Oral History of James “Jim” Sutherland

Interviewed by:
Dag Spicer

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Spicer: Hi, everybody. This is Dag Spicer here with Jim Sutherland on May the 18th, 2023. Jim Sutherland is the inventor and originator of the famous ECHO IV home computer system, which came out in about 1966 or so. We're going to be discussing Jim's life and how he came up with this remarkable idea that was decades ahead of its time – the ECHO IV home computer -- which also happens to be in the permanent collection of the Computer History Museum. So, that's of particular interest to us, to learn more about this wonderful invention of his, the ECHO IV.

Jim, welcome. Could you start by telling us a little bit about ...where you grew up, and your early life, the early years, school, maybe sports or hobbies, the kind of things that you were interested in?

Sutherland: I grew up on a farm. I was born on a farm in Missouri, and my folks had lived on that farm for about three years before I was born, during the Depression. I was born in 1933, which was not a good year to be born in any place. But my grandfather lived a mile away and I had five aunts and uncles who lived on adjacent farms. So, the whole Sutherland family was occupying a large part of that part of Missouri. I was interested in building things from an early age, didn't have any things like Erector Sets at disposal, but I did a lot of woodworking projects that my dad provided the shop, the woodworking shop for me to work in. I was about 14 or so when I learned about the 4-H Club. I don't know if you're familiar with the…...

Spicer: Oh yes.

Sutherland:…4-H Club?

Spicer: Yeah, yeah.

Sutherland: It's a great way for farm kids to learn how to do something. In fact, I named my memoirs, "Making the best better," which was a motto of the 4-H work. Anyway, my first project was raising steers, feeding them during the winter, and then selling them. Supposedly making a profit in the spring, but I was not successful in that because it just wasn't my thing. So, I started woodworking and built lots of projects around the farm, and in fact, the only building that's standing on that farm today is an oil house that I built when I was 15.

Spicer: Oh my gosh. What is an oil house?

Sutherland: Well, we had to store 55-gallon drums of gasoline in oil barrels for the farm equipment to...

Spicer: For the farm, oh yes.

Sutherland: It had to be in a fireproof building. So, it was all galvanized iron roof and siding.

Spicer: Wow.

Sutherland: …and it's still there.

Spicer: Isn't that lovely, to see that still there?

Sutherland: Well, then, that's the start of the 4-H Club, and from then there's a lot we can talk about in getting into the 4-H Club project of electricity.

Spicer: Right. What did your folks do... they were farmers?

Sutherland: My dad was a farmer, but he should've been an engineer. He went for two years at the University of Missouri in Agriculture, but he was an engineer at heart, and was always experimenting with things and showing us how to do things. My mother was a homemaker that knew how to do everything, and she taught us, my brother. I have one brother, no sisters, and the older brother and I were students of a lot of teaching that we received.

Spicer: How was school? Did you enjoy it?

Sutherland: Well, it was three quarters of a mile walking or riding a horse to a one-room country school, and I loved that, and learned so much that I needed later in life. But the experience of going to a school where you have almost a tutor that's devoting all of her time to you in certain cases, teaching you what we needed to know. We didn't have electricity, we had kerosene lamps, when I was born. But a couple of years later, my dad decided he wanted the electricity, so he built a wind charger tower, a sixty-five-foot tower with a ten-foot propeller on the...generator that generated thirty-two volts direct current. So, we had a battery in the basement that handled…. during a calm day, we could… but my mother still couldn't iron except on windy days <laughter>.

Spicer: Oh. Isn't that interesting? Did you use it mainly for lights at night, maybe? Or...

Sutherland: Mainly. We had electric fans, and had small motors that were connected to things like corn shellers, and other devices on the farm.

Spicer: This is a really technical question, but do you remember what the capacity, say, in amp hours of that battery might have been?

Sutherland: The battery was a 200-amp hour battery. So, the charger was generating probably about a kilowatt, about 30 amps at 32 volts.

Spicer: Wow, yeah.

Sutherland: So, you needed that to keep the lights going.

Spicer: <laughs> Yes, that's impressive.

Sutherland: Then...

Spicer: How clever.

Sutherland: … a few years later, the Rural Electrification Administration (REA) built the power lines through and we had 110 volts AC… I wired the house for that…

Spicer: Oh, did you?

Sutherland: It was wonderful having really true electricity...

Spicer: And what was the first thing you did when you had access [to electricity]?

Sutherland: Well, Sears, Roebuck sold thirty-two volt appliances.

Spicer: Oh, really? That's interesting. Wow.

Sutherland: But it was nice having a radio that ran more reliably on 110 volts.

Spicer: Was thirty-two volts a standard?

Sutherland: It was a standard for generators at that time.

Spicer: Really? For thirty-two volts DC, and there were a bunch of appliances made to that standard?

...**Sutherland:** There was a bulletin that Westinghouse Electric put out called “Farm Electric Power,” and it showed the thirty-two-volt generators and batteries that they provided, as well as they had the 110-volt alternating current generators too.

Spicer: That's very interesting. Moving along a bit, how was high school for you? Did you enjoy that?

Sutherland: It was good. I attribute my success in high school to two teachers, one was a science teacher, from whom we learned a lot about science; and the shop -- the manual arts -- teacher who let us use all the equipment in the shop to build things. I built a Tesla coil, turned [the coil] on a wooden thing on a lathe, three-feet long, and it was fun. Once we had alternating current, I could power that up and draw sparks and put on demonstrations of what the Tesla coil did.

...**Spicer:** So, just to flip back a second, in the earlier school you went to, was that a one-room schoolhouse?

Sutherland: Up to the sixth grade. Then the junior high was in town.

Spicer: Okay. And the nearest town was?

Sutherland: Windsor. Windsor, Missouri, was three miles away, and we had a school bus, but I had to walk a mile and a half to get to the place where the school bus [stopped].

Spicer: So, what happens in high school when you're... you know, often in the junior and senior year, students sort of get an idea of what they want to do. ...I mean, not necessarily, but some students do. Did you have a vision of what you wanted to do after school?

Sutherland: I did. Actually, in eighth grade, I decided I was going to be an electrical engineer.

Spicer: Oh. What made you decide that?

Sutherland: My mother had a friend who married an electrical engineer who worked for Wright-Patterson….. or Curtis Wright, actually. They had no children, so, when they'd come home for the summer, they'd spend time at our house, and I got to know him very well, and he was very encouraging on projects like that. So, when I built the 4-H Club project called the Model Farm, it was on a five-by-five-foot panel that had miniature buildings with lights that I'd taken from an old pinball machine that I tore up. He helped me come up with the captions on the backboard that was to demonstrate that electricity could do many things on the farm. This was in 1948, just before REA was coming in. So, it was a way to demonstrate to the people who didn't know much about electricity, of what they could be doing with it.

Spicer: So, that's eighth grade., That's pretty early. And at that point, now that you've got this goal, did you change anything in the way you studied...

Sutherland: No.

Spicer: …or do anything else?

Sutherland: When Westinghouse awarded six national awards to the 4-H Club projects that had been submitted that year, I was one of the six winners and got a $200 college scholarship. So, that was the thing that I used at the University of Missouri for electrical engineering.

Spicer: Wonderful.

Sutherland: So, Westinghouse, I owe a debt of gratitude for that.

Spicer: Yes, that's great. And, you know, back then, I imagine $200 was a good fraction of your tuition?

Sutherland: Yeah. I think our tuition fees <laughs> for the semester were $87, and that included...free basketball and baseball games <laughs>.

Spicer: Nice <laughs>. That's good. Well, tell us about your university experience? It's a four-year program, I guess?

Sutherland: Four years. I started in 1950, right after the Korean outbreak, where North Korea attacked South Korea in June of 1950. Boys were being drafted right out of my classes, and I said, “That's not good. I'm here, <laughs> I want to stay here, and I'll serve afterwards.” So, I enrolled in the advanced ROTC program, in the Air Force, and so I was a second lieutenant, commissioned, at graduation then, in 1955. I'd come to Westinghouse, they'd offer me a job in Pittsburgh, and so, I was working, and the orders came from the Air Force to report to State College, Pennsylvania, to Penn State University, and to study meteorology for one year and get a second bachelors.

Spicer: Oh.

Sutherland: Well, that's like a second driver's license, but it was a good… I enjoyed meteorology, because I got to travel with it.

