogrammable as we learned what to do to optimize in the flight trials, and theirs was not reprogrammable. This was possible for us because, as I mentioned earlier, we had switched from analog signal processing to software controlled digital processing. But we'd all learned so much since then that we knew how to make another mode see real small targets, so we added the new mode. We practically redesigned the whole system for this enhancement, and by the time I retired we were building the first one of those. It's installed in the fleet now, and people are happy. Of course a big thing back then was

stealthy targets because we were still worried about Russia. Who else can build stealth fighters but us and Russia, right? Well, Russia faded away, but now we have these little RPVs. The other guy can have them too, you know. They're real tiny.

Hochheiser:

RPV stands for?

Gretsch:

Remotely-piloted vehicles, like the drones that they are using over in Afghanistan. They fly around and they shoot missiles and take pictures. And some of them have very low cross-sections. So little tiny cross-section targets were of interest. We knew that was coming, and we knew that we would no longer worry about the thing AWACS was designed for, which was a massive attack through the Fulda gap of the Russian air force of thousands of airplanes storming Europe. We originally had to be able to direct fighters to shoot down these airplanes, and that wasn't the scenario anymore.

Hochheiser:

Right.

Gretsch:

So we had to develop this low cross-section detection capability. RSIP put this into AWACS, and I imagine the guys are still working on further improvements and it's all classified. It's a great platform.

Hochheiser:

In your long tenure as management of development and engineering for AWACS, about how large a group did you have reporting to you?

Gretsch:

Well, when I was managing we had 300 or something. That was at the end. In the beginning, the very beginning of my career, there were a dozen guys in receivers. It sort of built up. But you know, the numbers are not important, it's the talent, the talent of these guys. And that's probably the great thing about working there now. You get to work with people who are really sharp and really know their stuff.

Going to England and Airships

Hochheiser:

Anything further on this before I ask you about Westinghouse sending you to England?

Gretsch:

No. If I think of anything else, I'll chime in, but you can go ahead, change gears.

Hochheiser:

So in 1991, Westinghouse sent you to England?

Gretsch:

Yes, right.

Hochheiser:

What led to that?

Gretsch:

Well, this was a special assignment at first, to start out with. At Westinghouse the Airborne Warning and Control division had gotten into airships. We had been bidding on airships. We won an airship advanced development contract for a big, big airship, and the idea is it would have in it a big, big radar. You could float around to any place in the world, and you could station it, and it could look around like an air traffic control system.

Hochheiser:

Okay. So there were specific advantages for which an airship seemed to be better than using an airplane?

Gretsch:

Right. It was cheap. It would just float around, and you could put the whole command and control system in it. We liked that because most of our lives the command and control was all done by the prime, Boeing or McDonnell Douglas or someone besides us. And we wanted to get into command and control. If we had the airship contract, we would get to do the whole ball of wax, so we went after this airship contract. As a special assignment, I got assigned to that even though this advanced development was going on, and it got to occupy more and more of my time. I was over in Europe, and I was stuck in London because there was an air strike over the Channel and I couldn't get to France for a meeting of our consortium on future AEW, so I was faxing back and forth stuff for a proposal. The phone rang, and Bill Adams called up and said, how would you like to go to England? I said I'm here now. [Laughter]

Hochheiser:

[Laughter]

Gretsch:

He said for [an] assignment for three years to take over the airship design company. The airship company that designed the airship itself was in England. It was a funny operation. We built the airships in North Carolina, but the design company was in England, and all the program management was in Baltimore. Talk about a nightmare of coordination! So they wanted their man over there. What had happened is that the previous UK airship company had gone bust. So Bill Adams and West Building people [like] Milt Borkowski [the West Building General Manger] decided they're going to just buy the part of it that designs airships and let the rest of it go where it may. So they bought the 25 guys and the files and the computers and all that for the design of airships. They wanted somebody to go over there and run it. I liked the idea of being in England, and I thought I've done about everything I can think to do in Baltimore. 1992 was a big year for the European Community and Westinghouse wanted a presence there for new business. I thought I could probably do well, make a contribution and so on in England. I would have five more years to work, and I want to do something new, you know. This sounded great, so I went over there to run the company.

