ORAL HISTORY: Robert Dwight

About Robert Dwight

About Robert Dwight Robert Dwight was born March 28th, 1922 in New York City. In 1941 Dwight began studying at Princeton, soon after enlisting in the U.S. Navy's V-12 Program, attending Columbia and Cornell while in that program. After medical discharge, Dwight received a master's degree at Princeton and Harvard. During his career, Dwight worked at Sperry Gyroscope and General Precision Lab, but finally began at Westinghouse in the Air Arm Division in 1954. In 1972, Dwight became manager of administration for Westinghouse's defense center. During his years at Westinghouse, Dwight began looking into creating the National Electronics Museum, which opened in 1983. Dwight retired from Westinghouse in 1984, but continued working with the museum.

In this interview, Dwight discusses his early career as a mechanical engineer and later as administrator. The germination of the idea for the museum is talked about, as well as early acquisitions and growth. Dwight also talks about major highlights of the museum including the SCR-270, SCR 584, magnetron, phased array antennas, APG-63 and 64, Wurzburg Radar Antenna, and Navy Radar Antenna. (Biographical information from the IEEE History Center

About the Interview

ROBERT DWIGHT: An Interview Conducted by Sheldon Hochheiser, IEEE History Center, July 21, 2009.

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Interview

Interview: Robert Dwight

Interviewer: Sheldon Hochheiser

Date: 21 July 2009

Place: National Electronics Museum, Baltimore MD.

Background and Education

Hochheiser:

This is Sheldon Hochheiser of the IEEE History Center. It's the 21st of July, 2009. I'm here at the National Electronics Museum in Maryland. I'm interviewing Bob Dwight about his role as founder of this museum and also about his career with the Westinghouse Defense Electronics Division. Good morning.

Dwight:

Good morning.

Hochheiser:

Well I suppose we're ready to begin. If you could perhaps start by giving me a little bit about your background, born and raised, and things like that.

Dwight:

Okay. Well I'm a mechanical engineer. I do not understand electricity at all and I never did. I have three degrees in mechanical engineering and what I understand is nuts and bolts.

Hochheiser:

And where were you educated? Where did you get your degrees?

Dwight:

Well I'll come to that.

Hochheiser:

Ahh. Okay.

Dwight:

I was born on March 28th, 1922 in New York City, the middle of Manhattan Island. And I started in the fall of 1941 at Princeton. Shortly thereafter was Pearl Harbor day and so shortly after that I went to enlist in the U.S. Navy and they suggested I join what was called the V-12 Program. So I did, and the V-12 program kept you in college, and then they would send you to midshipman's school, and then you will become an Ensign.

And then they shortly sent all the engineers at Princeton up to Cornell, and probably sent all the medical students at Cornell back to Princeton. So I spent non-stop terms at Cornell, one after the other, but I flunked electrical engineering, as you can imagine. And so I did not degree there but I was sent to Columbia midshipman's school anyway and unfortunately in the middle of that I got rheumatic fever. That was supposed to be a childhood disease but three of us at Columbia got it. So then I spent nine months in the U.S. Navy hospitals, was finally given a medical discharge.

So I went back to Princeton and I said, “How’s about giving me a double E course, non-stop, six weeks, and then give me a degree?” And they very nicely said, “No we don’t do that, but why don’t you take a masters degree, while you're about it, bone up on electricity.” So I did. And that involved quite a lot of advanced math. I'd always been ahead in math, and I got quite interested in maybe pursuing that further. Now everybody got Public Law 16, that was called the GI Bill. But disabled veterans got something called Public Law 346. Now the way that read was “we'll pay for your education, any kind of course of education that you elect, we'll pay for it.” Now that has a nice ring to it, and so I decided I would go ahead and go for PhD, because by this time I had a bachelor’s and master’s degree.

So I applied to MIT. MIT said no, you flunked electrical engineering and by the way you flunked economics. And they were quite right, I had. And so I applied to the Harvard Graduate School of Engineering and since I'd gotten nothing but A's when I went back to school after I'd been in the hospital, they said yes. So I took another year of courses there and to my surprise they gave me another masters degree. And then I started another year of courses and I took an exchange course at MIT, sort of got even with them. It was a math course in something—and you would be familiar with this—it's what they call Fourier Transforms.

Hochheiser:

Yes.

Dwight:

Well, I did very well in the mathematics of that. But one day they had an exam, and they handed us a large sheet of paper, and there was an electronics diagram with all kinds of squiggles in it—tubes, and condensers, and you know what—squiggles. And down here was a battery and a switch, and up here was a meter. At t=0, that's a very important mathematical term, t=0, they said we're going to introduce a short circuit. Describe the motion of the needle of this voltmeter up here, or not necessarily a voltmeter, a meter up here. It's probably a sinusoidal decay. And I stared at that diagram for a whole hour and I was not able to put a single thing on the piece of paper. I handed in a blank sheet of paper, went out the door, hopped in the new Jeep which I had just bought, and drove to Sperry Gyroscope, where I was very shortly hired.

Early Work Experience

The main effort at Sperry was something called an automatic pilot. In any autopilot you've got to take off manually and then you engage the autopilot. You can do that by pulling a large lever back and on each axis of the airplane a device goes "kachung," because you pull this big lever, and that engages a flight servo, and that's how the aircraft is controlled. And the largest plane up to that time was probably the DC-3. The B-47 bomber, for which this was designed, was much longer.

Hochheiser:

Right.

Dwight:

And with temperature changes, in cold weather the cables going out to these flight surfaces would get very tight, and in hot weather they get very slack. So the Air Force said what we want to do is have an electrically engaged servo so all the pilot has to do is flip a switch and this device would just go "kachung," and it would be engaged. So it was called an electrically engaged servo. And I didn't have anything to do with the servo mechanism or the electromagnet, but I had a lot to do with the design of the spring. Because what you needed was something that was very soft axially but very stiff in torque. And after many, many tries, we finally got a spring design, on which I happen to have a patent, and that went into every B-47.

