Oral History of John Page

Interviewed by:
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Spicer: We can always edit this anyway. Okay, it's April 11th, 2017. I'm here with John Page. And John worked on the LEO, worked for Lyons Electronic Office and on the LEO III, was it--

Page: Yeah, right.

Spicer: -- computer? So, John, thanks very much for being with us today.

Page: Thanks for having me!

Spicer: We're delighted to have you here and to explore the story of LEO and also your life in technology. So you were born in 1944, West Kensington. And tell us a little bit about what it was like growing up right after the war.

Page: Well, I was born in the war. The war hadn't ended yet, but from what I can remember when I was little, I mean, the place was bombed out for star-- most of the streets had bomb damage around where I lived. In fact, one interesting thing was that we used to refer to a bomb site as a playground, or vice versa. You know, we played on bomb sites, but I never thought of the word bomb site, what it actually meant. It meant the place that had been bombed and flattened. And they came along with a bulldozer and just flattened the lot, and it was just an empty lot. So it was-- the economy was in bad shape. There was not much employment for the returning soldiers coming back. And industry had been focused on the war so much that there wasn't much in the way of industry to support ordinary life. And so food was very short. Food rationing continued until I believe about 1950. So my mom had ration books, and got so many eggs and so much milk, depending on how many children you had. And you know, the economy meant that it was tough making a living. So my dad did fairly well. He actually had a shoe repair business on the next street from where we lived, and he would do okay, but his health was very poor. So that often got in the way. My mom made up for that by doing dressmaking, and cleaning houses and other-- whatever she could do, you know? And so it was kind of tough. But we did-- like I say, we did okay. We made it, but--

Spicer: Yes. Was there any native computer industry at this point?

Page: Not that I knew of. I mean, obviously. Research was going on here in the UK and the US, but I knew nothing about it as I was growing up. I heard people talk about, you know, there were articles in the newspaper, which I thought rather silly, where it referred to them as electronic brains and things like that. But it was like so far away, it might as well have been on Mars, as far as I was concerned.

Spicer: What did you think of-- I picked up on that, too, in your summary, the silliness of giant brains. You know, and how did that affect you? You would have been a child, I guess, growing up.

Page: I didn't pay much attention to it.

Spicer: You thought it was hyperbole even then?

Page: Oh, clearly, yes. <laughter> I mean it was, yeah, it was silly. I mean, but that's going on now with people's fear of automation and A.I. I mean, just very recently, there's been a lot of fear of A.I. from quite prominent people. You know, "These machines are going to take over and kill us all." I mean, it's that-- it's a very similar fear, I suppose of unknown, new technology.

Spicer: That's really interesting, because as you say, the people making these comments are large technologists themselves, like Bill Gates and Elon Musk and Jeff Bezos, and they're not afraid of technology.

Page: Yeah, if they're afraid then--

Spicer: Then it would be a different story, but yeah, so to hear it from them is quite disturbing.

Page: That's right. So at the time, I think the press didn't know what to make of it. And the British press is notoriously bad. I mean, it would sensationalize anything it could get its hands on, even then, as it is now. And so I didn't pay any attention to that. But the people who knew nothing about them, but jumping ahead to when I worked at LEO, I mean, I would talk amongst my friends and my parents' friends, and they would say, "You work on those electronic brains! Oh! Can they really think?" You know, it was like, "They're just giant adding machines; don't worry about it."

Spicer: That's great. Now, onto the next step here, you're 12, it's 1956, you attend St. Clement Danes School, which is a very prestigious boarding school.

Page: Yeah, it was. It was. No, it's not boarding--

Spicer: Not a boarding school. Private school.

Page: No, it was a day school, but--

Spicer: Or a public school as they called as it's called in England.

Page: Well, you have to be careful with English and American there. So public school is a school anybody can go to, like high school is here.

Spicer: Here.

Page: Yeah, but there, the word public school for some reason means something very exotic. St. Clement Danes was a public school in the British sense up until the war. And when the labor government got in, they sort of privatized-- or that's not another word, is it? They took-- they made the private schools take a certain number of kids without paying. And that's what I got. So in England, they have this thing called the 11-plus exam. Which at Age 11 you take this exam that basically streams you. It's a terrible thing. But as luck would have it, I did well at it. And so they offered me one of these free places in what would otherwise be a paid school. And so-- but that was a mixed blessing. I had a good education, but man, was I an outsider. There were about five or six of us there on that program, and everybody knew who you were. And those people were nice about it, but you felt like you were a charity case. And I really did not enjoy that. I didn't have a happy time there. But even though, actually looking back on it, I got a very good education. So, yeah.

Spicer: Oh, that's very interesting. So you mentioned that you didn't fit in all that well. And these are your words, so I'm not saying that this "did not fit in very well."

Page: No.

Spicer: And that was perhaps because of the social strata.