Spicer: Yes. And so, I don't want to miss any details here. So, is there anything... tell us about the four years where they're…by joining ROTC, does that allow you to defer serving until…...

Sutherland: Yes.

Spicer: …you've got your degree?

Sutherland: Exactly.

Spicer: That’s the point, right. And then, so, tell us about the degree and studying? ...that's ...It's a very challenging course of work.

Sutherland: We had two options, one was power and the other was communications. If you went to communications, that meant you were going to work for the phone company, and if you had studied power, you're going to work for a power company in someplace. I decided communications made more sense. Electronics was more interesting to me than power.

Spicer: Yes, I see. Yeah, the old power versus electronics option. And anything remarkable or memorable about your undergraduate studies? Any good professors…?...

Sutherland: We had some great professors and they encouraged me in some of the projects. One of the projects I did for a Saint Patrick's Day celebration in the laboratories was to build a lightning bug.

Spicer: A lightning?

Sutherland: A lightning bug.

Spicer: Bug? Is that a little radio that hears...

Sutherland: Well, it was sort of like that. We used optical sensors on a round, about two-and-a-half-foot diameter, twelve-inch-high device that was on wheels.

Spicer: Wow.

Sutherland: It would rotate when the two wheels around the diameter of it, when they were going in opposite directions, it would rotate. There was an opening in the front with an optical sensor, actually, a photomultiplier, that would sense a light. So, it had lightbulbs on the station around the area, and switches, and we could turn the lights on or off, and it would then search until it found the light, and it would go turn the direction... not reverse the direction, but motors then started going the same direction forward, going to the light. It was very successful and I couldn't have done it with the help of Dr. Jim Tudor, who was my engineering teacher there.

Spicer: And was that a senior project you had to do?

Sutherland: I was a junior then.

Spicer: Junior project, yeah. And to graduate, did you have to do a senior project...

Sutherland: No.

Spicer: …or a thesis, or anything?

Sutherland: Actually, it's pretty simple. Just passing calculus was the only requirement, and it took me five sessions with calculus to do that. I wasn't very good at the calculus, but I made it through.

Spicer: Wow, that's great. Good for you for sticking with it. Yeah, that's really amazing. And tell us about just on the personal side, did you meet your wife during these years?

Sutherland: In 4-H Club work, we went to the county camp, and I was attracted to her because she could just dive and swim. I didn't know how to swim a lick at the pool. But we became acquainted, and three years later, then we were married.

Spicer: Oh, lovely. And was that just upon graduation for you?

Sutherland: We were married the last senior year. My folks paid the expenses, because the previous year I'd had two roommates. We had a three-bedroom room that we rented, and there was a problem, the landlady didn't like all the noise we were making. I was working at the State Fair and these two roommates visited me there, and they said, “We've got a problem because we can't stay with the landlord anymore and we're looking for another place,” and finding a place for three is almost impossible.

He said “Why don't you just get married?” <laughter> So, Ruth was working at another building in the State Fair at that time, and so I asked her, and she said well, if she could transfer all of her credits of

home economics that she had accumulated at a state school, she'd go to the university with me. She had all 90 credits transferred.

Spicer: Wow, fantastic.

Sutherland: So, sixty-eight years of marriage, and she passed away about a year and a half ago.

Spicer: Right, yeah. Oh, that's lovely. Well, yes, and any kids yet…...

Sutherland: We had… when I was in the Air Force..…my first baby was born in 1960, and...

Spicer: I was looking at the pictures of ECHO IV, I think from the Pittsburgh Gazette. Is that it?

Sutherland: Yeah, that's the one.

Spicer: When you're in the basement, and the three kids are there. So, anyway, we'll get to that. All right, so, you've graduated university and are married. Don't have kids yet. What was your first job?

Sutherland:…the Air Force. So, that was a big surprise when the orders came that I was to go to Marietta, Georgia for my first assignment as a weather officer, and we spent a year there. Of course, we had the baby then, the first baby was with us then. Later, I was assigned to Morocco, Sidi Slimane, Morocco. There was an air base and I spent time at the weather center there.

Spicer: Oh wow.

Sutherland: Then we moved to Madrid, Spain. Ruth was right along with me all those times and we got to enjoy international travel, and that's got us started. We traveled to sixty-eight countries and seven continents...while we were married. Some good memories.

Spicer: And what was the work product of your work there? It was to help navigators and pilots?

Sutherland: We'd sign the manifest, give them a weather briefing of what to expect. With flights traveling over the Atlantic to Madrid, it was good to interview the pilots who had just landed to see what the weather was like, because there were only five balloons over the entire Atlantic… to get an idea of what was coming, since they had a better idea than any of the balloons did. So, I could brief the outgoing pilots, then, with a lot more information.

Spicer: That's excellent, and pilots do that today, of course...

Sutherland: Oh yeah.

Spicer: …report to ATC what the... especially in the landing, if there was anything unusual in the landing. And so, did you use any computers, by the way, in your generation of these reports? ...

Sutherland: No computers.

Spicer: What was the information source…

Sutherland: I'm sure the Air Force used punched cards they had, probably IBM. I remember seeing a photocopy from a Xerox machine in Morocco. One of the planes crashed on takeoff and had a nuclear weapon on board, and so we had... the weather team had to come up with the prediction of where that radioactivity was going to go.

Spicer: Oh my gosh.

Sutherland: We had several texts that helped us draw the plot of where that was going to be. I remember seeing the results that we had drawn up, plotted and printed out on a Xerox copy machine. The first time I'd ever seen any... the old mimeograph was a terrible thing, its stencils were terrible, but this was really great.

Spicer: And it... was was that from a weather satellite, or these balloons that you... like, where are they getting these map... how do they find where...

Sutherland: Well, we had to take the wind directions at various altitudes that we had from balloons at our base. So, we knew, locally, what the weather was, the effects of that weather on the radioactivity. Fortunately, <laughs> as I was driving to work for an afternoon shift, there were a lot of cars leaving, and all the Moroccan workers had skipped out. They knew when they saw that smoke cloud going up that they didn't want to be around <laughs>. They were smart.

Spicer: But the weapon never detonated, of course, right?

Sutherland: No, we didn't have any problems because...

Spicer: Yeah...

Sutherland: -the...

Spicer: -but they... was it at Las Palmas? Is that the name of...?

Sutherland: No, this was at Sidi Slimane, Morocco.

Spicer: Ah yes, right -- did you acquire any skills during that that you could use later on, or that were helpful in any way?

Sutherland: Travelling was about the only...

Spicer: Traveling?

Sutherland: …skill that we learned. We loved Morocco. It's a good place to travel. Then Madrid, we made a lot of day trips around Madrid.

Spicer: How often would you travel, about every year, once a year you'd go?

Sutherland: Every week <laughter>.

Spicer: Every week? Oh my gosh.

Sutherland: Yeah, with working shift work, you have some days that are pretty long, and that's good.

Spicer: …yeah, right. So, you have days off as well?

Sutherland: Yeah.

Spicer: Yeah, great. So, you've done your stint in the Air Force.

Sutherland: Well, that's the outset. I'd only been on military leave, and I was welcomed back. So, I had my five-year pin while I was on the graduate training program for new graduates that were just coming in <laughs>...

Spicer: Oh yeah? Wow.

Sutherland: … from previous... coming to Westinghouse five years earlier, I had this five-year pin that I was able to put on my lapel.

Spicer: Wow, that's nice.

Sutherland: I was proud of Westinghouse.

Spicer: Yes, definitely. And just working during the Cold War too, a very kind of nerve-wracking atmosphere. I interviewed some operators of our SAGE system. I don't know, are... you must be familiar with SAGE?

Sutherland: No, not at all.

Spicer: Oh, it's a Semi-Automatic Ground Environment. It was a... that's a military name that means nothing by design. It's essentially a network of radar, of computers, about twenty-six of them around North America, built in giant blockhouses, that accept local radar input. So, it's essentially- it was a continental air defense system...

Sutherland: Oh my.

Spicer: -and the threat was incoming Soviet bombers coming over the East Coast of New York or Washington, and dropping an atomic bomb. So, what this system did is it found them, it first of all had a list of all commercial flights. So, anything not commercial would instantly show up, so the threat can be identified immediately. Then they actually tell the scramble interceptors to go and get this guy, including guiding the plane to the...

Sutherland: Boy.