But after three years there, I felt it was so, so difficult to get something done, I thought—really it wasn't but I thought it was—I just walked out. So then I found a small electrical lab, development lab, north of New York City, in a place called Pleasantville. This was called General Precision Lab. I think it was a subsidiary of a British firm called PYE. In any event, they were developing a Doppler radar navigator, and they needed some mechanical design. So I was hired to be involved in mechanical design there. And that was a remarkable device. It was designed for the B-52 bomber and the idea was you could "dial" in the latitude and longitude of say, Washington, DC and Moscow, Russia, and this would navigate its way, completely by itself, all the way. And if it had the good fortune to fly over a few known checkpoints it could simply update its navigation. And so the pilot could, so to speak, put his feet on the table, and just press the right buttons, and off he'd go.

And it worked. It's one or two percent accuracy from one point to the other, and that's pretty good. So that went on for about three years and again I thought it was so difficult to get something done. See, I had to build a factory as well as complete the design manual--

Hochheiser:

So you took it all the way through to production.

Dwight:

Yes, and including setting up the factory. And again I walked out. It was just so difficult to get things done, and get parts made correctly. So I thought well, I think my field must be "administration" not engineering. So I went out to Boeing, and they made me an offer but I wasn't mad for it. So went down to Lockheed Missile Systems Division in LA, and they made me an offer. Incidentally they said we put administrators and janitors in the same classification so that sort of gave me a clue as to what they thought of that. I

then went down to Convair Vultee in San Diego and they made me an offer, but I wasn't mad for it. So I came home and a small operation just north of Pleasantville, in Danbury, Connecticut, called Flight Refueling, made me an offer, and it was a marvelous offer, and right at the end of the interview they said by the way, we should tell you we are about to move to Baltimore. I said Baltimore? I never could see going there.

Westinghouse and Administration Position

So I came home again and now I'm sort of pretty much amongst the unemployed, and I began to think to myself maybe I'd better go back to engineering. Maybe that's where I'll find a job. So I was reading Aviation Week and I noticed an advertisement by an outfit called Westinghouse in Baltimore. Just started a new division there called Air Arm Division and they needed engineers. So I applied there and as a matter of fact I had an interview with the chief engineer and his main administrative person.

Hochheiser:

Who were these people? Do you remember their names?

Dwight:

Dr. Herwald, Sy Herwald, and the head of administration was Jack Heasley. And I was set to work, and I took all my drawings of the Sperry autopilot, and the Doppler navigator, and so forth, and I think he was fairly impressed. So I was assigned to the autopilot section. They were working on an autopilot for the Republic F-84 fighter, and it was in production. It wasn't working very well and my boss, who later became the department manager, soon realized that I did not understand electricity at all.

Hochheiser:

And who was, who was your boss?

Dwight:

A guy named Ben Vester . However there were various assignments he could give me—writing a handbook on how to fly the autopilot, things like that. But I always felt the F-84 had a built in pitch instability. In other words, all by itself it would do this, nose up and nose down, and nothing the autopilot would do to correct that, it seemed. So that contract was cancelled, so I'm suddenly left without a charge number and so had various assignments of this, and that, and the other thing, and trying to sell individual components of the autopilot, and pretty soon that ran out too. So I was now really without a charge number entirely, and just by coincidence, at that moment the phone

rang from Jack Heasley, whom I had had the interview with, and he said I need somebody to run the administrative part of the engineering department. Well I leapt at that. That's what I'd been looking for!

Hochheiser:

And about when was this?

Dwight:

This would be about '55, 1955. I started with Westinghouse in 1954 and as I said before, three years at GPL and three years at Sperry.

Hochheiser:

So now you're working as an administrator.

Dwight:

Right, which was exactly what I wanted to do. And, by the way, what's a short circuit?

Now my main contributions as an administrator: I put in a new drawing system. The drawing system that existed was pretty rudimentary, I felt, and so my job was to gather the key people in engineering and manufacturing, and bring them together to agree. And engineering felt all we had to do was say what's the part to do, and manufacturing felt tell us how to make it. The drawings should show how to machine it, how to make it, what do we make it from. Well that was a big chasm between them because the drawings should really only do one thing.

So anyway, we had two committees, Drawing Systems Committee, and Tolerance Sheet Committee. Each of those committees had something like a hundred meetings. I happened to be the secretary of the committees, so if I couldn't bring them to an agreement in the meetings I've managed to do that in the minutes. Anyway, that all worked out very well. We had a new drawing system.

And then I got involved in putting in a new charging system. How do you charge your time? Well the charging system they had, it was adapted from the commercial divisions and you used up many, many digits of the charge number to say only a couple of things. Four digits to say it was a CPFF contract. All you needed was the letter C.

Hochheiser:

CPFF? What does that stand for?

Dwight:

CPFF, cost plus fixed fee, and that was a common development type of contract before you went into a fixed fee production. So we finally developed a whole new charging system, which actually provided a lot more numbers that we really needed—probably the pendulum swung too far. But anyway, that was put into effect.

So the idea was to try to bring some financial visibility and control. And I hired a batch of guys to a new position called Project Administrator. And the idea was we would assign one guy out to each project, each major project. They would report to me but they'd be sitting out there, and their job was to help provide this fiscal visibility and schedule visibility so that cost control and schedule control could be more easily managed, because there hadn't been enough of that before. So the idea was to start eliminating overruns, and we didn't always succeed. On one development contract, even the development stage was overrun by millions.

Hochheiser:

Do you recall which contract that was?

Dwight:

AWG 10. A-W-G 10.

Hochheiser:

Which was?

Dwight:

A pulse Doppler Radar. It followed the BOMARC pulse Doppler, invented by the same guy, Harry Smith, and when it finally went to settlements several years later, Westinghouse filed a claim, and in the words of the U.S. Navy, they said that “neither the U.S. Navy nor Westinghouse had any understanding of the meaning of money.” And I think they were right because both parties kept on making changes. Anyway, it was a considerable overrun, in the millions. Anyway, now I'm going to fast forward from the 1950's to 1972.

Hochheiser:

Okay, I may ask you later to circle back if you don’t mind.

Dwight:

Sure. Do that now if you'd like.

Hochheiser:

I find it easier to do things in chronological order but I'm happy to not do that if that's not what you want to do.

Administration in the 1960s

But if you don't mind, if we could carry through—do the 60's before we get to the 70's.

Dwight:

Okay.

Hochheiser:

All right. So now did you continue in this very similar kind of administrative role?

Dwight:

Yeah. Exactly the same sort of thing.