Page: Yeah, the other kids there were from affluent families, you know? Daddy was a banker, and another daddy was, you know, ran a hospital. And my dad would fix shoes. And it was like-- it was a big embarrassing. You know, when you're a kid, you don't know how to handle that. And it's different in England, because England is so much more class-oriented. It was then, it's a bit less now, I think. But back then it was very class-oriented. Unlike California. California's the exact opposite. If you say, "My dad was a shoe repair," here they say, "Wow! Fantastic! You really did well!" <laughter> But there it's like, "Oh, I see. Well." <laughter> "Well, it's been nice talking to you."

Spicer: Oh, no. Oh, gees. Now tell us how you got interested in electronics, because I think that helped you get over your loneliness a little bit.

Page: Yeah, I sort of became a reclusive nerd for a couple of years, I think. There was a guy up the street that was a radio amateur. And he-- I don't know how I met him, actually. I think my dad's shop was rather a social center of the area, because everybody took their shoes in there to be repaired. And he sort of got to know everybody. And I think it must have been through that somehow. But he would-- I would be able to go down to his "shack," as it were, radio area, which was at night, and because, you know, radio propagation is better during the night. And sit in this darkened room with all these glowing valves, these vacuum tubes. You know, and sounds were coming from all over the planet. You know, to me it seemed like total magic. And I became hooked on this whole idea of electronics and what it could do. And I just began to get really immersed in it. And my dad sort of picked up on that, and he subscribed to a few radio amateur magazines for me, which I got. And I would read these in bed at night by flashlight. And so gradually I got to the point where I could collect some pocket money and buy some components and start building things. So that was good. I used to make pocket money by delivering sacks of shoes for my dad. That's a little anecdotal, I guess, but I think it was kind of funny. I mean, I'd be riding along on my bike with a sack of shoes on my back that weighed more than I did, wobbling along the street delivering them to various people's house.

Spicer: Oh, that's nice.

Page: Yeah, it's off the topic, but one interesting thing was in the Second World War, a lot of refugees from places like Poland and Hungary and Czechoslovakia came to England, made it to England ahead of the Nazi invasion. And they all signed up in the armed forces so they could fight back. And there was a whole RAF Squadron that was-- I think it was Polish. And they lived in our neighborhood, so I had to deliver shoes to people with Polish names all the time. And I couldn't pronounce them. <laughs> So anyway, a little off topic, but still.

Spicer: Yeah. And did you build any transceivers, for example? Did you actually get your license and begin speaking--

Page: I started getting a license, but I became more interested in audio, actually. It was, at that time, stereo had just been invented. And there was this thing called Hi-Fi, which was a term that people didn't understand, it's High Fidelity.

Spicer: I find it hilarious that Wi-Fi has come back now 60 years after the Hi-Fi.

Page: Yeah, yeah, exactly, but I'm sure there's a connection. But radios then after the war were these big mahogany boxes, you know, with a big booming speaker, you know, that was all bass, and nothing else. And they didn't sound what you might call "realistic." <laughs> But they worked fair-- well enough. And they broke down a lot, because they had valves in them, and those burned out all the time. And so what happened was I became interested in this and I built my own stereo Hi-Fi equipment.

Spicer: Oh!

Page: Yeah. There was a company called Mullard--

Spicer: Oh, yes!

Page: -- which made valves. And they published designs of things you could build using them for amateurs. And they had a circuit called a Mullard 5-10, which was five valves, ten watts.

Spicer: Was that the audio power, the ten watts?

Page: Yeah.

Spicer: Yeah.

Page: That's right.

Spicer: The 5-10.

Page: Yeah, five valves, ten watts. But it was-- it sounded fantastic! And I built my own speakers even. I took up carpentry, and built the boxes.

Spicer: Oh, wow.

Page: And the bass reflex cabinets and stuff inside, felt baffles, all this stuff. Bass reflex ports, and connected them up and made two of them. Two of everything for stereo. And when I fired it up, my parents couldn't believe the sound that was coming out of this thing. Because they'd had no experience of what to expect. They just had this boxy old radio.

Spicer: Coming out of one speaker?

Page: Well, there were two for stereo, but yeah.

Spicer: No, but in the previous.

Page: Yeah, right. And so it was a bit like when people first got the first high-def televisions. And people would go into the house, and like, "Wow! What a picture! I got to get one of those!" That sort of thing happened. My parents friends would say, "Can you build one for me? I'll give you the money for the parts!" And so I set up a little industry building-- didn't make many, but yeah. But some.

Spicer: Was it available as a kit, or did you have to source all the parts yourself?

Page: You had to source all the parts, yeah.

Spicer: Yeah, wow! Did they have Heathkit in the UK, by the way?

Page: No. I sort of knew of it, but it wasn't marketed there.

Spicer: Okay. But there was an equivalent, was there not? I forget what they were called.

Page: Yeah, I don't remember. I think you're right, but it'll-- what was that?

Spicer: They made a lot of kits.

Page: Yeah, but I didn't make mine from kits. I sourced the parts.

Spicer: Wow, that's impressive.

Page: Which before the internet it was difficult, because you had to buy certain value resistors, so many watts, low noise.

Spicer: Well, as a hobbyist, too, a lot of companies just wouldn't even bother with you.

Page: Oh, no! You couldn't buy them from the main--

Spicer: Quantities were too small.