Spicer: -intercept, all done by computer, done by IBM for the Air Force. And IBM made over a billion dollars in profit on that contract, and really, without it, it's hard to say if they would have had the resources to do System/360. So, it's a remarkable project that almost no one knows about it, and, you know, it cost more than the Manhattan Project. It was about an $11 billion...

Sutherland: When was that built?

Spicer: Mid ‘50s to ‘60- ‘61 was the first deployment at McGuire [Air Force Base].

Sutherland: I wonder, when I got my first job after I came back from the Air Force with Westinghouse, it was at the new products lab, where we were assigned the job of designing the first Westinghouse Industrial Control Computer, called PRODAC IV. The design of the architecture, that came from one of the bosses in Westinghouse, from an IBM computer system, and it could be that he copied the architect...

Spicer: Interesting.

Sutherland: -the features of that architecture.

Spicer: Yes. Could be.

Sutherland: Was there a priority director in SAGE, do you remember? Where programs could bid for...

Spicer: Yes.

Sutherland: -access?

Spicer: There was an interrupt system.

Sutherland: That was sort of unique in computers in those days.

Spicer: It's very early for that.

Sutherland: We had it in our PRODAC IV.

Spicer: Yeah. Okay, so, let's start... let's skip back. Sorry for that diversion. We're not here to listen to me. So, okay, so you're out of the Air Force and you're hired by Westinghouse now, as your first job, is that correct?

Sutherland: Hired back at Westinghouse.

Spicer: Hired back, that's right. What was their first project? Was that the PRODAC IV?

Sutherland: Uh-huh.

Spicer: Okay. Well, I had a question on the ECHO IV, which we're going to get to you in a second. Was the design of the ECHO IV inspired by the logical design of the PRODAC IV?

Sutherland: No.

Spicer: Okay. So, you literally... it's a new design?

Sutherland: The features of the ECHO IV were, of course, limited by the Westinghouse circuit boards that we used from the PRODAC IV that were available. So, I designed the ECHO IV with help from DEC. We had two divisions in Westinghouse. They were not competing, but they had to cooperate, and one was servicing the needs of utility customers with computer systems. The other Westinghouse division was building the computers. When it came time to settle up the profit and loss on that deal, it was always the computer system that came out ahead, because they could set their prices very, very high, and it became uncompetitive for the other division to use Westinghouse computers. So, they went to DEC, and they bought the first PRODAC, a PDP-5, and I was assigned by Westinghouse to go there and learn how to maintain it, and how to keep... when we put those things in the Westinghouse cabinets, we had to be able to maintain them. So, I was in charge of the engineering that we do at Westinghouse with the PRODAC, PDP-5. So, a lot of the features that I learned about in the PDP-5 I used in the ECHO IV, such as registers in memory, rather than in the hardware, and, yeah.

Spicer: Interesting. Okay, so, let's say, how many years were you at Westinghouse before the idea for the ECHO IV occurred to you? And before that, tell us about the PRODAC IV that you first...

Sutherland: Well, the design team started in '60 and worked for three years on the prototype, and it was... of the PRODAC IV, which we called the PRODAC X. It was then shipped to Sewaren, to a power plant that was just starting up, and they said "We got to have that computer," and we knew it wasn't ready, but it was shipped anyway. Management decided to ship the PRODAC X prototype to Sewaren. Well, that meant a year later it was all shipped back to Pittsburgh and dumped on the floor, and that's how I got access to it in '65. Now, '65, then, was the first year that I really had to think about what we could do with those scrapped circuit boards after having the experience of going to Maynard [DEC headquarters] to learn the PDP-5.

Spicer: Right, the architecture and the way it's designed, yeah.

Sutherland: So, I spent a year designing the ECHO IV, and building it, and then programming it, and the programming took a lot longer than a year.

Spicer: Okay. And the PRODAC IV, help me understand, was it actually a shipping product at one point, or was it just one main one...

Sutherland: I remember the drawings occupied rolls and rolls of Westinghouse drawings. That utility group in East Pittsburgh decided that they were going to make it out of reliable NOR elements that they made in East Pittsburgh, rather than in Buffalo, Westing...

Spicer: I'm sorry, reliable which element?

Sutherland: The NOR elements, N, O, R.

Spicer: Oh, okay, NOR gates? Yeah.

Sutherland: NOR gates. Westinghouse management said, “You got to use Westinghouse NORs built in Buffalo, because they've had experience with the 4449 using those elements.” But along came a guy with a cost suggestion, and he said, “I can save you money if we cut notches instead of drilling the holes in those little circuit boards for the NOR elements.” Turns out that that was a lousy idea, because you couldn't make a reliable NOR gate by having 8 notches for the resistors. Soldering was okay for a while, but it was weak, and they then went ahead and compounded the problem by potting them in epoxy that expanded with high temperature... with those temperatures. So, it might work good for the first 20 seconds when you started it, and then you'd have to go around searching for the bug. So, anyway, they decided to use the exact same design that we'd shipped to Sewaren, and build it out of East Pittsburgh NOR gates. Shipped it to Texas, it ran reliably for years, and years, and years, and never fails.

Spicer: This is one of the things that really impresses me about process control computers, is that they just last forever, if they're- if they're good. I mean, yeah, they're there for... their service life is in multiple decades, often. And in fact, wasn't there... so, just to go back, the PRODAC IV was...

Sutherland: There was only one and it shipped...

Spicer: But there was one, and it shipped to...

Sutherland: Texas.

Spicer: Texas, at an...

Sutherland: Fort Worth.

Spicer: …oil refinery, or...?

Sutherland: Power plant.

Spicer: …already. And tell me why the first batch of boards was returned? Because they had a bad experience with the system, I guess, and returned it to you?

Sutherland: The customer got tired of paying Westinghouse to repair the system that was always intermittently failing. So, the manager of the Computer Systems Group said, “We'll ship a UNIVAC computer, just like we've been shipping to the controlling steel mills, but we'll use different kind of input-output connections for the IO.” We call it the 580, and that 580 then was used to replace the defective circuit boards that came back to Westinghouse.

Spicer: Right. Now, that’s very interesting, you specified a UNIVAC. Is- was that unusual for Westinghouse to specify a...?

Sutherland: After their experience with the PRODAC IV prototype, they decided they'd go to an actual reputable computer manufacturer. So, they incorporated this, which UNIVAC had built for the Navy submarines or someplace, and put it in Westinghouse cabinets with input-output connections for the huge wires from the process that were connected to all the input and output connections.

Spicer: So, it was kind of a- like a concentrator, in a way? Like it takes all the inputs and then feeds that to the UNIVAC?

Sutherland: Yeah, with the input-output system for the UNIVAC.

Spicer: I wonder if the computer you're one- you were talking about is the NTDS, the Navy Tactical Data System?

Sutherland: It could be, I just don't know. I don't recognize that name.

Spicer: It was a shipboard computer, and one of Seymour Cray’s designs, actually, done by UNIVAC Remington-Rand.

Sutherland: Remember the circuit boards in it?

Spicer: They're very small. Yeah.

Sutherland: They're like four inches?

Spicer: Yeah. Yeah.

Sutherland: I bet it's the same thing.

Spicer: They're very small.

Sutherland: Yeah. What did you call it?

Spicer: NTDS, the Navy Tactical Data System.

Sutherland: Navy Tactical Data. Okay, I'll have to keep...

Spicer: Which was a...

Sutherland: That makes sense.

Spicer: -fire control... no, sorry, not fire control. Battle management, we would call it now, where you see- where you get radar inputs, and you- it displays on a screen, and you can, you know, designate things on the screen for later, for more action, and that kind of thing.

Sutherland: Well, since it had to be reliable <laughs>, Westinghouse...

Spicer: Yes...

Sutherland: -was interested <laughs>.

Spicer: -and that was in the early... I don't want to get my years wrong, but, you know, early 1960s, I think?

Sutherland: That would be the right time period, because I was a project manager of the second PRODAC 500, was shipped to Phoenix, Arizona, to control all the power in Arizona.

Spicer: And what was it... by the way, the Navy, the NTDS, as you might expect, is hardened. It... you know, military hardened, the cabinet is, it's- literally looks like a battleship.

Sutherland: This one is in Westinghouse cabinets. They took all the panels, and nowadays...

Spicer: <overlapping conversation> Well, they probably repackaged it, yeah.