Hochheiser:

You discussed two major things that you did in the 50's in terms of a new charging system. And what did you do? Were there any major projects, major innovations in administration notably after, later in your career?

Dwight:

Not really. No. Not that I can pinpoint. Just a huge variety. Certainly straightening out lots of accounting problems. When a contract was finally awarded, how much should the allocations back to engineering, and manufacturing, and so forth, how much should that be? Endless arguments about that. But that was all finally settled. And a host of just ordinary administrative problems.

Space allocations, that was a major job because contracts were constantly coming and going. So one group would need more space, either office space or manufacturing space. Another group was phasing out, so they could give up some space. How do you balance all this within four walls? And eventually you have to build some more walls, so additions to buildings, and new buildings, and space in general, became one of the major items I had to adjudicate. And that was an ongoing project really until the day I retired, because that was always a new problem

But bringing people together was a major job and really quite enjoyable. You got to meet lots of people. In fact, in that job one of the fun things was you got to know almost everybody because you were either allocating space, or arguing about overruns,

or this and that, and so you met almost everybody. And that was a good thing about that job.

Any other questions?

Cold War

Hochheiser:

So this is all, you know, this is all during the Cold War, but the Cold War ebbed and flowed, and politics, you know, the administration changed, and sometimes it was hotter, sometimes it was colder. How did these things affect the flow of your work or of the projects?

Dwight:

Well there was always a sense of urgency. Since that division opened its doors, everyone that was working there had a sense of urgency. Most of them had been in World War II, and as far as we were concerned, the war was still on. And so I think everybody in the building always had a sense of urgency. What they were doing was important. So there was very little argument about getting the equipment out of the door, and most of it went out of the door on schedule or ahead of schedule. And that of course was the main objective that everybody who worked there had.

So going back to Sperry, we were working there on three shifts, right around the clock, and I can assure you their people had a sense of urgency.

Hochheiser:

And you found that same sense of urgency here at Westinghouse?

Dwight:

Yes, and I don't think it ever really diminished because every project was considered pretty important.

Hochheiser:

Now I don't know how relevant this is to your position. How closely did you need to work with the other defense contractors who were working on other parts of a larger project?

Dwight:

I didn't get involved with that at all. Not at all.

Hochheiser:

And did you similarly not get involved with working with the customers—that is the Air Force and other government agencies?

Dwight:

No. Occasionally the local, what was called NAVPRO, the Navy administrative office, occasionally with them. I think we started under the Navy and then it became an Air Force. But very little contact there.

Westinghouse Atmosphere and Work

Hochheiser:

How did you find, personally, Westinghouse here in Baltimore, as a place to work?

Dwight:

Very fun. A very fun place. No doubt about it.

Hochheiser:

Was there social life revolving around the people you worked with?

Dwight:

There was. I was not a participant myself but there were lots of social activities for those who wanted to be involved.

Hochheiser:

Were there any ways in which the division evolved or changed over the course of your many years here?

Dwight:

It just got bigger. Bigger, and bigger, and bigger. I think the employment when I started, I'm guessing now, I think it was like 4,000. When I left it was 11,000. So it was constantly growing and in many outbuildings here and there, and in Baltimore, scattered around. I didn't myself get involved in the social activities.

Hochheiser:

Were you involved at all in the planning, and constructing, and allocating space in these new buildings that kept growing up?

Dwight:

Yes. Again that involved me, and lots of different people, and getting them to agree and come together on an agreement. So now I'm ready to jump forward.

Hochheiser:

Very good.

Dwight:

Okay.

Hochheiser:

Please.

Museum Idea, Approval and Early Acquisitions

Dwight:

So we're now in 1972. That's the 20th anniversary of the Aero Division. It had been built in 1952. We're now up to 1972. I'm now a manager of administration for the defense center. I was still in that same role but I moved up too. And it being the 20th anniversary, the public relations department thought it would be a great idea if their monthly newspaper, which is normally about four pages, would have lots of pictures of things that had happened over 20 years, be it people, be it events, be it equipment. Anything people had pictures of that they could think of, over that 20 years, please send them in. And the editor of the paper, who is since deceased, Glen Brown was his name, and the name of the paper was The Circuit, called me up and said if I had any pictures and would I help? Well I leapt at the opportunity, and I had a guy helping me, and together we gathered an unbelievable number of pictures. And what had been a four page issue is now a 44 page issue. The 20th anniversary. And this fellow who had helped me, in a letter he wrote to them, asking--

Hochheiser:

His name?

Dwight:

Cliff Parody. And he, at the end of his letter asking for more pictures, he said it is hoped that one day our plant will have a museum, and went on to say that it might have samples of the equipment that had been made and so forth. So he mentions a museum here. And one of our main contributions—see if I can find it here—was a montage of all

the equipment that had been made. Now there's four pages of this. Every piece of hardware that had been made. [papers rustling; holds up copy of The Circuit] There's another page and there's two more pages. So every single piece of hardware that had been made over the first 20 years was shown. And three of those pieces of equipment are in the museum right now.

So in the spring of the next year was an every-three-year Family Day. Now Family Day was the only day that you could bring your family into the defense plant. So all the classified material was put aside, the floors were swept and sealed, plant made just beautiful.

Hochheiser:

And this would happen every single spring?

Dwight:

No, every three years.

Hochheiser:

Every three years.

Dwight:

Yes. And the plant looked so beautiful the wives would say how come the plant looks like you could eat lunch off the floor and our living room looks such a mess? And it really looked beautiful. Well I was in charge of Family Day that year and we decided we'd re-do the floor of the hangar. There was a hangar at the plant, there still is. We'd put all the airplanes out on the tarmac where the kids could systematically destroy them, and I had a whole empty hangar. And I decided to have an airborne radar display—Yesterday, Today, and Tomorrow. And we had those three radars. We had what was called the Aero 13, had it in an APQ-50. And then in production, we borrowed right off of the production line an APQ-120, a currently produced airborne fighter radar, going right into F4J's. And Harry Smith's new radar, called the WX-200, which was tomorrow's radar. And we put those right out in the hangar.

