# ORAL HISTORY: Len Svensson

## About Len Svensson

Len Svensson, born and raised in Queens, New York, attended Brooklyn Technical High School, graduating in 1949. Mr. Svensson credits his father for sparking his interest in electrical engineering. After attending the City College of New York, he was drafted into the Army in 1952. Mr. Svensson attended both the Radar School and the Nike Guided Missile School in the Army, where he mastered the engineering of both types of systems, teaching the maintenance of these systems to his fellow recruits. Once discharged from service, Mr. Svensson worked for Westinghouse Electronic Systems of Baltimore, Maryland in the Air Arm Division while attending night school at John Hopkins University (Class of 1960). After 1954, Mr. Svensson moved on to a series of other positions Westinghouse until his retirement in 1994.

During his career at Westinghouse, Mr. Svensson worked on radar for the fighter aircraft (F2), infrared systems, and the missile warning system. Afterwards, he expanded his work into the television sensors realm, building the first integrated circuit television camera. This milestone sparked NASA's interest, leading to the building of a lab system for low light-level camera tube usage. After winning the lunar camera contract with NASA, Mr. Svensson managed the team that built the camera used in the Moon landing. After working on the Moon camera project, Mr. Svensson dedicated his expertise to the Pave Spike project, which was an integrated TV/laser-pointing gimbal system that designates targets for laser-guided bombs. He was the engineering manager for several other l projects while at Westinghouse, including the Aquila remotely-piloted vehicle payload (consisting of a TV, laser and gimbal system), the engineering operations systems of the section of the Advance Development group, a sensor development project, and a missile warning system.

Mr. Svensson holds four patents in signal detection, dual antenna system, sensor protection and image stabilization.

In this interview, Mr. Svensson discusses his pre-Westinghouse days in the Army working with the NIKE Guided Missile System, the advances his team made at Westinghouse in the fields of radar and camera technology, and other projects he participated in Westinghouse that were, at the time, deemed classified. He goes into great detail on the components of the various systems he worked on and the progress that was made in each project. Mr. Svensson also reflects on his career at Westinghouse,

the camera project with NASA, and other government bids on several of the projects he managed.

## About the Interview

LEN SVENSSON: An Interview Conducted by Frederik Nebeker, IEEE History Center, 13 April 2010

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## Copyright Statement



## Interview

INTERVIEWEE: Len Svensson
INTERVIEWER: Frederik Nebeker
DATE: 13 April 2010
PLACE: National Electronics Museum, Baltimore, Maryland

## *Background and Education*

**Nebeker**:

Len, could we start with your background, where and when you were born and a little about your parents?

**Svensson**:

I was born in a place called Jamaica, New York. It's in the city limits not too far from Kennedy Airport.

**Nebeker**:

On Staten Island?

**Svensson**:

No, it's right by Kennedy Airport in Queens, Long Island. My father came from Sweden. He was a seaman and then he came over here. He got mad at the captain one day and left the boat. [Laughter] My mother came over on a ship also, and she started in Delaware and then went to New York. Because she wasn't learning any English in Delaware, she moved to New York, and had to work for people that didn't speak Finnish. My parents married in the twenties, and they both became citizens. I have a sister that has passed away.

**Nebeker**:

What did your father do?

**Svensson**:

Well, on the ship he was the chief engineer, and he came here and became a roofer. He did roofing, and I started helping him when I was nine years old.

**Nebeker**:

So you grew up in Jamaica?

**Svensson**:

In Jamaica, New York, yes. I stayed basically in the same area until I left. I got married and got drafted.

**Nebeker**:

Did you go to public schools?

**Svensson**:

I went to the public school and then I went to Brooklyn Tech High School.

**Nebeker**:

Is that one of the special high schools?

**Svensson**:

Yes.

**Nebeker**:

Tell me a little about that, if you would.

**Svensson**:

It was a real technical high school. It was a huge building, about 8-stories high, and it took up a city block. It had all types of technical courses. I took the electrical course. It had mechanical engineering.

**Nebeker**:

Was it hard to get into?

**Svensson**:

You had to take a test. They accepted only so many students per year. Well, at that time, it was per semester because you could start in September or you could start in February. You took a test and they accepted so many. The school ran about 6,000 students, but

only about 650 or so per semester graduated. The fallout rate was a little bit high. Then I went to City College, and there, again, you had to take an exam to get into City College. They just went down the list of who had the best marks and counted down the list of how many students they could accept, and that was it.

**Nebeker**:

Were you interested in science and technology as a kid?

**Svensson**:

Yes, I always wanted to be an engineer.

**Nebeker**:

So your father had no doubt told you about his engineering work.

**Svensson**:

Yes. I enjoyed making things, seeing how things worked and getting into various types of things, so I really always wanted to be an electrical engineer.

**Nebeker**:

It was specific, electrical engineering that you were interested in?

**Svensson**:

I was at City College, but I was getting drafted. So I got married, and then I got drafted.

**Nebeker**:

Can you recall when you graduated from high school?

**Svensson**:

I graduated in ‘49. Then, I started at City College and got drafted in ‘52.

**Nebeker**:

You had started in the engineering program at City College?

**Svensson**:

Yes. They gave me a couple of the credits from high school. That's how good a school Brooklyn Tech was. In fact, after I got out of the army, I went to Hopkins [Johns Hopkins University] and finished my degree at night at Hopkins.

**Nebeker**:

How did that happen that you moved to Hopkins?

**Svensson**:

Well, I got out of the army.

**Nebeker**:

So you had a GI bill?

**Svensson**:

Yes. Neither one of us – my wife or I – wanted to live in New York anymore. We wanted to leave, so I shopped around and got a job at Westinghouse down here in Maryland.

**Nebeker**:

Was it before you completed your degree?