Page: No, you couldn't buy them on the industrial scale, but they were-- even then they were a little radio amateur shops around London. There was one that was about half-an-hour bus ride away.

Spicer: Oh, yes.

Page: And they got to know me in there. I come in there with my long list of parts. <laughs>

Spicer: Oh, yes, oh, I'm sure that they-- right after the war, I'm sure those kind of stores did really well, because a lot of them are selling surplus. Army surplus.

Page: That's right. Government surplus stuff, yeah. Although that wasn't very useful. I mean, that was military equipment. But with one exception, but it was like military strength solid steel, you know, painted brown. and not much use. But interestingly enough, there was one street in London, which specialized in government surplus electronics. It was called Praed Street-- P-R-A-E-D.

Spicer: A-E-D?

Page: Praed-- P-R-A-E-D.

Spicer: How interesting.

Page: I don't know what it means, but that-- it's not a very long street, but it was right in the center of Soho. And the other thing it was famous for was prostitutes. <laughs> So as a teenage boy wandering around, I must have-- it must have looked a little strange. But I'd go round-- go down there occasionally and get stuff, but nothing much useful was in there. But mainly it was a hobby shop that had all the resistors and the capacitors and stuff. And some of the things you had to special order. But this shop would order things for you

Spicer: Interesting!

Page: Interesting. But one government surplus thing I did get, which was a big deal was a receiver called an R1155A, which is actually now in museums in England, I believe. But it's certainly mentioned in Wikipedia. There's a Wikipedia article on it.

Spicer: Who's the manufacturer?

Page: I don't know who made it, but basically it was the radio receiver out of Halifax bombers.

Spicer: Oh, wow!

Page: They were like three-feet-- you know, two-feet by two-feet with big handles.

Spicer: And it weighed 400 pounds.

Page: Oh, they weighed a ton, yeah. For airborne equipment, it weighed surprisingly much.

Spicer: Yes, that's surprising, yeah.

Page: But there was a corresponding transmitter that went with it, but I never got that. That was just a monster thing. It was like-- stood about four-feet tall. It was huge! But the receiver was interesting in that it had these enormous knobs on it. Like the wave change switch was like this big thing about this big! <laughter> And I couldn't figure out why are all these controls so big. And a long time later, somebody who'd been in the RAF told me, "That's because we've got big gloves on," and you had to be able to work this thing with gloves, because these planes weren't heated.

Spicer: Oh, yes.

Page: They weren't pressurized, so it was freezing cold up in <inaudible>, and they wore these big gloves and wooly things.

Spicer: Once you get up to like 10,000 feet or something, it's getting really cold yeah.

Page: That's just-- yeah.

Spicer: In '61 you got your O-Levels, and you had to get a job to help with the family finances.

Page: Yeah, well, my dad's health was really failing at that point. And so yeah, it was one of those turning points really, where instead of continuing on with education, I decided to-- well, it wasn't just me that decided, essentially my mom said, you know, "We have to get something coming in here. So we have to get job-- and maybe you can go back to education later." Which never-- didn't really happen, but yeah, that was a difficult time. I mean, the national health system was just started then. I mean, it just started just after the war, I believe. So you get shades of discussions now about healthcare systems, single payer, national-- you know, whether it should be-- government should run everything, like Medicare or what. And it terrifies me to think that they'd wind up with a National Health System. <laughter> Because it was awful back--

Spicer: Is it better now?

Page: I think so, but the fundamental trouble with it is that it is a budget. It's a government department with a budget. And so the budget is political. So they mess with it all the time. The immediate--

Spicer: I'm Canadian, so I'm used to a National Health Service. I don't understand what other system is there? Why would you do it any other way? Makes no sense.

Page: I know. There is no good system.

Spicer: We're crazy here, though. It's too much the other way. But anyway, so tell us how you got started at Lyons.

Page: At LEO, yeah. So I never thought of it as Lyons. But--

Spicer: Oh, I'm sorry.

Page: Well, it was a separate division by the time I started at it.

Spicer: At LEO.

Page: Yeah, LEO, yeah. So Lyons was the company that bankrolled it. And building one machine, the LEO I and the second machine, too. But they said, "We don't want to be in the computer business. We needed this computer for our own use, but-- and they seem to be popular, so why don't you go off and start a separate company," in effect.

Spicer: Oh, I'm sorry. So you're absolutely right. So the company you work for is LEO Computers.

Page: That's right. They were computer--

Spicer: Nothing to do with Lyons.

Page: Well, in a sense that LEO came from Lyons.

Spicer: Except-- no direct link, yeah.

Page: No, I had nothing to do with them. It wasn't in the same building, and it wasn't in the same town. It was in North Acton, which is, you know, Heathrow Airport, if you just keep-- it's halfway between London and Heathrow and north a bit.

Spicer: Okay.

Page: But Minerva Road is the-- everybody in LEO knows Minerva Road, because that's where all the machines were built.

Spicer: The use of history, Minerva.

Page: It didn't look like it. It looked like a complete dump! <laughter> But it was very, very industrial, let's put it that way.

Spicer: Oh, yes. Yeah.