And early that day I was just standing there and a guy comes in with his wife and two boys, and he sees the old radar, and he just stops in his tracks and he says my God, I designed part of that 20 years ago. And he was right on target. Because the beginning of that design was in '52. Well a half an hour later, he's very excited and telling still about all of the things that worked and all the things that didn't work, and I got the idea right then and there we should definitely have a museum and save these wonderful

pieces of equipment from being scrapped. Because Uncle Sam will scrap them. Sooner or later they will be scrapped, no matter what. And so at that point in time I said we've got to have a museum and so we got some guys together and started mulling this idea over. We started collecting right away. The first radar set was one called the Aero 13 and it had been abandoned in place. Now that's a nice contract clause, it has a nice ring to it, "abandoned in place." They leave it there and it's for you if you want it. If you don't, you scrap it.

Hochheiser:

Right.

Dwight:

Well of course we could latch onto those pieces of equipment and so we started collecting right away. Of course in that year we didn't have any place to go with the museum. We didn't have anybody's approval for the idea of a museum. So it would take a lot of selling to get this idea approved and even more selling to get the space for it because space was always very tight, no matter what. There was really no empty, idle, available space anyplace at any time. You had to create it. So we actually were able to collect a few items starting right then and there.

Then in 1982 we finally were able to talk Westinghouse into a space, a small space, 2,000 square feet.

Hochheiser:

So it took nine years for you to convince Westinghouse that this was a good idea.

Dwight:

Yes. And during this time we didn't know whether we should be a wholly owned subsidiary of Westinghouse, or should be wholly owned, or be totally independent. We had numerous conversations with headquarters and they suggested we ought to be a non-profit, wholly owned museum, separate from Westinghouse, incorporated in the State of Maryland as a non-profit museum. Well being a batch of engineers we had no idea how to incorporate ourselves. It turns out to be very easy but we didn't know that, and it took quite a few years. In 1980 we were incorporated but we still didn't have a place to go, but we could at least have a board of directors, which we knew every corporation should have, and I selected two pilots, people who had been pilots in World War II, and two lawyers. I thought I should surround myself with lawyers and pilots to be prudent.

Hochheiser:

Who were these people?

Dwight:

A fellow named Jack Sun, retired from the Air Force, since deceased.

Hochheiser:

Now was he also from Westinghouse?

Dwight:

He had joined Westinghouse.

Hochheiser:

After retiring from the Air Force.

Dwight:

Yes. A guy named Chet Kelly, who had retired from the Navy Air Force.

Hochheiser:

And similarly then joined Westinghouse?

Dwight:

Yes. And then two of the lawyers who worked for Westinghouse. The Navy officer was Chet Kelly. The two lawyers-- one was Butch Gregory and the other was Gene Krach, who is since deceased. Butch Gregory. He'd been with Westinghouse for years. Anyway, that was my board. One of the items we acquired during that time was one of the very early Westinghouse transmitter / receivers built for the Navy, probably during the 20's. The Navy scrap yard out in San Diego called Westinghouse up and that call was soon referred to me. They had Serial Number One of this piece of equipment, with a sign on it that said “Do not scrap, call Westinghouse.” So the Navy had done this. And we said ship it east, what does it weigh? 3,000 pounds. [laughter] Of course today it would be about that big [holding up thumb].

Hochheiser:

Right.

Dwight:

So it was shipped to us, and it arrived pretty quickly, and the treasurer was quite surprised to discover we wanted a check on the spot for X dollars. But here we had this huge piece of equipment. The transmitter / receiver was about six feet wide, six feet high, and two feet deep. That weighed a ton. And then along with it was the rectifier unit and several other pieces of equipment. So we actually put it on display in a small showcase area that Westinghouse had in a central building. It was one of the first pieces we had we could display.

So finally Westinghouse was still expanding and renting buildings, and they rented something called Airport Squares. And they ended up with eight of these squares, separate buildings, more space requirements, and a period of real growth. And so I finally persuaded, I guess it was Harry Smith, who was in charge of the whole place at that time, we should have a space in there for the museum. And after much haggling back and forth he finally agreed to it. It was 2,000 square feet but at least it was a beginning. That was in 1982. So we started moving equipment in. We had the good fortune to know a person back at Westinghouse in what I called a "People Machine Interface Group." Their job was to make sure that a person could operate all the knobs and dials on a piece of equipment.

Hochheiser:

Right.

Dwight:

So we called head of People Machine Interface. Help. First it had to be a very good designer, to help us with the initial design of the museum.

Hochheiser:

And his name?

Dwight:

Well it was a gal. Her name was Ellen Prucha and she did a wonderful design job for us. I think a lot of people thought it was going to be just a batch of dusty laboratory benches with some hardware. Well it wasn't. It looked like a museum. And so we had an opening. It was actually in the fall of '83, and we had an opening for all the people who had been involved, and all of the department managers and so forth within Westinghouse, within the Air Arm Division. Anyone at all who had anything to do with the product lines or whatever that we were showing there. So we had a very great event there. And actually the chairman of Westinghouse had started in Baltimore . We had him down from

Pittsburgh as well as Dr. Sy Herwald, now V.P. Engineering, and the division manager, and Harry Smith spoke, and I had three or four speakers including myself. And so that officially opened the museum.

Museum Growth

Still we only had 2,000 square feet. Well, it wasn't long before we needed more space, so we asked for another 2,000 and Westinghouse said okay. And we soon outgrew that, asked for more space, and then they said no, to our dismay. Well we absolutely needed more space. So we convinced them of that and at that time they were starting to divest themselves of these rented buildings and build a brand new building. And that's what I call the "Glass Palace," which you'll see up the road here.

Hochheiser:

Right.

Dwight:

And I didn't want to be in the Glass Palace because, being very familiar with what happens to space, sooner or later somebody would say we need that space. It's not necessary to have a museum here, we need it for office space, and it would disappear. And of course everybody would argue for months ahead of time about that but it would eventually disappear. And it happened that I had built a warehouse for Westinghouse. The building we are sitting in now used to be a warehouse with high bays, ideal for a museum. So I persuaded them we should move in here and they agreed, finally, and we moved from 4,000 square feet to 10,000 square feet. So now we had honest-to-God space, and time marched on, and we rapidly filled it up. We also have a warehouse on the back side over here, which is still just a regular warehouse space, and the rest of this building was all Westinghouse at that time. And then it was 1996, I think, that Northrop Grumman acquired Westinghouse?