**Svensson**:

Yes. I worked there as an engineering aide when I first got there, and I went to Hopkins at night. They gave me credits from what I had in high school as well. In fact, some of the electrical experiments that we did in high school were higher class than what they had at Hopkins. But it took a little longer at night. I finally graduated in 1960 with a degree.

**Nebeker**:

What was your work as an engineering aide at Westinghouse?

**Svensson**:

I started as an engineering aide. After I had a couple of semesters of college in Hopkins, Westinghouse accepted [the credits] to make you an engineer. I became an engineer, and gradually worked my way up. When I started at Westinghouse, I worked on radar because I had worked on the radar systems in the army.

## *Service in the Army and the NIKE Guided Missile System*

**Nebeker**:

Please tell me about your army service.

**Svensson**:

After basic training, I was sent down to Fort Bliss, Texas. We went to an electronics school for a while, and we went to a radar school. We were training on maintenance of the radar system that controlled 90-millimeter antiaircraft guns. Then, I switched into the NIKE guided missile system.

**Nebeker**:

Was there some kind of aptitude test that got you into electronics in the army?

**Svensson**:

Yes. When you first went in the army, they gave you a test and decided where they were going to send you. I scored pretty well on the engineering electronics, and that's why they sent me to Fort Bliss. It was during the Korean War when we started, but I lucked out and didn't get sent over there. They kept me down at Fort Bliss.

**Nebeker**:

Tell me again the electronics you worked on in the army.

**Svensson**:

The main thing was the NIKE guided missile system. We had ground control of the missile and we had a two radar system. One would track the missile, and one would

track the target. It was a computer system that would command the missile which way to go to end up hitting the airplane. They were the first NIKE systems down there.

We would train the crews that were going to go out and man the stations around the county. We would train them on how to maintain the system, how to test it and maintain it, and find out what difficulties they were having.

**Nebeker**:

Were you able to do live tests of the system? Did you have drones or something that you could use?

**Svensson**:

No. They did testing out at White Sands. Each outfit that was going to take a system somewhere went to White Sands and they fired up the system, and they actually fired missiles. And they'd fire it at drone airplanes. It was pretty accurate. They had a film of one of them. Instead of blowing the thing up, they kept it from blowing up, and it went into the nose of the airplane and it came out the tail.

**Nebeker**:

[Laughter] That's pretty accurate.

**Svensson**:

It was an accurate system. That got me into knowing quite a bit about radar. How radar worked and what parts of it and everything because we had four systems that we were maintaining to teach these people on.

**Nebeker**:

Was it two years that you were in service?

**Svensson**:

I was in two years. Then I got out of the army, and we went back to New York just to return home. But we decided we wanted to move somewhere else. I got a job here at Westinghouse and moved down here.

## *Career at Westinghouse: the APQ-41*

**Nebeker**:

How did you find out about the Westinghouse?

**Svensson**:

I was at an IEEE show. The Westinghouse had talked to people about coming down, and I came down here to interview. And they asked me if I'd come to work here. I had had an interview with GE, but I turned them down. That was up in upstate New York.

**Nebeker**:

Schenectady.

**Svensson**:

I came down here, and when I worked on the radar system, we had built what they call the APQ-41. It was the F2 Banshee Aircraft. It was a fire control radar for the airplane, and we were testing upgrades for it. We had two airplanes here, and put the systems in there. We put in the upgrade, and they'd fly to airplane and see how well the upgrades worked. Once we got all the upgrades into it, we went down to Pax [Patuxent] River Naval Station with them, and they went on firing run down there.

They had the two F2 Banshees. One would fly along and pick up what they call a dart. It was a long cable, and it was, kind of, a triangular shaped device with a little radar reflector on the back end of it. They would go and run a firing run toward that, and then fire to see how many shots they hit the dart with.

Then they'd drop the thing back in the water in front of the hanger. They tried to drop it in front of the hanger, but didn't have much luck with it, except one time when the pilot of the pickup airplane missed picking it up on the first pass but got it the second time. They did all their firing and everything, and they come back because now he's got to get rid of this thing. It was hooked on his gas tank, on the fuel tank. They flew in, and the other plane came along behind and slipped the cable onto his wing. [Laughter] Right in the water, right smack in front of the building. With boat [unintelligible word] recovery, we did it. It was quite an experience trying to do it.

**Nebeker**:

Yes, it must have been interesting for you to go to that testing.

**Svensson**:

Yes, we've been down there. Once in a while, we stayed overnight. Other times, we'd drive down in the morning. It was about a 90-mile drive.

**Nebeker**:

Did the upgrades go well?

**Svensson**:

The upgrades went well, but the Navy decided not to buy it. However, the French bought it, and we built a number of systems for the French. They changed the classification of it, but we sold a number of them to the French Air Force. After that, I started working on the infrared system.

## *Work on the Infrared System*

**Nebeker**:

Is the infrared system like a night vision system?

**Svensson**:

No. Back in that time, the detectors were just little small things. This was a small detector and it scans just like radar did. It looked for a target and got a spot there, and you could lock onto that and track it just like you would do with the radar. It'd look for the tailpipe of the airplane. There again, we put it in the airplane and ran flight tests with it. We ran flight tests at Pax River with it as well. And I ended up having to come back and forth down there while we were doing the testing on that.

**Nebeker**:

This was a fire control IR system?

**Svensson**:

It was a fire control just like the radar system was. It was hooked on a computer that would calculate fire control. He did the tracking of [unintelligible word] and sent the results to the computer, and it would guide the airplane, so that he would fire at it.

**Nebeker**:

Did this system get implemented?

**Svensson**:

No, we lost the contract. I think Hughes Aircraft won the contract. We lost the bidding on it. They built some of them, but they never really ended up using them. It was basically used in the F-4, so if you look at the F-4 airplane – at some versions of it – you'll see the radar dome in front of it. It had a little bubble on the bottom, and that was where the IR camera would sit.