Page: Yes, but yeah, so what happened was, I applied for various job-- I wanted a job in something to do with electronics, because I was so interested in it, and the career office at the school set me up with interviews in places, and I really didn't take to any of them. I don't know. There just was something wasn't right.

Spicer: What do you think that was? Too easy? Too junior perhaps?

Page: No, it was what they were doing. So one company, I remember, was a company called ELECTROFLO. I remember to this day, and it was like very heavy industrial switching equipment for power stations, and stuff. Like big heavy electric. I was more into the subtle electronic small stuff components.

Spicer: I see.

Page: But anyway, so my dad, as I said earlier knew everybody in the neighborhood, and one of his pals was his illegal bookie, who took bet-- my dad used to bet on the greyhound dogs. Which was actually illegal then. It's a big off-track, but I think it was illegal. You could only gamble, if you were actually at the event. So it went on all the time, you know? But he said, "Oh, one of my relatives works at Lyons, and

they just started a computer operation. Why don't I see if I can set him up." So I get this letter from somebody in Lyons saying, "You know, a friend told me that you're interested in electronics, and we don't have any openings at the moment, but we have this computer thing, and we passed it over to them." And then I get a letter from them. It's all like it came to me. It was really odd, actually. I found it very strange.

Spicer: Somebody put a good word in for you, maybe.

Page: Well, obviously so. But normally that stuff like doesn't work, does it?

Spicer: No! <laughter> Usually it doesn't usually work. Yeah, that's right.

Page: So it was like it was meant to be sort of thing. I know it sounds kind of like woo-woo. But it actually did seem like it was sort of-- anyway, so they said, "We have this apprenticeship program." I didn't know what that was, but my interpretation of apprentice at that time meant like an apprentice plumber or something. You know? "Like how can you be a an apprentice computer engineer? Okay, but I'll see." So I went. They invited me to this aptitude test, and it turns out that all the employees of LEO had to go through the same test. Everybody. Including people like in the field, sales people, sales eng-- service engineers. They all had to go through this aptitude test. So I was just lumped into the next available slot on one of those. And so I was in this-- I went up to London to Hartree House, which was their Corporate Headquarters, which is in London. It's really just a sales office. And sat-- went into this room, and there were like 20 guys there! And I got the best grade of any of them.

Spicer: Oh, wow.

Page: As it turned out. I just instantly took to it. I mean, it's like this guy was, said, "What we're going to do is we're going to spend the morning teaching you how to program, and then in the afternoon, you're going to write some programs, but you can't run, because we don't have a computer here, but we'll desk check them and see if they would have worked." And some of these guys were much older than me. They were as old as my dad, some of them, and they weren't doing well, at all. And one guy, I remember, just broke his pencil and stormed out! <laughs>

Spicer: Oh, no, yeah.

Page: So, yeah, so I did very well. And so they offered me a job as an apprentice at Minerva Road, at the factory. And the first year of that didn't-- wasn't so good. It was-- the apprenticeship program was somebody's baby in the organization. They put it together. And-- thank god-- and I don't know, the people who had to actually execute the apprenticeship program, so, "Put him in accounting. Have him go over to stores and count screws or something. I got to do something with this kid." But so I got all these very

menial jobs. So said, "I thought I was kind of coming to work on electronics here, and you got me counting transistors in the boxes."

Spicer: Just to step back a bit, this aptitude test that you had to take. Can you tell us a bit more about that? Was it a mix of mathematics and the direct literature?

Page: It was more like logic flow. They basically said, you know, "The computer has--," because you have to know, understand, nobody understood anything about computers then in the public. And so every employee they were taking on was almost certainly not-- had never used one, or ever seen one. So they explained how a computer operates, having instructions or order codes, the code in LEO. And the order codes do certain things and then they can be modified, and there's this store, which is now called memory, and the store has-- can be addressed and the order codes-- yeah, they went through the whole thing. And they spent you the morning explaining what a computer does and how it does it. And then they showed some examples of-- it's getting lost in the mist of time now of what the example was-- but it was like, say, for example, you wanted to do this or this, they'd write out some instructions to it. And so then they went on to branching and conditional logic, conditional flow, looping kind of thing. But the order code they were using was from the LEO II, which was a vacuum tube machine, valve machine. Very, very crude, but--

Spicer: When you started there, we're still dealing with vacuum tubes as the main device.

Page: No, when I got there, they just shipped the last one.

Spicer: Oh, okay. Tell us a bit about that transition from valves to transistors.

Page: Well, I didn't witness that transition, but apparently the valve machines were very, very temperamental, and difficult to keep going. They worked surprisingly well, once-- 'cause-- have to step back a little bit actually. One of the things that LEO inherited from Lyons was a rigid, rigid process approach to everything. They analyzed the heck ? out of everything. And but that's why they needed a computer to begin with, because they were doing so much analysis, they had rooms and rooms of people doing it by hand with Burroughs calculators.

Spicer: Just making reports and stuff like that?