Hochheiser:

Yes.

Gretsch:

Well, timing is everything, they say, right? We had a great bunch of guys. When the original company went broke, these guys stopped getting paid. They went to work in a hangar that leaked, had birds flying around. The water was running underneath their feet when it rained. The birds had droppings on their drawings, and so forth. They worked for a couple, three months without any pay just to keep it going because they just loved airships. These guys were really, really motivated, but single-minded. I mean nobody could manage them. People had tried before me to manage them, but nobody could manage them. Bill said you get over there and do that, so I went over there. I moved over there and rented a house and so on, and I started to work with them. We got it organized, and we put a lot of procedures in and got control of the money and the organization, got specifications. We went out to bid on a Ministry of Defense job for an airship, which was won after I left. There were a couple of airships flying around, so that was kind of a neat assignment. It was engineering that I didn't know much about. I mean aeronautical, airframe design, stresses and strains and a little light thing that floated around with little tiny girders. And the stress department was just like way out there someplace, so it was really, really interesting. Than Baltimore's contract came up for review for the big airship contract in some way.

Hochheiser:

For the airship contract?

Gretsch:

For the airship contract because the big airship contract was with the US Navy. And meanwhile everybody was having budget cuts due to the peace dividend and so on. Apparently - the story as I got it - Westinghouse went to the Navy and said we want to redefine this contract with schedule and cost and all that kind of stuff. And they said yeah, that's a good idea. How about we cut it in a tenth?

Hochheiser:

Somebody shouldn't have brought up the topic.

Gretsch:

Well, I'm simplifying. It might have been a fifth or something. But really cut way back. We developed some new business for the staff and we were doing pretty well financially, but they really started to look at the cost, and here I was an expat over there, expensive to maintain. So they decided to go with a local manager, and they brought

me home. If it had gone three years it would have been really, really great. So I came back and worked on this and that for a while.

Retirement, Staying Active

Hochheiser:

They didn't have really a good assignment for you when you came back? You worked on this and that?

Gretsch:

Because of the peace dividend the work dried up. It was deadly. You'd be in an office with all these guys. You'd come in in the morning and the guy to the left of you would be gone. And two days later the guy on the right of you'd be gone. They were just laying off like crazy. They had no new contracts and whatever they were doing in new business wasn't working. What happened is we ended up being bought by Northrop Grumman shortly after I retired. Now I think that worked out really well because the people that are there now really think it's great, and it's very successful. The culture is still alive and so on, so it worked out great. But at the tim[e] for me, that meant I was going to get the early retirement.

Hochheiser:

And is that indeed what happened?

Gretsch:

Yes.

Hochheiser:

You were - how would you put it - given the opportunity to retire early?

Gretsch:

Yes. I worked on some special programs. No one hardly knew anything about them. We were bidding on some black programs, that's all I can say.

Hochheiser:

I understand.

Gretsch:

We were doing a lot of black programs. I worked on a lot of those, but they were not going to put the bread and butter on the table.

Hochheiser:

They just weren't big enough programs?

Gretsch:

A lot of those black programs are feasibility or proof of concept. Then they turn into something that's really deployed after all their theory is worked out.

Hochheiser:

In what ways have you kept yourself active since '95, since you retired?

Gretsch:

Well, my last day I went to a stockholders' meeting over in the hangar. The first part of it was the presentation of AWACS to the stockholders. At the end of that, they mentioned all the people who were contributors, and I was one, so I was feeling great. But I had my walking papers, you know. Here I am sitting in the audience with my walking papers. I walked out with Dick Linder, who was the president. And Dick said sorry about that. Thanks for everything you did. So I left there, and I went to BJ's or someplace and printed up some business cards. I was going to go into the consulting business. Well, of course, everybody who was laid off was going into the consulting business. So I got one gig, and I've tried a couple others, but my consulting business never really went very far. But I did get involved in church, and I'm an elder in the church, and I have [a] couple committees that I work on, so that's a very, very, very important thing.