Sutherland: Yeah, it’s repackaged.

Spicer: Yeah, yeah. Well, that’s very interesting. So, this first place, I'm sorry, I forgot the name again, that returned the PRODAC?

Sutherland: Sewaren, New Jersey.

Sutherland: It was a steam power plant.

Spicer: Steam power plant. Okay, for electricity? Yeah. And did they burn coal, or how does that work?

Sutherland: I can't remember.

Spicer: Natural? Okay.

Sutherland: I was only there once.

Spicer: Okay. Yeah, did you- did you have to bear the brunt of their... yeah <laughs>.

Sutherland: We suffered. Computer Systems Group, after they moved to the research lab Westinghouse had, wouldn't hire me because I worked... I was in the assigned group for that fiasco.

Spicer: Oh no. <laughs>

Sutherland: So, I was with the utility group, and that's why I was assigned the job of program manager for this first PRODAC 580. That went to Arizona.

Spicer: Well, that's very interesting. And at this time, is this all occurring in Pittsburgh, your...?

Sutherland: We built at the research labs, yeah.

Spicer: Yeah, yeah. And you basically lived in Pittsburgh most of your life, right, after that?

Sutherland: I moved twice. After 30 years in a suburb, moved to Monroeville, which is closer to Pittsburgh, and I've been there 33 years.

Spicer: Okay, great. Well, is there anything about Westinghouse that we should cover before we dive into ECHO IV?

Sutherland: Well, Westinghouse went through different phases. They only used the UNIVAC computers for a few jobs, but developed, in-house, their own computer system called the PRODAC 50, which was a small computer. I was in the part of that group that did the input-output connections, and the designing of the way that the customer could connect his wires to that. The good thing about that was the customers liked their input-output connections. They liked to see screws, and big barrier terminal strips, and access for the cables. So, we decided the P50 wasn't as big as it should be, and the UNIVAC was pretty expensive.

So, they decided to go to a company called SDS, Scientific Data Systems, California, and they were just introducing a thing called the Sigma 2, and it's the right size, the right price for Westinghouse. So, we used Sigma 2 computers in our Westinghouse cabinets, and I designed the interconnections to the input-output system so that all the field connections were familiar to the people installing the systems, and here was this very reliable mainframe. Later, I guess SDS got bought by Xerox...

Spicer: Yes...

Sutherland: -and...

Spicer: -a spectacular $900 million deal <laughs>.

Sutherland: Do you have any Sigma 2s?

Spicer: Yeah, we do. We have a Sigma 7 and a Sigma 9.

Sutherland: Is that right?

Spicer: Yeah.

Sutherland: Those are huge things.

Spicer: Yeah, they are big <laughter>. And what was I going to say? Oh, how was this branded, this... was that the PRODAC 50? That was- is the rebranded...

Sutherland: We called it the 510... no, 550. The first ones were 510 and 580, in UNIVAC, and then after we combined it with the SDS machines, it was called the 550, because it used the P50 peripherals. So, the 550s were very, very successful. I don't know how many, hundreds of those got shipped.

Spicer: And how many input I/Os could you put on there, do you think?

Sutherland: I can't remember how many thousand it was, but it was a lot.

Spicer: Thousands?

Spicer: Really?

Sutherland: Yeah. It was connected to every sensor and every actuator in the plant.

Spicer: Incredible. Do you remember who your competitors were at this time?

Sutherland: GE, generally.

Spicer: Okay. Would you have like Allen-Bradley, or Foxboro, or...

Sutherland: Foxboro's...

Spicer: -Honeywell?

Sutherland: -Computers, but they didn't have the recognition by our industrial customers.

Spicer: Yes, I could see that Westinghouse has a long tradition of a good reputation.

Sutherland: Once you make a friend with an electrician and the customer, you've got them hooked, <laughter> because they like the way that the connections are made.

Spicer: Yes, yeah, it's very nice. Yeah, the terminal blocks, row upon row of... it's like a central office in the phone company, right?

Sutherland: I never did any software design. I met... a lot of other people do the systems.

Spicer: Now, when you... tell us about your role in the- in the overall, you know, going from a clean sheet of paper to a shipping product? Did you have your hands in at each stage, like, you know, bringing the system up, debugging? Design?

Sutherland: Well, yeah, I got to sign a lot of drawings. Hundreds of Westinghouse drawings have my signature on the model. I worked with the draftsman, and he created the drawings from my designs. But fortunately, we had people in our division that moved from research out to a place called Regional and Development Industrial Corporation, RIDC, in 1968. So, we all moved out to the RIDC, and that's where the testing of all these computers was done. Test floor was just covered with systems and people who knew how to check them out. I remember we had the SDS computers with their big random-access memories, drum memories, or disks. I guess they were called disk memories then, huge things.

Sutherland: They didn't have much memory storage, but they were designed that if the power failed suddenly, that all of the heads would immediately lift off and the brakes would be applied, and it would stop in half a revolution. Now, I can still remember being on the test floor when you had eight or ten of these systems being debugged and the power failing, and it sounded like you were in a hall of dinosaurs shrieking, as these brakes all applied at the same time.

Spicer: Wow.

Sutherland: That was something you'll never forget.

Spicer: So, okay, let's talk about ECHO IV, which is the most amazing thing that you've probably done, besides having three great kids, and...

Sutherland: And a wife who's an economist...

Spicer: a lovely wife. Yes.

Sutherland: Ruth had a lot of ideas that perhaps she had thought that the computer would help her job, made easier.

Spicer: Yes, I was reading a lot of what she was writing. It's - it's really charming. And I included a lot of it in my blog, actually. I don't know if you remember that?

Sutherland: Oh yeah, “50 Years Later”.

Spicer: Yeah, yeah. So, okay, let’s talk about ECHO IV. What gave you the idea?

Sutherland: I guess I was disappointed that the prototype never was reliable, and so it reflected on our job of designing it, which we knew was a good job. We'd done a good job designing it. So, when I saw those parts, I had a boss that was willing to sign a property pass, so I could take them home on loan, as well as the memory. It used a telex... it wasn't called that. It was a different manufacturer at that time. But anyway, $40,000 core memory system that could handle the 8,000 words...

Spicer: Wow.

Sutherland: -28-bit words, and...

Spicer: Maybe Fabritech? No?

Sutherland: Some place on the East... West Coast. I don’t know.

Spicer: Anyway, yes...

Sutherland: Telemeter magnetic...

Spicer: -so, that’s...

Sutherland: Telemeter Magnetics was bought by Ampex in 1960.

Spicer: Oh, International Telemeter? Yeah. So, this is the single most expensive piece of the computer?

Sutherland: Without that, I couldn't have even thought of doing that.

Spicer: Right, yes. Okay, sorry to interrupt. Keep going.

Sutherland: Well, I had a good friend with a Station Wagon. I was driving a Volkswagen at the time, and so I needed somebody to carry all this stuff home. You can imagine the volume of 120 circuit boards and the core memory system, two 19-inch racks full of stuff.

Spicer: Wow. Yeah, now, the racks, by the way, were homemade? Is that right?

Sutherland: I made them out of maple wood that I bought at a lumberyard in Pittsburgh.

Spicer: Lovely. Yeah, and they're 19-inch wide, or the standard 19 inches?

Sutherland: Standard 19-inch wide.

Spicer: Yeah. Okay, so, the property manager was someone who didn't particularly care too much, I guess, about…like, you just said "Go ahead and take it," …

Sutherland: Well, it was an investment.

Spicer: -any higher level of authorization that you needed?

Sutherland: The higher level was embarrassed.

Sutherland: By the fact that they had to return their Westinghouse equipment, because it wasn't workable. So, there was a lot of encouragement on their part to get rid of the stuff and so they were quite happy for me to help them.

Spicer: Got it. Thanks for explaining that. Okay. So you kind of had an implicit go-ahead from the company.

Sutherland: So if it hadn't been for that unknown guy in Buffalo, New York, who worked for Westinghouse, who got an award for notching those holes, I wouldn't be sitting here.

Spicer: Wow. That's amazing. Okay. So where did you get the station wagon from?

Sutherland: A friend. Another engineer. During lunch hour, we were able to carry all this stuff home. Wow.

Spicer: And what was Ruth's….

Sutherland: She didn't think it was a good idea to have this stuff stacked in the dining room, but she was willing to put up with it for a while. And then gradually I built the cabinets and moved it all to the basement, to the game room.