**Nebeker**:

So when you see a picture of an F-4, you look for that little bubble.

**Svensson**:

I could see which one it is.

**Nebeker**:

[Laughter]

## *Television Sensors, Cameras, and Integrated Circuits*

**Svensson**:

After that we got into some other infrared system that we were trying to develop, but then we got into some television.

**Nebeker**:

Where are we chronologically? You became an engineer in 1957, and you got your degree in '60.

**Svensson**:

Yes. I worked on the radar system to begin with. It was in ’55, I guess, and ’56 when we were working on the infrared part of it, that carried for a few years. I got into doing television, trying to work television sensors into it.

**Nebeker**:

For, again, fire control?

**Svensson**:

For military fire control. I was given some research dollars to try to build a TV camera using all integrated circuits. At that time, the TV sensor was still a tube. We didn’t have these little sensors like you have on your telephone today. So they gave me the money in September, and told me I had to have it ready for the IEEE show in September. I had January to September to get it.

**Nebeker**:

Had they already gone to all transistorized TV?

**Svensson**:

Yes, this was a step past the transistors.

**Nebeker**:

So this was to make it less expensive to produce or manufacture.

**Svensson**:

Just make it smaller.

**Nebeker**:

Was it mainly the smallness of it?

**Svensson**:

That time the camera that I built was a little smaller than a carton of cigarettes.

**Nebeker**:

That must've been a special tube also then?

**Svensson**:

It was just an electrostatic vidicon. We went from that, looking at low-light level television.

**Nebeker**:

Did you succeed in building that camera?

**Svensson**:

Oh, yes. We had it demonstrated at the IEEE show in September. That was a do or die, [laughter] get it done.

**Nebeker**:

Did that get used any place?

**Svensson**:

No. In fact it was mainly a step to show our ability.

**Nebeker**:

It's sort of a proof of principle to show you can do that with ICs.

**Svensson**:

Yes, that you were able to do that. Later on, we built some versions of it that were used in various government agencies where they could get a small camera and hide it somewhere. Then we started looking at low-light level television, and at that time, Westinghouse, Elmira [New York] would build it. It was a tube division up there. They would build what they called the SEC vidicon, which was a low-light level sensor. That's

where we cut into the thing with NASA when they started talking about building a camera for the moon landing.

**Nebeker**:

Was it a low-light level camera with the same frequency response or the same band of frequencies?

**Svensson**:

It's still visible, but the front face plate had a photocathode on it that would emit electrons as light hit it. It had another surface that accepted these electrons, but they were amplified. Then you read that out, the same as you would a vidicon, so it was scanned just like a vidicon. It was a high voltage, though. They had to have them on the front end of it. That accelerated the electrons to get the multiplication.

**Nebeker**:

It's like you're getting more electrons on that plate that's being scanned.

**Svensson**:

Right. At that time, it was trying to see something, like, in moonlight, or it was one of the first sensors that you could do that with. After that, another intensifier was added in front of that so that we could see pictures – quality pictures – at starlight.

**Nebeker**:

Did you have another kind of amplifying or intensifying tube?

**Svensson**:

It was an intensifier tube that had a photocathode, and it had a surface that would illuminate when it got hit by the photocathode electrons. That was put on the SEC, which would then in an agreement, amplified again.

**Nebeker**:

So it was sort of a two-stage amplification before the standard scan.

**Svensson**:

Right. The front end of it was something like what they were using on the night vision goggles. But this was prior to the night vision goggles even.

## *Going to the Moon: Developing Cameras for NASA*

**Nebeker**:

And it's still all visible. I mean they're not going to infrared.

**Svensson**:

It went into the near infrared. It was the closest we'd got. But we got into the program with NASA where they wanted to be able to have a camera they would be able to see on the side of the moon that was only illuminated by the earth's shine rather than have the sun on it. So we built a demonstration camera, which was not a small size, but a camera that they could try out. We had a contract with them that all integrated circuits had this SEC tube.

**Nebeker**:

Roughly, when was this that NASA became interested in such a project?

**Svensson**:

It was '59, or something like that.

**Nebeker**:

So before Kennedy said we'll get to the moon by the end of the decade?

**Svensson**:

Yes, that was '59 or '60 when we tried to do that.

**Nebeker**:

Somewhere around there.

**Svensson**:

They got serious about it when Kennedy said we're going to go to the moon. And they wanted to have a camera that was lightweight, low power, and could exist on the moon. We beat out RCA for the contract for that.

**Nebeker**:

What were the real problems there? What were the challenges?

**Svensson**:

There were all kinds. You had to keep it a low power. Then you had to survive the vibration and everything to go with it. You had to go from where you had atmospheric pressure to where you had a vacuum, and then you had to go through that critical low vacuum that would cause arcing in a short distance and stuff, so all that had to be done. We had to have some way to cool the camera because even though it took a low power, you had to get the heat out of it.

**Nebeker**:

Without an atmosphere there?

**Svensson**:

They would be [unintelligible word] out there on the moon on a vacuum. So you had the heat coming from the moon's surface, and we had some brilliant mechanical engineers. They came up with a silver coating that would reflect the lunar heat and a paint on the top surface that would reflect the sun heat, but it would also radiate to space to maintain control of the camera so it didn't get hot.

**Nebeker**:

That's very interesting. Preventing heat buildup was a big issue.

**Svensson**:

Yes, that was a big issue. And it had to be lightweight.

**Nebeker**:

Reasonably small and light.

**Svensson**:

It was six pounds. We also had to come up with a connector that we could disconnect and then connect the thing without having a spark.

**Nebeker**:

What's the great danger of a spark?