Hochheiser:

Yes, 1996.

Dwight:

And when they acquired the Defense Center they kept the whole thing intact, and if anything grew it. They didn't chop it to pieces. We soon introduced them to the Museum here, and we said we need more space, and so after working with them for a while they decided that a large conference room would be in order, which they could

use, and they agreed we did need more space. Well they finally built this whole complex, which is now 22,000 square feet, from 2,000 years ago. It has 10 galleries in it. It has a huge conference room called Pioneer Hall.

Hochheiser:

Right.

Dwight:

We still have a large store room back there. We've outgrown it again, but I must say, it is a very complete space to work with. Before I go on, we could pause for a moment because the next thing I'd like to talk about is what I consider the significant events here which are the most significant electronic devices that we have collected.

Hochheiser:

Okay, so do you want to take a break now?

Dwight:

Yes. [Tape stops, then resumes]

Dwight:

Well first of all I should say again that I do not understand electricity. All I understand is nuts and bolts. [Laughter] And it takes a nut and a bolt to hold a radar set together. If you look outside you'll see nuts and bolts [that are] even bigger. So I emphasize again that I don't understand electricity at all but I've always worked for companies, Sperry, General Precision Labs, and Westinghouse, that made absolutely fantastic electronic equipment. I just couldn't see it being scrapped by Uncle Sam, which it will be. And if you don't collect an item as soon as you can, it disappears, and it's gone. You don't have that bit of history anymore. So that was one of the driving forces behind the idea of creating a museum.

SCR-270

I'd like to talk next about what I consider to be the highlights of the museum. The first item is what is called the SCR-270 Pearl Harbor Radar Antenna, and that sits right outside the museum. It's called a bedspring antenna sometimes because it's a whole batch of open pieces of metal, sort of spaced like this. It's about 60 feet high and perhaps 15 to 20 feet wide. SCR means Signal Corps Radio. Radar is radio. Radio

Detection And Ranging, which was the term coined by the U.S. Navy, radar. A radar wave is simply a radio wave. I don't understand radio waves either. [Laughter]

But in any event, the history of why the SCR-270 was built by Westinghouse goes back quite a ways to the Signal Corps, U.S. Army Signal Corps, at Fort Monmouth, New Jersey. Now they had been working with the need for aircraft detection for a long time. And they had built all kinds of devices that would send waves out and gather them back, and they realized they needed a lot more transmitting power.

Now they knew or found out that Westinghouse station KDKA in Pittsburgh had built for themselves a very high powered tube. And so they went to Westinghouse and said could you build us a tube many more times more powerful than anything we've ever had. Such a tube that had been built in the research labs of Westinghouse some number of years before. It was called the AW-220, and it was designed by a Russian named Mouromtseff, Ilia E. Mouromtseff. And by the time the Signal Corps came to Westinghouse, Mouromtseff had moved to the Tube Division in Bloomfield, New Jersey.

So the people at Fort Monmouth went to Bloomfield and told them what they wanted, and the job was given to Mouromtseff. As the story goes, the first tube that he designed was, he thought, producible. He took it down to the factory which had many old time glass blowers, and they took one look at it and said we can't build this. And he said okay I'll move my laboratory right down to the factory and we'll learn now to build it. And the story continues, he made 57 tries before they got one they said yes we could build this. Anyway, they sent eight of them back to Fort Monmouth and Fort Monmouth was overjoyed with them—found they had exactly the additional power that they needed. So they decided they would continue to come to Westinghouse and by that time Westinghouse had a division in Baltimore called the Radio Division.

Hochheiser:

Right.

Dwight:

And what better place to come for someone to build a radar set? So they came to Baltimore and said now we'd like one of the black boxes to be built by RCA but the balance we want you to build. So Westinghouse set about to build it. That's how we got involved, because knowing that Westinghouse had built the Pearl Harbor radar, we were most anxious to try to get one.

And at that time we had what I would call a "professional scrounger," and he lived in Chicago, and he happened to subscribe to a publication called Wheels and Tracks. Now that is a publication that's entirely on World War II wheeled or tracked vehicles, and scanning through that one day he noticed there was a reference to a mobile radar. And he knew there was only one mobile radar and that was the SCR-270. So he dug further into this and discovered that this was from a guy in Saskatchewan, Canada, and he continued to dig and he tried to get the guy to take some photographs of what he'd seen. That consumed about a whole year. This device was at the University of Saskatchewan in Saskatoon, I think it is. So finally we did confirm that it was the radar we were interested in, and so eventually we got an agreement from the university. Now they were given two sets, two complete sets, right after the war, because they were the leaders in measuring the interface between radar waves that could be sent out and the Aurora Borealis. And it turns out that they had two of these radars.

They had long since given up the original electronics and replaced them with modern day electronics, and they had replaced the bedspring antenna with a parabolic antenna. So they said to us well, if you'll build us or buy us a tower for this parabolic antenna you could have both radar sets. All they had left was the antennas because they had scrapped all the rest. We said well we'd like to take both. They said you can have them if you can come and get them. So we sent two flatbed trailers to Saskatchewan from here with a volunteer. It was Harold Watson. He went out there and both trailers were loaded up with nothing but just pieces. The trailers, the bedspring antennas were in pieces. A few other odds and ends were in pieces, and the trailers came back to Baltimore, and we sent them out to a large antenna range that Westinghouse had—25 acres over there someplace. And they let us spread all these parts out on the ground—all the parts of two complete antennas. So we picked the best pieces from each and reassembled one antenna. Any pieces missing we had to have machined and made, and finally I had about four or five volunteers working on this. They got it all together and got the motor operating. We could rotate the antenna, six RPM, and sat it right outside of the museum.

So on the 40th anniversary of Pearl Harbor, which would be 1991.

Hochheiser:

That would be the 50th anniversary.

Dwight:

50th anniversary, I'm sorry.

Hochheiser:

That's okay.

Dwight:

--we had quite a gathering. We actually had the guy who operated the radar set at Pearl Harbor, Joe Lockard, the designer at Westinghouse, Fred Suffield, and the designer at the Signal Corps, whose name I've forgotten, were there. But they were all there, and at the appropriate moment they pushed a button and the antenna started rotating. We had a real live antenna and we restored it so that if necessary we could transmit from it. We restored it to perfect operating condition. That's the only one in the world, I think.