Spicer: Okay. Yes. Now, did you have the cabinets up in the living room or just the boards?

Sutherland: Just the circuit boards in the pile. It had metal cages. I think 16 boards in a cage.

Spicer: Card cages.

Sutherland: Card cages. And I moved all that to the basement, where the cabinets were built.

Spicer: Tell us about the technology. Was it DTL or RTL or something else, just transistor technology?

Sutherland: I guess RTL would be the closest. Diodes are too expensive, they thought. And so they built NORs instead of NANDs.

Spicer: Yeah.

Sutherland: But as long as you weeded out the bad guys, we were okay. NANDs, I think, would have been a better thought, but since they weren't making NANDs in Buffalo, Westinghouse Management says, we don't want to use them.

Spicer: Right.

Sutherland: We've got to use whatever's coming out of Buffalo.

Spicer: Why would NANDs have been a better choice?

Sutherland: Well, they're more reliable, for one thing. At the time? And faster. They'd have been faster. The diodes would have been a lot faster.

Spicer: Right. So it's not a logic reason.

Sutherland: No.

Spicer: It's an AC characteristics reason kind of thing.

Sutherland: Yeah.

Spicer: Okay. Great. So that's very nice. So you've got a good feeling that the company, you know, you're not doing anything untowards or anything. You've got the company sort of behind you. And so what's the next step? What did you do with these boxes of boards?

Sutherland: Well, after I designed the system, I can say with help from the architecture of the PDP-5, my first good test was to exercise the memory by writing checkerboard patterns on alternate locations and reading them back.

Spicer: Right.

Sutherland: I knew we were on the road then, that it was going to work.

Spicer: Oh, yes.

Sutherland: You know, to read that memory.

Spicer: Yeah. How did it display results to you -- on a printer?

Sutherland: Well, we had the maintenance panels, one maintenance panel from the PRODAC X, which was still on the floor. I was able to use those maintenance panels. They had green little neon lamps and so you could read out the contents of the instruction register and the address and the accumulator and all the important stuff. And then I fixed up an interface to an old, it wasn't a Friden typewriter, it was a serial typewriter printer. **Sutherland:** Kleinschmidt was the name of it.

Spice Oh, Kleinschmidt. That's right.

Sutherland: And I couldn't generate serial at the right rate, so I converted the printer to accept parallel codes of the letters and figures.

Spicer: Wow. That's pretty good.

Sutherland: And it would print out the results. In fact, the first printouts were probably on the Kleinschmidt. And then later I interfaced two Selectric 735 input-output typewriters, and that's what printed out those results.

Spicer: Right. What, by the way, the protocol, is it EBCDIC?

Sutherland: It was.

Spicer: Yeah.

Sutherland: It had to convert ASCII back and forth.

Spicer: Right. How did you do that?

Sutherland: The computer did it.

Spicer: Using the PRODAC. That's great.

Sutherland: Well, ECHO IV was able to convert the various input-output codes.

Spicer: Right. Right. So let's talk about the architecture of ECHO IV. How would you go ahead and describe that?

Sutherland: Well, it was a lot simpler than the PRODAC X because there's only one user, so we didn't have to worry about things like priority. Oh, yes. Even though I think that it was capable of taking on lower priority jobs when it was in the middle of something and it had to pause on a higher priority job, the lower jobs would be running. While it was inputting and outputting to the typewriter, it could do lots of work while the typewriter was printing the character. So we sandwiched a lot of stuff with the priority.

Spicer: Yeah. Kind of interleave tasks.

Sutherland: I've told you many times about how it could play music with the jump instruction. True programmers don't like a jump instruction because they lose control immediately. Yes. Well, I used that to create loops of various lengths. At the end of the loop, I could output a pulse to a speaker, and by varying the length of the loop, the frequency of the tone generated by the speaker could be changed. So we had music. I told you we had “Silent Night” on odd hours and “Oh Come, All Ye Faithful” on even hours. That was fun to use the computer to play music.

Spicer: How was the speaker connected?

Sutherland: To bit zero. It was one of the output bits.

Spicer: Bits, yeah. How many I/Os in total?

Sutherland: It had enough to run the house. Later, we had the keyboard for the TV controls where you could press the buttons nine through zero in the right order. That would go into the computer, and it knew what channel you wanted to watch. So it output signals up to the little motor on the TV that turned the tuner to that particular channel. Also, it could control the antenna rotor to point to the right space.

Spicer: That's really good, Jim. This is why I love ECHO IV. It's just so cool. So I didn't even realize, you added that motor, I guess, onto the TV tuner?

Sutherland: It was something you could buy from Heathkit.

Spicer: I vaguely remember. Zenith, maybe?

Sutherland: Finally Zenith. In the early days, it was Heathkit.

Spicer: They used those ultrasonic controllers?

Sutherland: I don't know how they did it. I used wires.

Spicer: Oh, yes. Right. So that's great. Let's step through the different functions of ECHO IV. So the TV, we just discussed, you could punch in what channel you wanted to watch. The TV set was in the family room?

Sutherland: It was actually in the family room.

Spicer: In the family room. It would automatically select the desired channel, rotate the antenna for maximum signal, and you're all set. The location of terminals, now, you had three?

Sutherland: Just one of those terminals. Binary coded decimal clocks, with the lights flashing the time in binary coded decimal. I don't know if you've ever seen binary coded decimal clocks before. We had lights denoting one, two, four, eight for the seconds, minutes, and hours.

Spicer: So 12 separate lamps?

Sutherland: There were more… there were four lights in each group of seconds,minutes, and hours, three for each group of tens of seconds and minutes. And then there was one extra lamp for the tens of hours.. It didn't have a 24-hour system.

Spicer: I see. Why did you use this system? Was that to stimulate your kids' brains?

Sutherland: Yeah, it was a challenge because I'd built that before. Before we had the ECHO IV, just out of NOR gates.

Spicer: Okay.

Sutherland: And we had four displays, the kitchen, bedroom, living room, and the dining room. It was nice to see what time was. Preferably, you could just tell what time was by glancing.

Spicer: How adept were you and the family at decoding this?

Sutherland: Well, the kids amazed me. They caught on to that. Seven was their favorite because one plus two plus four is seven. So when you saw three lights on you knew immediately that was a seven. But they went to school and had a hard time learning about big hands and little hands. But they know all about binary codes.

Spicer: Oh, no. Yeah. Right.

Sutherland: I can't think of all the jobs that we did, but one was to control the Hi-Fi amplifier and the speakers that it was connected to.

Spicer: Right.

Sutherland: And the alarms. It could sound a binging alarm.

Spicer: I was watching your lecture and one thing I didn't quite understand was this amplifier you mentioned had like a kilowatt output or it drew a kilowatt. I didn't quite catch that.

Sutherland: You know about Class A amplifiers? Well, they're very inefficient. So these tubes they used were transmitter tubes with graphite plates, so the dissipation during Class A operation was all dissipated by the plates. Wow. Yeah. Also, the filaments were 10 volts and I used DC on those filaments. I can't remember exactly. It may not have been 10 volts, but there was a lot of power and there had to be direct current. So that had to convert all that direct current and the plates had to run at 1,300 volts to give a good, very sharp, flat line across a series of flat lines.

Spicer: Right. A linear response.

Sutherland: Very linear.

Spicer: Yeah.

Sutherland: And with the DC filaments, you could turn the volume up to the maximum and turn the bass up to the maximum and hear nothing from the speakers at all. There was just no hum.

Spicer: Oh, I see what you mean. No noise.

Sutherland: No noise from the filaments getting in. That was fun. So the computer controlled that and could turn it on and off and select which room would have the music that was coming from the tape deck that was in the living room.

Spicer: Right.

Sutherland: Coffee table.

Spicer: One thing I noticed in this era, the 60s, mainly 60s and 50s, there was a lot of interest in building built-in systems in people's homes, like built-in stereos, built-in clocks, built-in appliances. You know what I mean by built-in? Like built into the wall?

Sutherland: Yeah, yeah.

Spicer: And I noticed your amplifier was on the other side of a wall.

Sutherland: In the locked cupboard.

Spicer: Maybe in your furnace room or in a cupboard.

Sutherland: In the game room. Actually, right by the computer.

Sutherland: Okay.

Sutherland: But I had to have the keys.