Page: But not only making reports, but analyzing the, which are selling well in which regions. They analyzed everything. How long it took to get the bakery goods from this place to that store, and could they optimize the route of the truck? And they were really operational crazies. And probably leading edge in that regard. And so you can see why they'd take to computers. Like, "Whoa, we can all do this, but we

can do it quicker!" In fact, that was the key thing that LEO did was it allowed them to do those calculations in time to make a difference. Before it took so long to do the calculations that the bakery order's already gone out. And so the-- but now, with the computer, they could actually figure out what to make that night, based on today's orders coming in off the trucks.

Spicer: Yes.

Page: So the truck drivers would bring back these sheets of orders and they'd get in about like five/six o'clock at night, end of their shift. And then they'd go like crazy, and then they'd start baking at 2:00 a.m., and in that time, they got to work out what to make, and in what quantities and sizes. It was a massive data processing problem, and it was for the whole of England. So.

Spicer: That's incredible.

Page: Yeah, so but that feeling of analyzing things carefully and getting to the nubbin of things was that percolated into LEO as well. And one of the things they did was they did a statistical analysis on the reliability of vacuum tubes and valves. And they figured out that-- they figured out two things. They figured out that the life of a vacuum …

Spicer: It's okay.

Page: That the life of a valve is predictable. And they give off signs of failing before they fail. And so they came up with a system called margins, which is what-- there was a big switch on the computer that you could reduce the power voltage by five percent. And you can increase it by five percent. And every morning when they go the machine ready for work, it had to run on both margins. And if it didn't you had to find out why. So they knew they were operating within a sort of a safe band of reliability in the machine. And doing those things, and routinely replacing valves before they failed, made a big difference. They got surprising reliability out of these old valve machines.

Spicer: Did they realize that you never turn the computer off? Like pretty early on?

Page: Oh, yeah. Pretty early on.

Spicer: Yeah, you only have to do it once, and you realize you have to spend the next day turning it on.

Page: That's right.

Spicer: Yeah. No, that's great. So to jump back to where before I interrupted you. You were given some menial jobs like counting transistors.

Page: Yeah, in stores, and yeah, doing paperwork.

Spicer: When did your work become interesting?

Page: Well, it was interesting-- oh, I see.

Spicer: To yourself.

Page: To me, yeah. It's something I made happen, which was that I got to the point where I was getting really tired of being shown around different departments. They basically wanted me to have experience in all the departments. Like the metal shop and everything else. And the metal shop was kind of interesting. I got to make some of the parts of the computers. But I remember I had to make the aluminum bus bars, the power bus bars. But that was sort of interesting. But every time I walked by the place where they were building these giant machines-- they were huge! I mean, they were vast machines. They're big as this hall, each one.

Spicer: Wow!

Page: I said, "Why won't they let me work on those?" And in the end, I just-- I was working on something-- it was a document reader, which was an input device, and I was building those. It was so simple. But and in the end, I just remember, I think it was like one lunchtime, I sort of said, "I'm tired of this!" <laughs> and I went up to Tony Morgan's office. He was the manager of the whole Commissioning Floor.

Spicer: Oh, wow.

Page: And he had the secretary guarding the gate. You know, the guardian of the gate. I said, "Can I talk to Tony?" Yeah, so I walked up to his secretary and said, "Can I talk to Mr. Morgan?" And she said, "What about?" I said, "Well, I just want to talk to him." I don't remember the exact words, but she said, "Fine." So he went, "You can come on in." So I went in and sat down, and he said, and he was busy. So, "Yeah, what do you want?" You know? <laughs> This cheeky kid was sitting there. And I said, "I want to work on those computers. I'm tired of-- I've been an apprentice now for like two/three years, and I haven't done anything very interesting, and I want to work on those computers. Is there some way I can work on those computers?" And he said, "I don't see why not!" And he said, "Come with me!" And he walked out and walked up to one of the Senior Engineers, whose name was Fred White, and-- Dave White, I'm sorry-

- and said, "Dave, this is John. He wants to work on your computer. He's all yours," and he just turned around and left! <laughter>

Spicer: That's the fastest promotion I've ever heard of!

Page: Well, my pay didn't change! <laughter>

Spicer: Oh! Okay, yeah. Well, that's great you could do that.

Page: Well, they sort of missed it on the apprenticeship program, it's like another stop. But I never left there. And luckily, Dave White was this very nice soft avuncular character that just, very fatherly, he took me under his wings. Yeah, okay.

Spicer: Oh, that's nice, yeah.

Page: And he let me do this thing. And I swear I had the time of my life! I couldn't believe that-- each day you'd go in I'd think, "They're going to find out, and move me on again, aren't they?" <laughs> You know? But nobody ever did.

Spicer: Now what kind of things were you doing there?

Page: Well, this machine was just-- the machine that he was working on at the time-- I forget which one it was. I must have been somewhere around 3/12, 3-- something like that, the 12th machine. And they were just assembling it. And so he said to me, "Grab this cable, and start cabling it up!" So I was cabling it up and putting things together. And he said, “So now we’re going to do--” the machines were so big actually it was much easier with two people, pulling cables and--

Spicer: Oh, yes.