Now it's a production model. That is, it has eight steel crossbars. The early models had nine wooden crosspieces because the early ones were made of wood.

Hochheiser:

Right.

Dwight:

And you'll see a very good picture of that in the radar gallery, taken out in the island of Morea in the Pacific. That's one of the ones that had a wooden antenna, original one, and the one we have is a production model, and I suspect it's the only restored one in the world. So I think the history of how we got to acquire it really goes back to that tube, and so that's one little piece of electronic history.

SCR 584

The next major item is again a Signal Corps, SCR, Signal Corps Radio, 584. Now the unit that we have, it's a huge van, and it's part of a complete system that we used in England very successfully against the German V-1 buzzbomb. We found this at our war surplus dealer up in Danbury, Connecticut, Radio Research Labs. They have a five story building and many acres outside just crammed with olive drab war surplus equipment. They happened to have one of these vans up there and after some negotiating we agreed what we could pay for it, which we agreed we could only do over a period of time, and that we'd like to have it sent down here.

So in due course it arrived on a flatbed trailer and we started to do some repair work on it. Shortly thereafter an outfit called Nova—you may have heard of Nova, headquartered in Boston—they had come down to look at our library which wasn't nearly as big at that time as it is now, and they looked out the window and they saw this 584 van. They got back to Boston and said hey we've got a great idea. How about restoring that thing to working condition so it will track targets and bring it to Boston because we're going to

be filming the alumni from MIT who built that. And we didn't know what to say. Well we finally said yes. We had 90 days to get that thing working—working and tracking targets. That means it really had to, honest to God, work. And so the volunteers who knew what a vacuum tube was—there were about 400, plus or minus, vacuum tubes in it—

Hochheiser:

Right.

Dwight:

If you look at one end, which is open out there, you could see how many there are. I mean, there are just vacuum tubes, of all shapes and sizes. And amazingly enough, vacuum tubes are still available if you look around for them. I think some are still being made in China. But you can find vacuum tubes if you have to. They're out there someplace.

Hochheiser:

There are even a few specialty manufacturers in the United States.

Dwight:

Yes.

Hochheiser:

There's still used, particularly in audio equipment. There are audiophiles who are devoted to vacuum tube equipment.

Dwight:

Ah, right. So anyway, one day before that thing was due to go to Boston we were tracking targets. Got it working right. I think it was a training unit because all the cables had been jumbled up underneath the floorboards, so the people could learn how to figure out which cable was really which. They had all been jumbled up and so forth and it was a mess. But the volunteers would take some of the black boxes right inside and they'd work on them component by component, just completely check out, each unit. And of course we had the manuals. That was the first thing that we were supposed to get. The manual was about so big, or this thick, and having the manuals is absolutely indispensable, and we had them both on the Pearl Harbor radar and on this thing. And amazingly enough, some guys who would just come wandering in, would bring us a training manual. One guy brought in a training manual, stamped Secret. Well I had to

learn how to declassify. This badge I have here said I had a Secret clearance. I had maintained the Secret clearance because this type of thing would come in and was it now declassified or not? I had to learn how to declassify.

Hochheiser:

Right.

Dwight:

So we took it up there to Boston and on that particular day they flew a P-51 over and we tracked it. So that was quite a day. The significance of the 584 is, to me anyway, that it was part of a weapons system. And it combated the V-1, German V-1 buzz-bomb, which in 1944 was bombing London. This radar set would pick up the precise position of the V-1 and would feed that information to a computer. We don't have one of those computers. But it's a huge computer, about—oh it was the size of three iceboxes. And that would compute the lead angle. As in shooting ducks you've got to have a lead angle, and all the ballistics like the wind, and peculiarities of the shell, and so forth, and it would feed that to a battery of four 90mm aircraft guns. We have one of them right outside. And those guns were armed with 90mm shell which had in its nose a proximity fuze. The advantage of the proximity fuze was all the shell had to do was come in the vicinity of the target. It didn't have to hit it, just come near it, and it would blow up. And the 584, which was called by the British the most significant weapons system of the war, they got 90 percent of the V-1s that they engaged. That's a pretty good record.

Hochheiser:

Very.

Dwight:

It was not only used in London but it was used in Antwerp. The main objective of the Germans during the Battle of the Bulge was to recapture Antwerp. So we had plenty of 584s over there and again it got 90 percent of the V-1s that they shot at. So again as the British said, the most significant weapons system of the war. So anyway, we're very glad we have that 584. Hundreds were built by Westinghouse and G.E..

And I mentioned, there is a 90mm gun outside which a volunteer had found through the Army. One of the guns was available to us if we wanted it. [It] was up in Rome, New York in a swamp at an Air Force base. So well, we'll go get it, and so we sent a volunteer who was familiar with that part of the country up north with our own moving company, and they extracted this from this swamp and brought it down to, I think first to Fort Meade

where it was de-leaded. Almost all the equipment, including the 584, had lead paint. We had to de-lead it before we brought it inside where it is now. This had to be de-leaded and then we brought it back here. Where we first had it located it was in a firing position, the muzzle was pointed up. Right now the muzzle is either rusted or jammed in a horizontal position. But it's sitting outside and it's part of this weapons system. We also have a mockup of the proximity fuze on display with the 584. So we actually have everything here except the computer.

Magnetron

The next thing I want to talk about is the magnetron. A magnetron is the heart of developing microwaves in a radar set. And we happen to have one of the first 30 that were ever made. The Tizard Mission came over from Great Britain, probably in 1940, and they brought all kinds of secrets they had. They had developed a large number of… Great Britain had been at war several years before the U.S. got in the war, and so the Tizard Mission brought one magnetron they had developed. They brought it over here and a large group of people who met with Tizard, including Dr. Hutcheson who was the general manager of the Radio Division here in Baltimore. And this magnetron was given to the Bell Labs. Bell Labs hooked up everything they needed to do to make it work and the U.S. was excited at what it could do.

So it was sent to Western Electric, which is the manufacturing arm of Bell Labs, and they made 30 of them. And these were distributed to universities, to companies, and so forth. Westinghouse got one. And again it was given to Dr. Hutcheson. So in due course it trickled down to be in the hands of Butch Gregory, who is shortly to be on our board. So we ended up with one magnetron of the 30 ever built in this country. So that is a real collector's item.