**Svensson**:

In the space capsule, it was all oxygen in there. If you disconnect it, you can get some bad results, but also you have a problem with vacuum welding. If they rub a little bit, they'll weld in a vacuum. So we had one engineer come up with a connector that was part of the handle, and you could disconnect and connect it in the vacuum. And we tested it in an explosive atmosphere and all to make sure you didn't get any spark.

**Nebeker**:

Wow. [Laughter] That's a good way to test it.

**Svensson**:

We used that on a camera, and we also used it on the color camera that went to the moon.

**Nebeker**:

That connector?

**Svensson**:

The same connector and handle. When they went to the color camera – I don't know if you recall it – the astronauts ended up pointing it at the sun, which was too much for the camera. So they wanted to bring the camera back, and they went to disconnect it with this handle connector. Some reliability guy had taped it with mylar tape, so they couldn't disconnect it. They ended up having to cut the wire and bring it back that way.

**Nebeker**:

Oh, that's interesting. [Laughter]

**Svensson**:

So we went to all that trouble to build the connector.

**Nebeker**:

[Laughter] It was taped on. Tell me about the project management of that development for NASA.

**Svensson**:

We were broken down into several groups. We had the electrical engineers designing all the circuitry for it. The mechanical engineers had to do the packaging of it. Then we had a power supply group that had to build a power supply to run this camera too from using just a 28-volt source. That was one of the first times we came up with one of these high-frequency chopping methods, so we didn't have a low-frequency transformer there. You could transform the electrical signal into a higher level. And we had the reliability people. Reliability was the big criteria on it. Everything had to be done from scratch. You had to go back to the source of the materials to build anything.

**Nebeker**:

Was NASA interested in a small, low-power TV camera earlier on?

**Svensson**:

Yes.

**Nebeker**:

You said it was '59, '60 or something like that. Was there other work or did fairly soon a project get defined for the lunar mission?

**Svensson**:

We did the demo camera with the SEC vidicon. At that time, NASA expected that we would also be on the moon during earthshine. That's why they wanted a more sensitive camera. It took years for them to develop the specs of what they wanted.

**Nebeker**:

Was it in the early sixties somewhere?

**Svensson**:

Yes. Not too many of the scientists were interested in whether we had a TV camera or not.

The astronauts really didn't care. They didn't want a camera looking at them when they were taking off, so they were, kind of, lax about where this camera was going to be used and how it was going to transmit pictures to the earth.

**Nebeker**:

That's certainly a big challenge, but it's surprising to me that people didn't, early on, think this would be marvelous for the country to be able to see.

**Svensson**:

They really didn't have that much enthusiasm about it. Only after we landed on the moon had everybody watched the pictures. Now they wanted a color camera. So we had to go in and try to develop a color camera to take the place of the black and white camera.

**Nebeker**:

Was the camera used by NASA before the lunar landing?

**Svensson**:

No. I think they had a small vidicon camera in the capsule, but I don't recall ever seeing any pictures from it. It was mostly instrumentation type of stuff.

**Nebeker**:

The famous one that gave us pictures of the lunar landing – that was this project?

**Svensson**:

That was the one that we built, yes.

**Nebeker**:

How long did that project last? It was somewhere in the mid-sixties that the specs were developed?

**Svensson**:

Yes, it took us a couple of years to get it developed and tested, and it sat.

**Nebeker**:

There was some time.

**Svensson**:

It sat for about three years, I guess, before it was actually used. They had sent it back to us to redo the acceptance testing and everything. But we didn't finish with the project for quite a bit.

And we developed the color camera. I don't know if you're familiar. Stan Lamar was the program manager—he passed away recently—and he'd been fighting to try to find the original tapes that they took from the moon. They had taken original tapes at the scanned frequency. The cameras only scanned at ten frames per second. That was driven by the Datalink, so it didn't have as much resolution in it.

**Nebeker**:

At that time, they didn't have a means of storing the image.

**Svensson**:

No.

**Nebeker**:

Did they have to transmit it immediately?

**Svensson**:

It was transmitted down, the original picture at ten frames per second. And they did tape it, but they rewrote over those tapes and they disappeared.

**Nebeker**:

You mean taped in the spacecraft?

**Svensson**:

No. I think they taped it down at Canberra. That site had different places around the world depending on which way we were sitting and looking at the moon. That's why the pictures have a little ghostly look to them because of the slow frame rate.

**Nebeker**:

Because it was ten frames a second.

**Svensson**:

The way they converted the picture to be able to transmit it to send it out over the air was that the picture came down from the moon, and then it was put on a display. They had another camera looking at the display, running at normal TV rates, so they lost a lot in the translation. They didn't have the capability that they have today of converting things back in high-resolution mode.

**Nebeker**:

You were saying the original tapes that are taking these ten frames per second have been lost.

**Svensson**:

They were written over.

**Nebeker**:

[Laughter] Valuable magnetic tape.

**Svensson**:

Yes, yes. They wrote them over. They had so many of them.

**Nebeker**:

But people still have, of course, the tape of the TV broadcast of 30 frames a second there.

**Svensson**:

They have the tape [unintelligible word] have, yes. Yes.

**Nebeker**:

The standard TV.

**Svensson**:

Yes. It was a shame. You know, if you'd have done it today, you would have done it differently. You would've had the 30-frame per second picture that you only stored so many of them at a time. Just like when you look at a traffic camera now, you see a real clear picture, but it doesn't follow the speed.

**Nebeker**:

Yes. That must've been exciting for you.

**Svensson**:

It was.

**Nebeker**:

What exactly was your part in that?

**Svensson**:

I started out in the electrical design, and I ended up the engineering manager on it.

**Nebeker**:

Engineering manager?

**Svensson**:

Yes, Stan Lamar was the program manager.

**Nebeker**:

How many people were involved in that?

**Svensson**:

We had about ten of us, I guess, that were involved, day-to-day.

**Nebeker**:

Sort of, full-time on the project?