Page: --also, you had this enormous engineering control panel. It was a full 19 inch rack that was sole purpose-- actually it was two of them, the sole purpose was an engineering console that you could control anything. You can set numbers in any register. You could see the values of the registers in binary, on these all neon lights. But sometimes you had to have somebody manipulating those controls. Where somebody else is looking at something on <inaudible> so it would actually-- I became his assistant.

Spicer: Yes.

Page: And I got quite good at it. I have to say-- I did mainly-- I think you get good at anything that you really enjoy, right?

Spicer: Yeah.

Page: Yeah, even if you're not very smart, you can get good at something if you enjoy it enough.

Spicer: And well-- and you start-- there's a process of mutual alignment between yourself and the computer.

Page: That's right.

Spicer: You decide, we're going to make-- we're going to get through this one way or the other. But I wonder if-- let's see, so you're working on the LEO III it is, right?

Page: Yeah. Yeah.

Spicer: And what did I want to ask? How did that differ from the II and the I?

Page: Oh, completely different.

Spicer: Yeah? A much larger scale?

Page: Well, LEO II-- LEO I was-- they only made one LEO I. And it was-- it was the computer. LEO II was sort of a productized version of LEO I, basically. It was valve machine, mercury delay line memory. And it was architecturally very similar. I understand-- I never worked on one, but I-- this is what I've read, like you, but I ne-- in fact there wasn't one in the factory when I went there. They'd shipped it, it was gone and they were starting on the LEO III line.

Spicer: I see, yeah.

Page: But the LEO III was completely different. It was very sleek, it had printed circuit cards that plugged in with bright blue handles on it. It was very-- the industrial design was much better, it was much more compact-- it was transistorized and used for a core memory. So, it was a completely different thing. So what happened was I-- I started working on these machines kind of like an assistant. And gradually, I think they saw that I was getting the hang of it, and they'd give me more and more to do, and they had

peripheral controllers, called assemblers which were, often one or two racks of equipment that connected the computer to a particular type of device, like magnetic tape, or printer, or something. They're like hardware drivers as it were. Hardware adapters. And so, as I recall the sequence, I got given a printer assembler to start from scratch. 'Cause--

Spicer: Oh, wow.

Page: Well, the guy was-- the engineer in charge of the machine, was working in the main body of the thing working. And he'd have to get to this, so he just said, give it-- see how you get on. If you're in trouble, give me a call. So, I got it working pretty well.

Spicer: Oh, wow.

Page: And so, gradually, it's like they gave you more and more responsibility. Until one day, they said, we got this machine coming along for the post office-- the GPO in those days, ran the phone system. Don't ask me why. But the-- the GPO, the General Post Office, ran the mail, the royal mail and the phone system for the whole country. And so the GPO bought, I think it was eight, big LEO III's to do telephone billing, nationally.

Spicer: It's a major-- it's like buying an aircraft carrier.

Page: It is. That's right, like buying a nuclear power station. But they-- so one of these-- the parts were arriving and they said, "Why don't you put the machine together." So, I started, literally, a pallet truck, wheeled cabinets around, and set them down and cable them up, and gradually <inaudible> power them up bit by bit. And, because-- they hadn't gotten any chief engineers available to work on it, they just let me play. They figured they'd come along and repair the damage I did later, but-- but I got the damn machine working. So I think, I remember there was one guy-- the guy-- this chief engineer that was going to be responsible for this machine, was a guy called, Alan Potter came along and he finally came back from his previous assignment, and I'd been working on this machine, he says, "How's it going?" And I said, "Well it's all put together, it seems to be alright." He said-- so he was expecting to work on it for like a month, getting it working, but he got it working the same day, 'cause everything was-- yeah.

Spicer: Wow, that's amazing.

Page: So that was-- I felt pretty proud about that.

Spicer: That is amazing.

Page: Yeah.

Spicer: Did they usually have a--

Page: So gradually-

Spicer: --a team of commissioning people that would go to-- and this time you were the one that--

Page: I wasn't formally responsible for it. And it's just that they had nobody else. So like, let--let John put it together and see how far he gets. And then when the real engineer comes in, he can--

Spicer: Finish?

Page: --do the work? But I got it all done so there was-- that was pretty nice. So, after that they said, "Well, I think he's ready. Let's promote him to senior engineer." And they gave me machines completely my own, and I was the chief engineer for the-- for some of those machines.

Spicer: Now, this printer interface that you made. The control?

Page: The assembler, they called it.

Spicer: They assembler. Did you-- at what level was your design expertise, was it like circuit design, or block diagrams, or something in between.

Page: It wasn't-- I didn't design it, I mean, it was-- I built it, but I got-- so but they gave you a big sheet of logic diagrams, and--

Spicer: Oh, okay. And say, "Build this."

Page: Well, it was built but it-- it wasn't running. It was like the-- the cards all came from some factory, God knows where, in boxes. And the cables came from somewhere else, and none of the connections in the back were made. So it was-- it was kind of like-- that's why they call it commissioning, it wasn't manufacturing.

Spicer: Right.