Phased Array Antennas

And one of the next things I think is noteworthy, I think we have the only collection in the world of the evolution of phased array antennas. I first became familiar with this type of antenna when Westinghouse was building something called the EAR, electronically agile radar. Now that turns out to be a phased array antenna, and by this time this technology had been further developed and they built one of these units, I had to build a tower out at the antenna range for it because they needed a tower where this radar could look down to the horizon and scan the horizon for testing something that was called terrain avoidance. If you're going to fly an aircraft real low you want to not hit the mountains and so one of the modes of operation was the terrain avoidance, so you could fly along in valleys and not run into the mountains. And it could do everything

else under the sun in the instant, twinkling of an eye. Again, these were individual modules in the face of the fixed faceplate and computer controlled so they could switch from one mode to another instantaneously, tracking multiple targets, terrain avoidance, doing everything but fry eggs.

So I was asked to build a tower. I was in charge of facilities. That was another item that I was involved in over the years. About five million a year over a period of years is 100 million dollars worth of capital facilities. That was one of my jobs. And so they needed this tower built out there so they could actually look down on the horizon from this hilltop, and it actually does look down on the airport. It's amazing. So we tested it out there and that tower became involved in phased array antennas.

Now at an earlier date, in 1972, Texas Instruments developed something called molecular engineering with radar applications. They called it MERA, and they really were the first to be able to get the idea. What had been a huge black box as a transmitter, a huge antenna, and another huge black box as a receiver, they now put into something that big [holds up two fingers], the whole works, the transmitter, receiver, and a little antenna on the front. They put 800 of these in a fixed faceplate. Again, computer controlled. This was before what I was just describing. It was the very first phased array antenna.

Well we had a volunteer named Warren Cooper who was a microwave engineer and had been at Westinghouse for years, and he helped us get this from the Avionics Lab out in Dayton, the Air Force Avionics Lab. So we were able to get that one. And then Raytheon had built another one in 1969, a year later, called RARF, Radar Application Radio Frequency, RARF. And that is a monster, a great huge device, very heavy, K-band not X-band, and we had to liberate that from Raytheon. Actually it was in storage outside filling up with leaves when we got it.

The EAR I've already described. I was able to get one of those and then the B-1 bomber, which was an outgrowth of the EAR, was a contract with the Air Force for the B-1 bomber, with this type of antenna in the nose. It was a big oval shaped phased array antenna.

Coming up to modern times, the F-22 and the F-35, and you read a lot about those in the paper today, modern airborne radar. And for the F-22, they now call it the Active Electronically Scanned Array, and everybody in the world is building them now, the Russians, the Chinese, you name it. Everybody has got that technology underway. They've all found out how to convert these huge black boxes into a little tiny gadget

that big. Currently a lot of discussion is in electronic warfare, and jamming the enemy's electronic warfare. So anyway they're very popular antennas today.

Pioneer Hall, APG-63 and APG-64

I guess another significant event is, as part of the expansion this site, we said that it included both for our benefit and the benefit of Northrop Grumman, a very large conference room. It's called Pioneer Hall, and one of the reasons it's called Pioneer Hall is it has two displays. One of the more significant ones is the Pioneer Award winners. The IEEE has a section called Aerospace and Electronic Systems Society, AESS. I'm sure you're familiar with it.

Hochheiser:

Oh yes, I certainly am.

Dwight:

One of the things they do each year is to have a Pioneer Award for a piece of electronics that has withstood the test of 20 years. Something that has been in service for at least 20 years and proven itself as a noteworthy piece of electronics. Now we have certain pieces of equipment whose inventor was awarded the Pioneer Award. So I had the task here of designing the placard for each of these now hanging in Pioneer Hall. And very rapidly, 1968, Bill Tull, the Doppler Navigator, the APN-81, the device that I worked on, and we have one here. And then Ivan Getting for the SCR-584, which I talked about, microwave radar. Mooney, and Smith, and Perkins, Airborne Pulse Doppler, which we have here. Bill Skillman and Cowdery for the AWACS. We have an AWACS antenna here. J-STARS we have here, the MERA antenna, which I just talked about, we have here. That certainly was a major breakthrough.

Another very significant item we have is the APG-63, the first digital fighter aircraft airborne radar. Digital mind you, not analog. Now this was designed and produced by Hughes. Hughes has always been the major competitor of Westinghouse. In the early days Hughes would win one, we would win one, back and forth, back and forth, back and forth. Hughes was eventually bought by Raytheon and we were bought by Northrop Grumman, and still in the same competition, back and forth. They win one, we win one. Like the F-22 and the F-35, Westinghouse won or Northrop Grumman won. The F-18 is equipped with Raytheon radars.

The APG-63, I mentioned that Hughes developed that and the development was awarded the Pioneer Award. We've been successful over the years in applying to the Air

Force Avionics Museum in Dayton to get equipment on loan. The Air Force will not give you anything. It turns out we believe the Navy will not give you anything either. We thought that they would but we were wrong.

Anyway, the Air Force loans you something, they will not give it to you. And so we applied to them to get a complete APG-63. Well that was out of the question. Could we get the black boxes? Because we knew that they had to have a supply of spares and at a large Air Force base in Georgia, whose name I've forgotten. They were the headquarters of having all the spare parts for the Air Force for this type of radar. And we reminded the Air Force that we already had a loan agreement and could they help us find the black boxes? Well we finally made direct contact with the Air Force base. I'm not saying we bypassed the museum but we just found it quicker to call directly down there to some of the representatives. Now it turns out that Raytheon, formerly Hughes, had a field representative down there. We were able to reach him and he came up with a complete list of part numbers for us, a gold mine, because these were the original Hughes Aircraft part numbers, black box by black box, and the revisions of each one.

Hochheiser:

Great.

Dwight:

Plus the Air Force designation, and some Air Force code numbers for them - a complete gold mine. We now could talk the language of Hughes in spare parts, to the spare parts department, that we wanted. We were looking for maybe the very earliest part number, which would have been superseded by others, and any sequence would be fine for museum purposes. And so to our amazement, one of the first things they acquired was an antenna, one of the most significant pieces of the whole set. And then in due course they found one more and we got that.