**Svensson**:

We had a number of other people doing materials and processes, and stuff. There were several hundred people, I guess, that had their hands in it at some point or other. It was not a single person doing it.

**Nebeker**:

It must've been very exciting for you when you knew that the camera was going up.

**Svensson**:

Yes. I had promised my children that we were going camping that day. We were up at Cape Cod, and I had taken a small TV with me that I could run off of the car battery. We watched it with the TV sitting on the hood of the car late that night, watching the moon landing.

**Nebeker**:

My goodness. [Laughter] And your camera was up there.

**Svensson**:

Yes, and the kids were all excited, running around the camp area, telling the people to come and look at their daddy's camera.

**Nebeker**:

[Laughter] That's fantastic.

**Svensson**:

It was pretty exciting when you're sitting there looking at it and wondering, is it going to work?

**Nebeker**:

Yes. There's always that anxiety.

**Svensson**:

Yes. I saw something and most people never noticed it, but the TV camera was sitting on a [unintelligible word] on a door, and when they were going to come out onto their walk down the ladder, they hit a lanyard and opened the door, and the camera was looking at the ladder. Well, when you first saw the first couple frames, the astronaut was at the bottom of the picture coming up because they had a means of reversing the picture.

When they took it off of that door, they were going to turn it upside-down and put it on a tripod outside. Most people didn't notice that it was upside-down.

But what had happened was that before the actual coming out on the ladder there, they had tested all the different stations to see that everything was working right, and they had a switch that could switch it one way or the other. Then they forgot where it was.

**Nebeker**:

So then they saw—

**Svensson**:

Somebody quick.

**Nebeker**:

[Laughter]

**Svensson**:

If you have looked at the original pictures, you can see that he started out on the bottom of the picture, but it was pretty interesting.

**Nebeker**:

Did you talk to the astronauts?

**Svensson**:

Yes. We had shown them the cameras and looked at the command module and how they were working here and there. We got to meet a number of the astronauts doing that, when they were doing their training sessions and stuff.

**Nebeker**:

Did you ever get together with the group when you got back from vacation to celebrate your camera?

**Svensson**:

Yes, yes. We had some times of it.

The Pave Spike System-Gimbal System
**Svensson**:

And we got into the color camera. Some of the other guys picked up most of the color camera, and I went on to work on a different system called the Pave Spike system.

**Nebeker**:

Yes, I saw that here. That's a TV laser pointing gimbal system it says.

**Svensson**:

Yes, it had a TV sensor in it. It was in a pod mounted on the F-4, and it had a gimbal system, so it was actually the operator – the radar operator – that was controlling it. He could point the gimbal at a target, and it had a laser in it.

**Nebeker**:

This is a TV camera that he's pointing?

**Svensson**:

He's pointing a TV camera at the target. The TV camera was stationary. The optics were all in the gimbal system.

**Nebeker**:

He had a laser, so he could see where the target was.

**Svensson**:

Yes, there was a laser that would go in parallel with that and it would go right down to the center of the picture, so we could put a laser spot on the target.

**Nebeker**:

That must've been one of the first laser-pointing systems.

**Svensson**:

They had these laser-guided bombs, which would sense that spot. And the bomb would steer itself down onto that spot.

**Nebeker**:

Was that part of the Pave Spike system?

**Svensson**:

Pave Spike System. The bomb was not. The bomb – Pave Spike – was the system to designate it.

**Nebeker**:

To put the laser on the target.

**Svensson**:

Right. And it was accurate. I mean, they would spot a truck and they could put a bomb right on the truck.

**Nebeker**:

Was that the beginning of this kind of fire control of putting a laser on a spot?

**Svensson**:

Yes, yes, the laser guided bombs. They used it in Vietnam. It started in that war.

**Nebeker**:

Was it for the F-4?

**Svensson**:

Yes, it was modeled on the F-4.

**Nebeker**:

Westinghouse produced that for the Air Force.

**Svensson**:

Yes. Other companies built some other versions of it for some of the other airplanes.

**Nebeker**:

What was your role in the Pave Spike?

**Svensson**:

I was a technical advisor, mostly because they had me working on the TV camera, the laser, and the optics. I, sort of, stepped from one to the other. I did a lot with the optics, though, and the optics were, kind of, complicated because you had a TV path, and you had a laser path going through the same optics. We also had a receiver that would sense the return of the laser spot, and you can get a range reading from that so that you know how far the range was.

**Nebeker**:

How did you get the range reading?

**Svensson**:

The laser was not a steady beam.

**Nebeker**:

Was it a pulsed?

**Svensson**:

It was a pulsed one. And you could time the pulse. The pulses were controlled by a special coding thing that they put a code in it every day – a different code – so that somebody could steer a bomb away from where it was going.

**Nebeker**:

They could give false range data, if they knew the code.

**Svensson**:

Right. Yes.

**Nebeker**:

My goodness. They think of everything. [Laughter]

## *Aquila Remotely Piloted Vehicle (RPV)*

**Svensson**:

Well, after that I went into a program that was for a remote piloted vehicle.

**Nebeker**:

This is an aircraft?

**Svensson**:

It was for the army to use. They had the laser guided artillery shell. So we would build a system to go into the Lockheed RPV. They called it the Aquila. It's a remote piloted vehicle, and they would fly it.

**Nebeker**:

They'd fire it or it had its own propulsion?

**Svensson**:

It had a wooden propeller to keep down the radar cross section. We had a TV and a laser and a gimbal system, and that was transmitted back to the ground. There was an operator that could see where it was going and everything. Lockheed had quite an ingenious system that the guy didn't have to fly that airplane. He just commanded it to go to some altitude or some direction or circling an area and stuff, so he didn't have to do any flying of it. But he would spot a target and just like Pave Spike, he'd lock the system on a target, fire the laser, and a laser guided artillery shell could come flying in there from ten miles away.