Page: The manufacturing of the parts was done elsewhere. But they all came together in a big pile of boxes, and you had to turn them into a working computer. That's what commissioning was. You'd think it would be easy. But you wouldn't think that these machines would take long to get working once they put them together, but they did because-- well, because, is interesting question. For start, the production quality control systems weren't as a reliable then as they are now. And so you'd wind up with a lot of stuff that was mis-wired, connected up backwards, and things like that. And the reliability of electronic components back then, wasn't what it is now.

Spicer: Who was actually building the-- the modules that go into the LEO's? Was it LEO employees?

Page: Some of them were subcontracted out. But there were some that were made, actually in the same factory way down the end, in a different department. There were these ladies sitting at desks, with powerful lights, soldering. 'Cause they're hand soldered.

Spicer: Right.

Page: And, they'd make a lot of mistakes. And they'd have a bad day some day and connect onto pin six, when it should have been pin eight, type of thing. They were all hand soldered. And so, a lot of these machines-- so there was one reason, being handmade, and they were fantastically complicated. They were very wide machines. They were 48-bit wide machines. So the-- everything was times 48.

Spicer: Forty-eight of everything.

Page: Forty-eight of everything. And so there were lots of places to make mistakes.

Spicer: Wow.

Page: But the other thing was the technology itself was pretty hairy. I mean it was-- the reliability of the transistors, they were germanium transistors for start which are very temperature sensitive, and we had a number of DOA's just on the transistors. And so you had to de-solder them off the boards and replace them. Find out which one was broken.

Spicer: Oh, yeah.

Page: And so, there was that. And then there was the fact that, it was on the hairy edge of not working all the time, anyway. I mean, it was pushing the logic to as fast as it could go. And so there was noise, because the machines were so big, the wire runs were very long, and there was a lot of cross talk

between the wires, and noise pick up. And oddly enough, the germanium transistors are very temperature sensitive. In fact, they cease functioning above about 100 something degrees, completely. I mean, but-- so they-- we insisted customers had these fancy air-conditioned rooms that held temperature, plus or minus, a millionth of a degree. Exaggerating. But the factory didn't have any air conditioning. So, what we-- I've rapidly realized that these machines were nothing like as reliable in the summer as the winter.

Spicer: Oh, isn't that interesting.

Page: Yeah. In fact, what would happen is on a hot day, they'd fail margin check almost immediately. They had no margin left.

Spicer: That is really interesting.

Page: Yeah. But they-- air conditioning was expensive.

Spicer: So you try to do your computing in the winter, if possible.

Page: Well, there's commissioning-- the commissioning-- yeah, that's right. Well, when it was on site, it was fine. 'Cause the customers had air conditioning, but just the factory didn't have air conditioning. It struck me as very ironic, in fact, the guy from the Post Office that did the acceptance test on the machine I worked on, he said, "How come you're make us put in all this air conditioning and you haven't got any?" I said, "Well, go and ask the boss, I don't know."

Spicer: By the way, why do you think they went with such a wide word like-- 'cause that's really for more scientific computation to have that many--?

Page: Yeah.

Spicer: --rather than just decimals.

Page: It's a trade off in speed, I think. Well the word length is-- is more that you can fetch more information per memory fetch. And so, by being wider, you compensate for the fetch being slow. You get-- you're getting more information in one shot. So they were-- I think that was the rational. It was a tradeoff between width and speed.

Spicer: I see.

Page: Right, if you think about it you can-- if it takes-- if an adder only operates at a certain speed, then by adding more bits at once, you don't have to do so many adds.

Spicer: Sure. And then you're doubling the-- the adders though. It's not a 64-- not a 48-bit adder, it's probably 6 bit adders.

Page: 49.

Spicer: Oh, it was one 48-bit adder.

Page: Carry out at the end. Actually it was very interesting architecture, I don't know if you want to talk about technical stuff like this <inaudible>

Spicer: Yes, absolutely, I think so.

Page: So, one of the weird things about this machine is it had-- in the hardware, it could do variable radix <inaudible> arithmetic. What that meant was it divided the word into four-bit groups, which represented a digit usually. So each four-bit group-- you could operate in binary. The root mode of the machine was to operate in binary. They just added all 48 bits to the-- a 48 bit result in binary. But there was this other register called, Excess Constants, which you could specify for each group of four-bits, what the difference was between the base of that -- that digit and 16. It was like adding an access constant every time. And so, you could actually, in the hardware add up, pounds, schillings, and pence. By setting, 'cause there was twelve pennies to a schilling. So they had to have two digits. And the first one could be zero to nine. The second one could only be zero or one. And then the schillings, there were twenty schillings to a pound. So that was two digits, maximum 19. And then the pounds were decimal. So they had access constant of six, each one to make them operate as decimal. And so you could actually load register A, with 1 pound and 17 and six pence, and register B, with 3 pounds 11 and nine pence. And it would come up with the right answer in one machine cycle.

Spicer: Wow.