Spicer: Right.

Sutherland: With kids, I didn't want to have them on the 1,300-volt power supply.

Spicer: Yes. Oh, my goodness. Yeah. Well, that's surprising. I've never heard of an audio amplifier with 1,300-volt plate currents. Was it just...

Sutherland: You should have seen the characteristics. I plotted the characteristics of those tubes.

Spicer: Amazing. Is that just because of what you had on hand, these tubes?

Sutherland: A friend of mine in Long Island, New York, who had an antique radio museum in his home, wanted that amplifier and power supply, so I gave it all to him.

Spicer: Oh, interesting.

Sutherland: Many years ago.

Spicer: Yeah. So it's gone. And you had a record player, I suppose?

Sutherland: Yeah. We had a record player that fit into the coffee table with a spindle that you could take out and stack up records on this record player.

Spicer: Right.

Sutherland: It was only about this high when you slid it back into the table. Then there was a Viking tape deck and FM radio tuner all built into the marble top coffee table.

Spicer: Very nice. Were these Homebrew or Heathkits?

Sutherland: Heathkit tuner, FM, but it was a Viking deck. I forget who, where the record changer came in. It was a very unusual record changer. But if you look back through all the old literature, I'm sure the one that would stand out is the one that had no spindle, but yet you could stick a spindle in there and then put the records on the top of that spindle.

Spicer: Yeah. Yeah, Dual was a big manufacturer. Do you remember that?

Sutherland: It was a Garrard.

Spicer: Anyway, okay. Any other peripherals that were interesting?

Sutherland: Well, we had the 735 typewriter in the kitchen, which Ruth could use for recipes.

Spicer: Yeah. How did that work?

Sutherland: It worked out beautifully. She'd print out new copies of recipes when the old ones got all dirty and torn. We used it for Christmas letters.

Spicer: Oh, nice. Were you able to do mail merge? Like take a group of, what I mean by that is take a group of names and...

Sutherland: They could say “Dear” and the name would be put in automatically. Yeah.

Spicer: That's remarkable. That's really advanced. Wow. Was there a form of storage as well, like tape or punch…

Sutherland: Paper tape. Eight-channel tape. I didn't have mag tape. I was going to try to put audio cassette tape on it, but it just didn't seem to work out. The paper tape, reader, and punch. It's all built into a unit.

Spicer: Tell us a bit about the promotional side of ECHO IV. What was the first public notice of this? And then tell us a bit about the public history of ECHO IV, what newspapers and other media said about it.

Sutherland: Very soon after it was running, the word got out to a local newspaper, and so there was an article with a picture of me standing at the maintenance panel and an article about what this home computer was going to do. Then it kept growing. AP had a wire that went all over the country and on Mother's Day -- they really played that up and had 75 million readers.

Spicer: Oh my gosh.

Sutherland: Westinghouse was like that. They liked the fact that it was a Westinghouse computer.

Spicer: Oh, right. So Westinghouse was confirmed in its faith in you.

Sutherland: They were happy to see their name published in a positive way.

Spicer: Right. Very nice. And then how long did this last, the newspaper coverage? And then Ruth also went and gave some talks, I think, and maybe you did too.

Sutherland: '68 she went to Dallas, Texas and spoke to the American Home Economics Association and you featured that in your article. She was amazing.

Spicer: Yes.

Sutherland: Nobody else would have put up with me for 68 years.

Spicer: Aw. That's lovely. Yeah, she was, I could tell she was definitely a partner in many other things, but ECHO IV especially, and I really liked the potential applications that people came up with during that home economics conference. That was very forward looking, a lot of what they came up with. So did this go on forever? So when did ECHO IV… when did it sort of quiet down…...

Sutherland: After the big thing there with the Associated Press where you didn't hear much about it, but it was in Byte Magazine and some of the other computer magazines.

Spicer: Oh, right.

Sutherland: Stephen Gray, who headed up the Amateur Computer Society, which probably wasn't known on the West Coast, but he had his group there in New York and Pennsylvania area. He found that there wasn't anybody else using computers in their home before ECHO IV. Yeah. Some guy in Switzerland, he said, was trying to build one, but it just couldn't get it all put together.

Spicer: Yeah, I think...

Sutherland: So Stephen was a real promoter.

Spicer:

You mentioned there were, I don't know how many different power supplies in ECHO IV. And I was wondering how you sequenced all of those when you brought up the system.

Sutherland: Well, that was part of the Telemeter Magnetics thing. The core memory system had 17 different power supplies. And they had to come on a certain sequence. Yeah. And so there were relays in each of the power supplies that turned the next one on, which in turn turned the next one on. So when you heard all these relays clicking, like I say, it sounded like a bunch of Khyber rifles.

Spicer: Were there delay elements between the relays so that it would give it time to settle?

Sutherland: The power supply had to charge up enough to get enough voltage to pick up the next relay.

Spicer: Oh, I see. Yes.

Sutherland: So it was maybe a half a second or a second between.

Spicer: Right. Now, one thing I'm really interested in is in the instruction set and how you came up with that. Because that's wired into the machine, right? So at some point you had to make a decision like, what am I going to choose as the instructions for this? How did you do that?

Sutherland: I guess I looked at the old PRODAC X instruction set and just took out the ones that I didn't need to get to house. But there was one case where as I was writing programs, I could see that this one instruction was not being used and wasn't able to be used. I forget what it was. But I said it would be nice to have one... that would... increment the program counter and jump to a location. I think that was it. And it would allow me to do some things that I needed to do. It was very satisfying there at home to make that change in the instruction set.

Spicer: Yes. Great.

Sutherland: And have it implemented in an hour or two. All the programs were converted.

Spicer: That's incredible.

Sutherland: Because I knew at work you could never take that step.

Spicer: Yeah.

Sutherland: You'd have to communicate to an awful lot of people. It would be impossible. Once that instruction set was published, , you could never change it.

Spicer: Yeah, exactly.

Sutherland: So it was very satisfying.

Spicer Was it a diode matrix, a diode decoder that decoded the instructions?

Sutherland: No.

Spicer: Do you remember how that worked?

Sutherland: It was all done with NANDs.

Spicer: Oh, okay.

Sutherland: Or NORs.

Spicer: Yeah.

Sutherland: All in the logic.

Spicer: Right. The instruction decoding.

Sutherland: Yeah. Yeah.

Spicer: Great. Tell us about the programmer's desk, the things that are on that.

Sutherland: I don't know where that desk came from, but it was the desk that Ruth probably brought home from someplace. We painted it and put a white top on it. That's where the tape deck was and the Kleinschmidt printer and the keyboard that I built out of an IBM Selectric typewriter. You mentioned EBCDIC. So I took all the keys off and didn't use the mechanical encoding that was built into that machine and put microswitches under each key.

Spicer: Oh, I see.

Sutherland: And then with diodes, generated the ASCII codes.

Spicer: Wow.

Sutherland: So we could sit there on this IBM keyboard and generate ASCII codes that went into the computer.

Spicer: That's remarkable. Wow. I thought initially you just converted EBCDIC to ASCII in the machine.

Sutherland: Well, that was initial. You still had to output it that way.

Spicer: Yeah. Oh, I see.

Sutherland: But not on the inputs with this fix.

Spicer: Wow. That's labor of love, all those little microswitches. Oh, my gosh. Yeah. So tell us how ECHO IV was used in terms of duty cycle. Excuse me. I think it was turned on once an hour or something. Yeah.

Sutherland: We had a system that generated the binary coded decimal numbers. And so at 59 minutes after the hour, it closed the start button on the circuit on the computer, and it would then start up at 59 minutes after the hour. And of course it had to work for a minute so that when it rolled over to the next hour, the computer did that.

Spicer: Right.

Sutherland: It controlled the hours on all the displays.

Spicer: Yes.

Sutherland: Well, you can imagine the problems of a core memory that was not really temperature-stabilized. And the first location that you brought up was the program counter, which was location zero, and you had to bring up the right program counter, or it was not nice. And with these NORs, we had one kind of problem, but with the memory, those amplifiers had a hard time knowing the difference between a hot one and a cold zero or a hot zero and a cold one. And if you plotted it on the scope, the amplitude of the feedback from a zero being generated or a one, that one got, as it was cold, almost became a zero.

Spicer: You're saying it approached the transition voltage at which it becomes a zero or a one. So it's amplitude…

Sutherland: No, the threshold there was crossed.