**Nebeker**:

The artillery shell's not coming from that vehicle.

**Svensson**:

No, it came from an artillery gun ten miles away.

**Nebeker**:

That's like a spotting device for the artillery.

**Svensson**:

It had the same kind of coding and everything.

**Nebeker**:

You were able to carry over a lot of the system from the Pave Spike.

**Svensson**:

Right. Yes.

**Nebeker**:

When did it happen?

**Svensson**:

I [unintelligible word] roll back now. It's in the eighties.

**Nebeker**:

You remember what that system was called?

**Svensson**:

That was the Aquila.

**Nebeker**:

Aquila?

**Svensson**:

That was the name of the remote piloted vehicle. It was called the Aquila.

**Nebeker**:

Did the army buy that system?

**Svensson**:

No. They decided not to buy that, and they wanted to go into guided missiles more. It was originally run out of St. Louis , and they wanted the remote piloted vehicle, but they transferred it to Huntsville, and they were a missiles-oriented place. People might get mad at me saying that, but that's what happened.

Reflections on Projects, Westinghouse
**Nebeker**:

I see. Was that a psychological blow that you developed some system you're proud of and then the army decides not to buy it?

**Svensson**:

Oh, yes. I remember looking at the Gulf War, and I'm thinking what that system could've done over there. They could've wiped out any of the tanks that came toward them. We ran tests with it, and we hit 12 out of 13 tanks.

**Nebeker**:

This is from ten miles away, with some artillery.

**Svensson**:

Yes. It was a good system, but that's what happens when you're running these programs.

**Nebeker**:

Yes. It's not Westinghouse's decision whether to implement it or not.

**Svensson**:

No.

**Nebeker**:

How was it working at Westinghouse in those years?

**Svensson**:

Oh, I enjoyed it. I put in a lot of hours because they were pushing technology.

**Nebeker**:

It was not just a 40-hour work week?

**Svensson**:

I didn't know a 40-hour week.

**Nebeker**:

[Laughter]

**Svensson**:

I spent a lot of time out-of-town traveling to different suppliers, particularly optic suppliers.

We had to travel for that and for the TV sensors, and I spent a lot of time just going to the West Coast and different places around the country. More time than I really wanted to do. I spent nine months out of one year in California, traveling back and forth.

**Nebeker**:

Did you have a lot of suppliers out there?

**Svensson**:

Yes. My wife was pretty good about it. She took care of the kids.

**Nebeker**:

Was it a good working environment?

**Svensson**:

Oh, yes. I mean, I enjoyed it. It was challenging work, but it was good to work at it, and everybody respected what you did.

**Nebeker**:

Did the overall management work well?

**Svensson**:

They were good. They were good. I mean, you put in a lot of hours on a program, and when it was completed, they gave you something a little easier to do for a while until you rested for a bit. So you didn't get constantly beat up.

## *Forward Looking Infrared (FLIR)*

**Svensson**:

I guess the next to the last program I worked on was the stuff for the A-12 airplane, but the airplane got cancelled. That was a Navy airplane, which, instead of using a TV sensor, had an IR sensor – an infrared FLIR – forward-looking infrared.

**Nebeker**:

This is fire control again for a naval aircraft?

**Svensson**:

Yes. It was fire control and they had wide-angle views and narrow-angle views.

**Nebeker**:

Why would you go to an IR system?

**Svensson**:

You go flying at night and you get much better a response from a forward-looking infrared, but it'll give you just like a TV picture. The infrared had advanced so much that you had the rays of detectors started out with 10 x 10s, and then 100 x 100, and 500 x 500.

**Nebeker**:

At night, you could get a picture that looks something like a daytime picture?

**Svensson**:

Yes, because you can see perfectly well at night. Even the police helicopters have FLIRs on them now. You see them going over areas at night and following—

**Nebeker**:

Was the A-12 aircraft the first time or early development of these FLIRs?

**Svensson**:

No, they had FLIRs.

**Nebeker**:

They've had those earlier?

**Svensson**:

They developed FLIRs earlier. After Pave Spike, the military started going into FLIR. We built some FLIR systems that were development systems, not production type of [unintelligible word]. We built several of those for the Air Force.

**Nebeker**:

You worked on the system specifically for the A-12 and that aircraft got cancelled.

**Svensson**:

Well, we were going to be building that. We were supposed to build a number of them to go through all the testing and stuff, and it was eventually going to go on the A-12. But then they cancelled the A-12.

**Nebeker**:

Again, it must've been a psychological blow to the team.

**Svensson**:

It's tough. You know, you got the system about ready to ship, and chop, that's it.

**Nebeker**:

All this thought and problem solving, and—

**Svensson**:

At least one of the systems was all through test, but when it was ready to ship, the program got scraped. It gets a little disheartening when that happens. But that's the way the business went, and it wasn't the only one.

## *Underseas Division & Cameras*

**Nebeker**:

But there's certainly some technology transferred to other projects, right?

**Svensson**:

Oh, yes, yes. It was quite a bit. I guess in between the lunar camera and just after the Pave Spike, I did some work with the Underseas Division. We did some TV work for under water type of television for use on subs. The big thing there was you had to have a pressurized container that would hold the pressure from the water.

**Nebeker**:

The idea is the camera's going to be at atmospheric pressure inside the container?

**Svensson**:

Yes, it's inside of it. And you have a big container that keeps the pressure in there. The optics have to be different because you have to put something there that's letting – so when you measure it, you're looking as if you're looking through water, but the water has a different index.

**Nebeker**:

Yes. Of course, whatever window is in this pressurized container has to be taken into account.

**Svensson**:

Yes, particularly in the water. It has a different index, and it changes the focusing of the lens and stuff.

**Nebeker**:

That must've taken a lot of development work.