Hochheiser:

Right.

Gretsch:

I follow community affairs and so on, and I taught myself all about computers. When I was working, it was Windows 3.1. Well, now I've got my own couple of computers at home, and I do all kinds of things. I love to work on the computers and swear at them and so on. So that's it - and my family. Family's really important to me. Then for about four or five years I was a director in the museum here and helped write some papers as to what the museum could do to perk itself up. And it's come a long way. The present people running the museum are really, really good. We've got a great director, and the board is great, and they're doing well - it's come so far since the '90s. It's really, really good. I enjoyed that time, but my wife got sick then, and so I had to resign from the board.

Career, IEEE

Hochheiser:

Looking back, how would you overall characterize your career?

Gretsch:

Great. The second thing is I learned that the most important thing is the people you work with, the talent and the teamwork and so on. That's the important thing. The third big thing I learned is that all engineering is the application of non-linear differential equations without constant coefficients. What that means is the world doesn't behave like the textbook. But it's useful. It's really useful. You can't do anything without the theory. But you have to really understand that the world is different, and you have to appreciate that. That goes not only for resistors and capacitors but for software. Software is the same in that regard. Software breaks. In fact, if you go out and look at anything we do in life, it's the same. Things don't behave like you'd like them to. So you've got to be resilient and flexible, and you've got to be able to take the blows and bounce back up the next morning and love the struggle. If you don't love the struggle, then you shouldn't be in this business.

Hochheiser:

Sure.

Gretsch:

But I was blessed to be alive in times when the technology was moving. I was there when the first transistors came on board. I got to use them. Germanium with the purple plague and all that kind of stuff, and then ICs, and then fast Fourier transforms. It's just the whole technology has just been moving so fast: the signal processing, computers, Moore's Law, the explosion of computing capacity. The communications we have now with each other, the way we can tie together with each other with e-mail and Twitter and all that stuff. I use all this stuff. I love it. It has been just a great, great time to have a technical bent, and to want to do something - well, it's a big thing. The last word is people.

Hochheiser:

I know we touched on this a bit earlier - did your membership and involvement with IEEE assist in your career?

Gretsch:

Yes

Hochheiser:

Right.

Gretsch:

From time to time, greatly. Most of the time I was down in the weeds, you know. But from time to time the IEEE helped greatly because when I'd start a new project, I'd go over to the library. Back then we had the libraries. You didn't have Google. I'd go to the library and I'd dig out all the papers that had something to do with what I was doing, and read them and try and understand what other people had done and what didn't work. It was very, very, very helpful at that point because back then we had all the IEEE journals in our library. I had them at home, the ones at least in my field. So IEEE was very, very helpful. We couldn't have done some things without knowing what our predecessors had done because we couldn't afford to reinvent the wheel, and there was great stuff going on. I edited papers for IEEE for a few years, and I appreciate all that goes into vetting them. It's reliable, what you get. So IEEE has been a big help. Career wise, I don't know. I'd look at the salary survey once in a while and, big deal. Engineers don't work for money. I mean we're stupid.

Hochheiser:

[Laughter] Historians don't either.

Gretsch:

You do it because you love it, huh?

Hochheiser:

Exactly. Is there anything you'd like to add that we haven't covered or I neglected to ask?

Gretsch:

No, it's great that you're doing this project. This is really great. It's great for folks and great to get that history in the can because I think history is going to repeat itself unless we can learn from it.

Hochheiser:

Okay. Well, in that case, if you've got nothing further you'd add, I'd say we're done.

Gretsch:

I enjoyed it. I enjoyed it.

Hochheiser:

Well, so did I. I enjoyed listening to you, and learning about your career.

Gretsch:

It's nice to be able to talk about it.