Spicer: Threshold voltage, right.

Sutherland: And so that was bad, if a one became a zero any place in the program counter.

Spicer: Yeah. Yes. Definitely.

Sutherland: So I added light bulbs in the core memory system to heat that and a thermostat on the light bulb.

Spicer: Did you have a lamp test, by the way?

Sutherland: What kind of test?

Spicer: A lamp test to test the bulbs so you can tell whether all the bulbs are good.

Sutherland: Well, the bulbs were good. They only ran for three hours.

Spicer: Old mainframes used to have sometimes, because is that a zero or is the bulb dead?

Sutherland: And then, of course, there was too much heat generated because it drew a lot of power. Memory power supplies drew a lot.

Spicer: Right.

Sutherland: And at 200 amperes…

Spicer: Oh, my gosh.

Sutherland: Memory that was joining the minus 24 volts throughout the system, that's the one that needed the voltage – the 220 volts.

Spicer: I think you said it drew two kilowatts?

Sutherland: The total was two kilowatts. So I had to knock a hole in a concrete block wall in the basement and put a fan unit in there to draw that heat outside.

Spicer: Oh, my gosh.

Sutherland: It only ran when it was needed.

Spicer: Yeah. Did you divert any of that in winter? For house heating?

Sutherland: No. Should have saved it.

Spicer:. How did your kids react to being in the media and seeing themselves in newspapers?

Sutherland: I think they had fun when they saw the truck from the TV station sitting out in front of our house.

Spicer: Yes.

Sutherland: The neighbor kids would come in with them and sort of see what was going on.

Spicer: Oh, that's fun.

Sutherland: They liked the notoriety, I think, of having a house in the neighborhood that TV crews were out to.. making programs.

Spicer: I'm sure they were proud of you. That's amazing.

Sutherland: We had an interview from one of the TV channels in Pittsburgh, KDKA. We had a recording of an interview and he had ECHO IV playing the theme song of KDKA.

Spicer: The theme song from the station?

Sutherland: From the TV station. They have a theme song that they played throughout the day. Wow.

Spicer: That's clever.

Sutherland: We had ECHO IV and he recorded that. I asked him, it should be nice to have a copy of that recording. He said, well, I'll see if I can save it for you. Well, two or three days went by and so I called down to the TV station and they said, That tape was written over by another interview later, a couple of days. So I never got it. But my boss at Westinghouse, who was in favor of this project, had listened and noticed that. He turned on his tape recorder and recorded the program.

Spicer: Oh, you're kidding.

Sutherland: He missed the theme music, but he got the interview. He got the theme.

Spicer: Wow. Boy, that's lucky.

Sutherland: He was a great boss. He, in fact, wanted to write an assembler. Writing everything in machine language is sort of awkward, but it makes a lot of work. He thought it would be a lot easier just to write with mnemonic codes, so one day he wrote a program that ran on ECHO IV that would convert keyboard entry into the machine.

Spicer: Wow. Can you tell us who this person is again?

Sutherland: He's no longer living. Jack Froggatt was his name. He was a Westinghouse engineer. He was my Westinghouse manager. He was the only one at Westinghouse that really helped me. Everybody else was sort of poo-pooing the whole idea, but he encouraged me to keep on doing that. He was a great boss.

Spicer: Yeah. So let's see. ECHO IV is now probably 1980 or so, I guess, in our chronology.

Sutherland: Well, we're not quite to Boston yet.

Spicer: Yes.

Sutherland: That was 1983.

Spicer: Yes.

Sutherland: Well, 1983 was here. What time did it come from here, from Boston?

Spicer: '96.

Spicer: So let's talk about the Computer Museum in Boston and how ECHO IV came to be part of its wonderful collection.

Sutherland: Well, as I've said many times, Gwen Bell is the reason that we're all...

Spicer: Right. And Gwen Bell is, with Ken Olson and Gordon Bell, a co-founder of the...

Sutherland: Gordon Bell, of course, is the father of the VAX machines.

Spicer: Yes.

Sutherland: Very successful product.

Spicer: Right.

Sutherland: And in fact, she and Gordon were here in Pittsburgh while Gordon was a professor for four or five years at Carnegie Mellon University. And so she missed the IEEE program where Ruth and I were telling about ECHO IV. She'd heard about it and she then wrote a letter saying that she would like to see ECHO IV in Boston. And they'd moved everything from Maynard into the museum there in Boston.

Spicer: Yes.

Sutherland: So it was good. The truck showed up and they loaded that on. The last I saw it was on the tailgate of the truck. This memory system was on the side.

Spicer: Yeah, I saw your picture. How did that feel? It must have been a little sad.

Sutherland: A little sad.

Spicer: Yeah.

Sutherland: I was glad to see it go to Boston.

Spicer: I'm so glad it came here because a lot of times those things get scrapped or you sell the house. You know, what happens to it? So thank you, first of all, for donating it.

Sutherland: She also encouraged me that there was an extra…. It's the line printer that DEC made.

Spicer: Oh, yes.

Sutherland: LA-125 or something like that.

Spicer: Right.

Sutherland: But the line printer was nice to have.

Spicer: Oh, you had a line printer on ECHO IV?

Sutherland: I had a line printer.

Spicer: Oh, I didn't know that.

Sutherland: It was later. I used that with my Heathkit, H-89.

Spicer: Oh.

Sutherland: My son had a Z-89. When he went to university at Penn State, he used his Z-89 with a modem, a 1200baud modem, to the university computer systems. He could then access the computer as if it was a terminal and print out papers for his friends who didn't want to wait in line for the print stations to be free.

Spicer: Oh, I see.

Sutherland: Charge them 50 cents a page, make money on that. But he had a good time. And then we learned that the VAX had a mailbox. You probably know about that. Gordon Bell designed that in there so that you could call in and leave a message and your co-worker then could access that same mailbox. Well, Jay and I, Jay's 100 miles away, so every day we wrote messages before email. We were using the mailbox on the VAXs. Did that for three years.

Spicer: That's great. Yeah, again, you're ahead of the curve.

Sutherland: I guess there was email someplace, but we didn't know about it.

Spicer: Right. Yeah.

Sutherland: We didn't know about the Internet. You know, ECHO IV has always been a project like having a car in your garage but no streets. No streets to drive it on to go around to the neighborhood like you have with the Internet. The Internet has opened up the horizons of home computers so you're no longer limited to what that computer does for the home.

Spicer: Right.

Sutherland: And that has some good features and some bad features.

Spicer: Yeah. Well, computers in the home have been part of science fiction for decades, you know, probably over 100 years. Robot butlers and computers in the home for recipes is the classic application, you know. By the way, I see just as we wrap up, I'd like, I notice you've got, you brought a couple of things with you today. Would you like to show us what you brought and give us a little explanation?

Sutherland: Yeah, Parker Brothers introduced Instant Insanity. It had four blocks all loose, not connected together and you could rotate them. Each block could go six different ways and the job was to have each side showing all four colors. And as they said, you were unlikely to ever see that again if you took it out of the box and scattered these around because there were over 300,000 possibilities there. So ECHO IV did it, it added these up and said it's looking for four sides that had added up to 15. The 1 plus 2 plus 4 plus 8 came 15. Any other combination would not be 15. So it was good to see that was successful.

Spicer: It's almost like a 1960s Rubik's Cube in a way.

Sutherland: It was, it was before the Rubik's Cube.

Spicer: And so how long did it take ECHO IV to solve that?

Sutherland: 18 minutes.

Spicer: 18 minutes?

Sutherland: Trying all the combinations to come up with that.

Spicer: So do you know how many tries it made before it found the solution?

Sutherland: Well, it probably had to go through at least 32 because I thought it might be one solution, but there could be more. So it printed out, it started printing out. whenever it found the sides, sides were

adding up to 15, all four sides. And so I saw it printing and printing and printing and printing and printing. and I said, you know, what's happening? Well, it was looking at it from four different ways. Each one it follows a new solution. So that was four of the solutions. Then it started rotating them, every block in here was turned. Right. So that was another solution because all the numbers then were turned upside down.

Spicer: Are those glued together?

Sutherland: I've got a piece of tape on the side.

Spicer: Oh, you've got tape on them. Okay, just wondering. But they do spin around, right?