**Svensson**:

It's taken a lot of just testing it and developing how much it should be different because they're all fixed. They weren't controlled. They had a fixed focus.

**Nebeker**:

How did that project go?

**Svensson**:

We had a number of them that we delivered. It was one of those quiet programs.

**Nebeker**:

In what way? It didn't get publicity?

**Svensson**:

You didn't talk about it.

**Nebeker**:

It didn't get publicity, or it's highly classified?

**Svensson**:

Yes. You didn't talk about it.

## *Reflections on Camera Systems Work*

**Nebeker**:

Okay. So you'd gotten to be something of a specialist in these camera systems, right?

**Svensson**:

Yes, I did a lot of TV camera work, and FLIR work, and got into a lot with the systems, because I spent time, out in the field, with the whole system all the time. It's kind of rewarding when you're working on something and actually see it in the field.

**Nebeker**:

Yes. I know the concept of systems engineering, managing, or getting a system to function. Did you find yourself in that role often?

**Svensson**:

Quite a bit, yes, but it was really good to take it out in the field and fly it or whatever. You get to see it actually in the environment it's going to be in.

**Nebeker**:

Had your courses at Hopkins been valuable to you? I mean, were you able to take courses at Hopkins that were particularly relevant to the work you did at Westinghouse?

**Svensson**:

There was some. But I was already designing circuits for transistors before I had a course at Hopkins on transistors. And some of the test equipment they had at Hopkins was

passé compared to what we had. At that time, things were changing so fast that the schools couldn't keep up with the funding for it. But yes, I got some knowledge of not just the electronics but the thermodynamics, and I got an understanding of how to control the heat in these big equipments.

**Nebeker**:

Besides the lunar camera, was heat often an issue?

**Svensson**:

Yes, because we were only getting it in the pod. It's all enclosed. You've got to get the heat out, and you can't take a lot of air in or you start slowing the airplane down.

**Nebeker**:

So you have some kind of heat conductors that get that out.

**Svensson**:

No, usually you have a radiating surface on it that will radiate.

**Nebeker**:

On the camera itself?

**Svensson**:

Or on the pod. On some of it, we had a liquid coolant. Like with the lasers, we had a liquid coolant there that would keep the laser system cool, and then went through a heat exchanger to the outside. I guess some of the stuff at Hopkins that you wouldn't expect to be of any benefit—

**Nebeker**:

I see. You were surprised that your thermodynamics course turned out to be valuable. [Laughter]

**Svensson**:

Yes, yes. Because when I was taking it, I was thinking, 'what am I going to do with this?'

**Nebeker**:

Yes. [Laughter]

**Svensson**:

But even the economics course teaches you a little bit about what are you doing and what is it going to net the company.

**Nebeker**:

Were you involved in that kind of financial management of projects?

**Svensson**:

We always got involved in bidding on a program and figuring out how much it was going to cost to do it.

**Nebeker**:

Yes, giving the estimates.

**Svensson**:

When I did some project management, I'd have to keep the budget, and get into the finances of it. Like a lot of the things, you don't expect to make money on the development, but you expect to make money on the production. It's a tradeoff, how much you're going to be able to make. So we got to the A-12 sensor work.

## *Missile Warning Project*

**Nebeker**:

Was there a project after that you worked on?

**Svensson**:

I worked on missile warning.

**Nebeker**:

Missile warning, what was that?

**Svensson**:

We tried to develop a system that you could put in an airplane and then if somebody fired a missile at the airplane, you can detect it, and then take maneuvers to escape it or drop in some flares or something, a countermeasure type of thing.

**Nebeker**:

I see.

**Svensson**:

Let's see what I could talk about.

**Nebeker**:

Is it because it's still classified information?

**Svensson**:

I'm not sure anymore, you know. It was doing mostly ultraviolet type of stuff.

**Nebeker**:

Because a missile firing would generate that?

**Svensson**:

It generates ultraviolet light, and there's a band of light in the ultraviolet that does not exist at the surface of the earth. The ozone blocks it. So if you use that, you're not going to get all of the background out of it. And all of these missiles emit it, just by virtue of their engine. They emit ultraviolet too, and a whole band of light.

So you'd look for that ultraviolet color, and it's expanded since then. I mean, it's gotten to be Northrop Grumman, which is building the number systems for it. It's grown into

that. We started out just a unit, but we're planning putting several of them on the airplanes, so it'd cover the lower surface of the airplane. We were into the testing of it when I finally retired.

## *Retirement and the Take-Over by Northrop Grumman*

**Nebeker**:

Was there anything that triggered your retirement decision, other than it was time to retire?

**Svensson**:

Yes, I was getting tired.

**Nebeker**:

It wasn't that the project reached some point that made you retire?

**Svensson**:

No, but it wasn't as much fun anymore. So I figured I might as well. Westinghouse wanted to reduce the force some, and they offered a package to people – a reasonable package, so.

**Nebeker**:

What year did you retire?

**Svensson**:

I retired in '94.

**Nebeker**:

Okay. Shortly before Northrop Grumman took over.

**Svensson**:

Yes, just before Northrop Grumman took over.

**Nebeker**:

That wasn't a factor in your retirement?

**Svensson**:

No.

**Nebeker**:

You didn't even see it coming or did you see it coming?

**Svensson**:

There was talk about it, but there had been talk about that before. What happened was that Westinghouse originally was an engineering company, and financial people started trying to take over. They sold a lot of the manufacturing just to buy CBS. Westinghouse sold the Baltimore Divisions to Northrop Grumman. But I don't think there's been that much of a change in what's going on. From what I understand, it's pretty much doing the same kind of things.

**Nebeker**:

Did things remain at this location?