And then it occurred to me that from of our war surplus dealer, much earlier, we had gotten something called the APG-64. It turns out the only difference between an APG-63 and an APG-64 is something internal which you can't see from the outside, and it was for firing one phase of the Sparrow missile. We were up there one time, we bought four of these black boxes. They didn't have an antenna up in Danbury. They said oh, we'll get one of them. Of course they didn't get one. But now the Air Force Museum has got an antenna and another black box. And it turns out we had four black boxes that externally looked exactly the same. So we now had six black boxes. So we said let's build a mockup of the nose of the aircraft. So we sent away through one of the Northrop Grumman

departments, the E&S department, for the actual aircraft drawings of the McDonnell Douglas aircraft in which this radar was used. And lo and behold we got back all the aircraft drawings. So we could now make a mockup to scale and put all the black boxes we had found in it, just as they were mounted to the aircraft. So that you could see right in one of the galleries out here—probably one of the better displays that we have. So that's how that happens to be here.

And then the trail went dead. No more black boxes were found. We're missing two but we've had no word from Dayton, no word from the Air Force, the base in Georgia, not a word, and we stopped pestering them. I used to call the guy in Dayton once a month, and I got tired of doing it.

Wurzburg Radar Antenna and Navy Radar Antenna

Another significant item that we have here is something called the Wurzburg Radar Antenna. Now that's a big huge antenna. You can see it outside at the far end, almost the end of the building. It's about 23 feet in diameter. Some years ago the folks out in Boulder, Colorado, I think the Bureau of Standards had this. Said they would no longer need it out there. If we'd like to have it we could come and get it. So we sort of hemmed and hawed about that for a while and said well, I think we'll go get it. It was built in 1938 by the Germans. The Wurzburg was installed from Norway to Normandy for coastal defense against British bombers.

So one of the volunteers went out there to look at the thing and further decided we should get it. And then our director, Mike [Simons], actually went out there and he was fortunate enough to find an antique aircraft moving company. What they specialized in was moving old airplanes anywhere in the country. It was a very small outfit but this was what they specialized in, moving delicate objects. And so we had to wait our turn because they were criss-crossing the U.S., back and forth, moving airplanes, and we had to take our turn in line. Their headquarters was in Omaha, and when they finally scheduled to go out, Mike Simons went out with them and they loaded the Wurzburg onto two flatbed trailers. It could be taken apart into a semi-circular piece, a middle piece, and then a lower piece. It took two trailers to carry all this. And they brought it back to Omaha and stored it because they weren’t quite ready to bring it back here.

They didn't have any airplanes to move in this part of the world right then, but in due course they brought it back. And they were experts at handling that equipment. They set these pieces down within one inch of each other, right out here. And then the job was to build a stand for it. So Mike had contacted a mechanical engineer at Northrop Grumman who designed a stand that would support this thing. We'd already figured out

where to put it and so in due course cement pads were poured outside here, and the stand was built. And then a different outfit who had installed and moved lots of antennas around for Northrop Grumman, came with what I would call a crawler, a device that had a crane, and a little basket up here, and four wheels. This crane could be lowered, and swiveled around, and then the four wheels driven again by the operator up here. So they could manipulate this thing any way they wanted it. And they took these pieces and they put them together up there. And so finally we had a completely restored antenna, Wurzburg antenna, right outside.

And it was built by the Zeppelin company. The Zeppelin company had built all the Zeppelins for Germany and [it is] absolutely beautifully built. If you look closely at that antenna out there, you could see why it was built by the Zeppelin company. A beautiful piece of design.

And another significant event is under way right now. The Navy designed a radar antenna in 1938, one of the very first antennas. And again it's a form of bedspring antenna. It's about 20 feet square with a whole batch of wires going back and forth. It was on display by the Navy for quite some time and then eventually it was put in storage in pieces, and some of it was actually cut up with a hacksaw to make the pieces smaller. Anyway, the Navy said to us we could have it if we'd come and get it, if we could restore it at our expense. Well we thought about this and said okay, we'll do that, even though it was quite expensive. Again, it is of the same era as the Pearl Harbor antenna and the German Wurzburg. 1938, the beginnings of radar. So first of all we had to retrieve it from Norfolk, put it in storage in this building. We started taking some of the parts apart right here in this building and sent them out for refinishing. Some of the paint had to be taken off and some of the drive motors had to be taken off. So we've already had one or more volunteers working like mad on it to get it further disassembled, and we are planning to have it assembled just beyond the Wurzburg. So we'll have three 1938 antennas outside, the earliest electronic antennas that there are.

Retirement

And so now Sheldon, I'll end my part of this. If you had any questions?

Hochheiser:

Just one. When did you retire from Westinghouse?

Dwight:

'84. 1984.

Hochheiser:

And what led you to retire at that point?

Dwight:

What led me to retire?

Hochheiser:

Yes. Why did you retire in 1984 rather than earlier or later?

Dwight:

I was 62 so I was eligible for retirement. And I decided at that time I could be busy with this. I've worked on this for 35 years.

Hochheiser:

As I now know since you've given me this whole story.

Dwight:

Yes. So it's been a labor of love.

Hochheiser:

Yes.

Dwight:

I'm no longer really involved with the... One or two projects. But I've really bowed out. But it's been a labor of love for 35 years, as you can tell.

Hochheiser:

Yes, as I can tell.

Dwight:

I was immersed in it seven days a week, 24 hours a day. Do you have any other questions?

Hochheiser:

No, I think we've covered it.

Dwight:

Okay.

Hochheiser:

Okay, well thank you very much for your time and your recollections.

Dwight:

Well thank you for having me. Appreciate it very much. I'd say we were on schedule.

R.L. Dwight Postscript:

I personally and the Museum in particular are immeasurably indebted to Al Spencer. For most of my years at Westinghouse he was there, and we had gotten to know each other. He gave long-standing support for the idea of a Museum while Administrative Assistant to the Director of the Westinghouse Defense Center. He became a Board member of the Museum, then President – and now a Board member again. In many of the early years of the Museum his excellent relations with Westinghouse and then Northrop Grumman helped put in place policies and procedures in use today.

In closing, I would like to say: Thank you Al.