Sutherland: Oh, yeah. These are individual cubes. Yeah, yeah. Each one was six sides. And there's a, I've even forgotten the algorithm that went through and tested every combination.

Spicer: Did you do any major work? Like, for example, you worked on this land registry project, correct? A land registry project?

Sutherland: Oh, yeah, that was a book. That turned out to be a book, yeah.

Spicer: Tell us about that, because that was a serious project.

Sutherland: Well, I was always interested in family genealogy and when I learned that my great, great, great grandfather had come into Kentucky from Virginia in 1789, he had a plot of ground that he had bought from a veteran of the Revolutionary War. It was described just with a curve on the river, one corner notched out, and a couple of neighbors. No other description of where it was. So my job was to, I said, I've got to find out where that is so I can plot it on a current map and know how to find it.

After we did find it, we went to Kentucky and saw that land. But anyway, the way they wrote those deeds back in those days was everybody knew their neighbors and so they had the names of their neighbors and a few landmarks if they knew them. So we had about 20 or 30 of them. Like a jigsaw puzzle, put them all together where the adjoining neighbors were next to each other, and there was our grandfather here in the middle and here were these major landmarks on the edges that we could recognize on today's map. So we moved this around and lined it up and there he was. So we had all these things to throw away, I guess. I decided let's put it into a book. And at that time, the Historical Society for this county in Kentucky, where this was located, wanted a project for the bicentennial, and so they took it and had it published.

Spicer: So what was the book? Was it maps or tables?

Sutherland: It showed the survey analysis, how many acres each one was, and a plot.

Spicer: Okay. Oh, wow. And ECHO IV, you used ECHO IV for that?

Sutherland: ECHO IV did the compiling of the words, numbers and stuff. The actual numbers were created by the computer at work. I brought the tapes home and ECHO IV then read the tape and created the pages.

Spicer: Oh, my gosh.

Sutherland: It was about 400 pages altogether. Right. And the later project, of course, was to read all the microfilm in Louisville, Kentucky, for the state of Kentucky, for all the land grants, which we alphabetized.

Spicer: Oh, my gosh.

Sutherland: And in those days, they didn't know how to spell it very well. They used a lot of biblical names and they were good. There was Benjamins and Josephs and stuff. But a lot of the other names were just hicks. They didn't know how to spell. And the guy on horseback going through there, gathering up the information so that they could create a tax list at the end of the year, wasn't really as careful as he should have been. And so from year to year, there'd be changes in the way they spelled the names.

Spicer: Oh, yes.

Sutherland: So it was a big challenge to take this little Heathkit computer and analyze, I forget how many hundred thousands of records it was, and rationalize the misspelled names and have them all grouped so that they came out together.

Spicer: Also, wouldn't it be challenging to go by a 200-year-old map or whatever it is? Because the geography might have changed. The river could have moved, right?

Sutherland: Yeah, the river's changed. Yeah.

Spicer: But you were still able to do it.

Sutherland: I was still able to do it.

Spicer: Wow, that's great. Amazing. Any other big projects that ECHO IV handled? It was kind of like an electronic butler, I think, right? I wonder if you used it for, like, did the kids use it for schoolwork, for example?

Sutherland: Well, I have this project here that we did on ECHO IV.

Spicer: Oh, great.

Sutherland: Yes. Ann came home saying her science teacher wanted to know what 2 to the 72nd power was because they were counting fruit flies and said that if they multiplied every 30 minutes, they didn't know after seven days how many there would be, and so she couldn't do it by hand.

Spicer: Can you hold that up to the camera? Yeah, that's great. Thank you.

Sutherland: And so we had ECHO IV do it, and it added up these numbers and later when Jay, our younger son, was in school, he wondered how wide he could do it, what's the widest number he could have and it turns out that our typewriter platen was only wide enough to do 2 to the 209th power.

Spicer: Wow, that's still pretty good.

Spicer: Wow. How fast was the Kleinschmidt printer? How fast?

Sutherland: I forget.

Spicer: Like 10?

Sutherland: It wasn't very fast, maybe 15 characters per second.

Spicer: Okay, yeah. It's essentially a teletype, right?

Sutherland: Yeah, about the speed of a teletype, maybe 10. But the IBM machine had a characteristic sound that once you hear you'll always recognize it. You know, the Selectric typewriter is a wonderful machine.

Spicer: Oh, I know. Yeah. They're really.. I think they're in the Metropolitan Museum of Art because they're iconic both in terms of beautiful design --industrial design and then the mechanical design inside is beautiful.

Sutherland: We used to use audio tape recordings. With my parents who lived in Missouri, we were in Pennsylvania.

Spicer: Right.

Sutherland: And we had little 3-inch diameter mailers that we could send back and forth. That ECHO IV then printed the labels.

Spicer: Oh, I see.

Sutherland: We could easily just peel off a label from ECHO IV's printout and drop it in the mail.

Spicer: Oh, that's handy. And when you did form letters too, your family mailouts, would the printer do the labels as well?

Sutherland: It could do the labels because it had enough memory for that, but that was just about it. You know, it was 8,000 bytes. Well, it had 8,000 half words, 15-bit words. And so you're sort of limited in what the memory can do, but we did it.

Spicer: As far as bringing the machine up, did you have to boot it, was there a boot sequence you had to follow?

Sutherland: There was a stored program that we had that we could execute and it would come up.

Spicer: How was that stored in...

Sutherland: In the core memory.

Spicer: In core. Okay, yeah, because core is non-volatile. Right. Okay.

Sutherland: One thing I didn't talk about was the fact that when we were in Morocco in the Air Force, we thought it would be nice to communicate with sound back and forth. Yes. Telephones, of course, were no good because they were too expensive.

Spicer: Oh, yes.

Sutherland: But we had found a magnetic disk recorder. that was magnetic disks that were about 10 inches in diameter. And you could then speak and record about three minutes on that disk.

Spicer: Oh, yes.

Sutherland: And then we'd roll the disk up and put it in a plastic tube, put a label on the outside and drop it in the mailbox.

Spicer: Oh, wow.

Sutherland: And when we were in Morocco, I had connections with the pilots coming back the next day and they could drop it in the mail system as soon as they got back here. It saved many, many days. So you had two of those, one for receiving and one for sending. I figured that with ECHO IV, it was fulfilling many of the tasks that we assign to handheld calculators and computers today. Communications, math, photography, and entertainment. So it did all of those for us.

Spicer: Yes. So explain the photography part.

Sutherland: Well, ECHO IV only… It didn't do any of the photography itself, but it kept track of what we were doing with our cameras.

Spicer: Oh, I see.

Sutherland: Listings.

Spicer: Like an index.

Sutherland: Indexes, directories.

Spicer: That's handy, yes. That's really cool that you got your hands on a computer and got to see what it would be like to use it in a home.

Sutherland: I was blessed.

Spicer: Decades before.

Sutherland: There's no other way to explain it.

Spicer: Yeah. Yeah, and I think your kids and Ruth were blessed too to have such a lovely guy building this thing.

Sutherland: Today, all three of them have been traveling. They live in three different states. They live in Pennsylvania. Okay. But Sally, our middle daughter, is on a ship in Scandinavia coming back through some ports in Germany from Helsinki today. Our daughter Ann, our oldest daughter, is in Florida with her husband rebuilding their house that was damaged by Hurricane Ivan back in November.

Spicer: Oh, dear.

Sutherland: And she's starting back for Pennsylvania. They're driving back to Pennsylvania today.

Spicer: Okay.

Sutherland: And of course Jay is here in California with me, and he's been so good at doing all the arrangements.

Spicer: Oh, great.

Sutherland: I couldn't have been here without him.

Spicer: Yeah.

Sutherland: So those three kids have also been a blessing.

Spicer: Yes. Yeah, I can tell just from the pictures, you know, you're a really loving family. Well, let's see. Is there anything you would like to ask?

Sutherland: I can't think of anything. You've covered all the bases.

Spicer: Okay. I feel like, you know, now that I've got you here, I'm just like, is there anything else I want to ask? But anyway, I guess we'll just leave it at that. And thank you, Jim, so much for coming in today. We're going to go look at ECHO IV right now, so hopefully that will be fun. We'll get some pictures of you in front of your old friend.

Sutherland: And Jay will be there. He's a little older now.

Spicer: And show Jay and Evan, your wonderful grandson. Okay. Well, thank you, Jim.

END OF THE INTERVIEW