**Svensson**:

Well, let's see. We had the Undersea Division and the division of [unintelligible word]. We had an Electric Motor Division out in Ohio, and we had another division out in California that built the launch too for the Polaris missiles. And we had a division down in Texas that built integrated circuits, printed circuit boards and stuff. They would build the boards for them, and ship them up here. They had another group down in Florida, so it was, kind of, spread out, but they all reported to the Baltimore Division now. It was, basically, all defense and government work.

## *Involvement in IEEE*

**Nebeker**:

In the course of your career, you've mentioned, a couple at least, IEEE conferences or involvement that you had. Have professional societies, either IEEE or other ones, been important to you for conferences, publications, or in other ways?

**Svensson**:

I went to some of the optical conferences of the Optical Society of America, and that was primarily the ones that I attended.

**Nebeker**:

I imagine with a lot of your work you couldn't present at a conference. I mean, it's classified work.

**Svensson**:

That's right, yes. You got so restricted with what you could tell people that it was like tossing them a bone, then pulling it back. So it got to be difficult to write a paper even on it and stuff.

You could give it at some of the classified meetings. They had the IRIS, the Infrared Information Symposium, and I gave a couple papers at some of those. You could get stuff cleared because it was all classified people there.

## *Patents*

**Nebeker**:

I see that you have patents for signal detection, dual antenna system, sensor protection, and image stabilization. Can you tell us a little about those patents?

**Svensson**:

The one for signal detection was to detect when a missile was being fired at you. Missiles have different signatures, definitive signature that they have. So if you're looking at it, you can tell what type of missile it is.

**Nebeker**:

Is this in the optical range?

**Svensson**:

Look at it either in infrared or in the visible even, and you'd see a difference. It'd be different than seeing a jet plane coming. Another one was the sensor we put in the F-4. We were going to put the IR system in the F-4. We had worked up – instead of having two separate gimbals, we made an optical and radar antenna combination, so that it only took one gimbal system to work. That's what the dual system would be. It had an optics and radar reflector combination.

**Nebeker**:

What was the policy at Westinghouse on patents?

**Svensson**:

You gave the patent to Westinghouse, but they would give you an award.

**Nebeker**:

The patent's in your name, but Westinghouse owns it.

**Svensson**:

It's in your name, but it was owned by Westinghouse. They would give patent awards, depending on the patent, and you'd get a certain amount of money depending on how it turned out.

**Nebeker**:

And the sensor protection patent?

**Svensson**:

If you got too much power, like they did on the moon when they pointed at the sun, we had to come up with a sensor, a separate little sensor that would determine before it got into the field of view of this sensor. If something out there was too much, you know, it would block it out, so that you wouldn't burn up your sensor.

**Nebeker**:

Was that a response to the astronauts pointing the camera at the sun?

**Svensson**:

No, we actually did that beforehand. We needed it beforehand. The thing with the astronauts was that we had wanted to put a protection device in there. But the reliability people at NASA said no, they didn't have to worry about the astronaut pointing at the sun.

**Nebeker**:

[Laughter]

**Svensson**:

Low and behold.

**Nebeker**:

What was the consequence of pointing it at the sun?

**Svensson**:

It had an SEC vidicon in it, and the secondary part of the sensor got burned off. So it didn't really present a decent picture at all anymore.

**Nebeker**:

It really did destroy the image.

**Svensson**:

It got just too much power.

**Nebeker**:

Yes. What about this image stabilization patent?

**Svensson**:

Using a sensor with the SEC or an image intensifier and putting a coil around it, and sensing any of the movement, you could control the coils, so magnetically you move the opposite to what the actual image is moving, and you get the thing stabilized. We were trying to do that, instead of trying to maneuver the optics to keep them stable.

**Nebeker**:

That sounds ingenious.

**Svensson**:

So we tried it, and I worked on it.

## *Life After Westinghouse*

**Nebeker**:

How have things gone since retirement? Have you found activities?

**Svensson**:

I took up golf. I never played golf before, and I took up golf. Now I work at two different golf courses. I run the pro shops. It keeps me occupied, and it keeps my mind going. I enjoy it. I find that I'm not a good golfer, but I enjoy being out with the other people and spending time. It's relaxing, and it's a good way to get outdoors, except when it's snowing. It's a little hard to play golf then.

**Nebeker**:

You haven't moved down to Florida yet?

**Svensson**:

No. I have no desire to go to Florida. You know, I spent time in Florida a couple times, and I decided I didn't want to spend my time down there. So much of my life has been in this area. I've been here for 50 years now, so I don't want to pack up and leave and go someplace, and have to make all new friends. I'll put up with the snow.

There're a number of the people that I work with at the golf course, and everything, who took the same kind of route. You know, not necessarily working for Westinghouse or something, but they've all left the job. They retired from where they were, and they're working at the golf course, and playing golf. It's a different kind of atmosphere.

**Nebeker**:

Is there anything I haven't asked about? Would you care to comment on about your work at Westinghouse, or is there anything else you'd like to tell me?

**Svensson**:

No. I've got a wonderful family, a big family. I've got five children – four boys and a girl, and eleven grandchildren, and four-plus great-grandchildren. Another one's on the way.

**Nebeker**:

I hope some of them are in the area here?

**Svensson**:

Not one of them.

**Nebeker**:

Is that right?

**Svensson**:

No, the closest one is in Pennsylvania, and he's going to move to Delaware. My daughter's down in North Carolina, and one son's a dean at Purdue University in Indiana. Another one works for Level Three out in Colorado, outside of Denver, and the other one's got a law practice in California.

**Nebeker**:

That's the world these days.

**Svensson**:

They're all over. I left home. I left. We didn't want to live in New York. And we came here. My parents came from Europe.

**Nebeker**:

From Scandinavia.

**Svensson**:

They moved here. It's a dynamic world.

**Nebeker**:

Thank you very much, Len.

**Svensson**:

Thank you very much.