Page: I don't know why they thought that was important, because you could do it in software fairly easily, but it was-- it was a bizarre arrangement-- that's how they-- that's how they made the machine operate in decimal. So for scientific purposes they just set the access constant to sixes, which meant that each digit had a base of 10 and it was doing arithmetic directly in decimal. I think that they did it that way, because they wanted to make sure that you can't-- actually, this problem exists in computers now. You can't do monetary calculations in floating point because floating points an approximation. So, even now you have

in software, you have to fudge that. You have to hold it as strings and do the arithmetic yourself in some cases. That was certainly true with the PC.

Spicer: What do you think was the mix, the application mix for LEO III, let's say, between something that works with currency verses a number cruncher that's doing floating point? Maybe there are-- may there were no such app--

Page: Well, there were.

Spicer: --more scientific applications.

Page: Well, the LEO III was micro-programmed. It was one of the first micro-programmed machines on earth. Yeah, so it had floating point as well in hardware.

Spicer: Wow.

Page: It wasn't really in hardware. It was just in another layer of software, which was in a ROM.

Spicer: Memory location, yeah.

Page: Yeah. So it was going at machine speed, trying to-- it didn't have to-- it had fetching instructions and stuff. But your question was the ratio, I didn't really know, 'cause I never really saw these machines in their everyday use. Once I built them and shipped them, that's the last I saw of them. But, judging from the software that was used to do acceptance tests, I would say it was 99 percent commercial. One percent scientific.

Spicer: Okay.

Page: I could be wrong but it's heavily biased towards commercial.

Spicer: Right. Right. Is there anything else about the architecture or the technical side that you--?

Page: Oh yeah, I could go on forever. I mean, it's--

Spicer: --talk about.

Page: Let's see, I think-- I think the thing that I found fascinating about machines, which I got-- I developed into a bit of specialty, was dealing with the machines that were failing intermittently. They were the worst, I mean, it's true now, that if a computer goes off the rails somewhere in a piece of software, by the time you-- it comes to a grinding stop, it's miles away from the-- the scene of the crime, right?

Spicer: Yeah, right.

Page: And so-- that was-- these machines did that all the time. They had these things, they would just stop. The operators-- actually back up again a bit. One of the other things that's fascinating about the LEO operating system, was it was multi-tasking. All these things were very early accomplishments in the computer industry. So it could run six programs at once. And, I believe it's six.

Spicer: The three? The LEO III?

Page: The LEO III, yeah. And it could-- it actually had-- it had four tag bits on every memory word. So the-- the machine was wider than it seemed, because it had these extra four tag bits. So I guess it might be 15 <inaudible> I don't know. But essentially what happened was, when you wanted to run a program, you'd request the program to be loaded and it would allocate a piece of memory to that program, and it would set the tag bits to the code for that program, which was assigned on the fly. And the hardware, wouldn't let that program access memory locations that weren't tagged for it. It would stop immediately. Like a bounds violation. And so, it was very safe, you could-- you could program it anyway you want. You could try and access out of your range, and it-- it wouldn't let you, the hardware would stop you. Interestingly it failed soft, it failed only that program, but the other's kept going. And so, because it was core memory, actually a little side anecdote was kind of funny. I remember one time Dunlop had a computer up in Birmingham, and somebody said that the memory had failed. The core memory had failed. And so we actually took-- I was working on a machine, and they said, we need to take your core store, out of your machine and take it to Dunlop, 'cause they're dead in the water. Aircraft on the ground, sort of thing. And we'll give you a new one and you have to test it all over again. I thought, "Thanks very much." So, but I got to take it up there. So I put this core memory in the Dunlop machine and turned the machine on, and the programs that were running on my machine, continued to run on this one.

Spicer: Yes, exactly, right.

Page: It picked up right where it left off.

Spicer: Yeah, 'cause core is nonvolatile, right?

Page: That's right.

Spicer: Yeah, yeah.

Page: And so all you have to do is-- all you have to do is know the entry point to the operating system, and it would just take off and-- that was-- it was like doing a brain transplant.

Spicer: Yes, exactly. And would you say that most of the failure modes were-- were hardware related, or software related.

Page: Well, the ones I saw were hardware. I didn't-- once I handed the machine over, the operational people started using it, and they obviously had bugs, but we had-- we had an acceptance test suite which we ran there was-- there was two. There was an engineering suite which was-- I think it was 23 programs that had to all run-- that we exercised every part of the machine. And then, there was a commercial simulation which ran, sorts and prints, and all those kinds-- multitasking, and-- and every time the machine was delivered, it had to run that suite for two weeks. And have--

Spicer: Constantly?

Page: Well, they-- they ran it like-- no, they didn't-- they didn't want to do shift work. But basically, I think, it ran all day for two weeks.

Spicer: Right.

Page: And it mustn't fail more than a certain percentage of the time. It had to deliver certain up time.

Spicer: Yeah.

Page: And then when it was delivered to the customer, you had to do it again. So.

Spicer: Oh, yeah?

Page: Yeah.

Spicer: Remember just knowing somewhat later contemporary to this, but contemporary with the LEO I, was the UNIVAC I, and how difficult that was from, okay it's running in the-- in the shop, but to get it running in the customer's site, was a multi month process with half a dozen engineers.

Page: That's right. So with the last machine I built was for SUSZ, which was _____.

Spicer: Italian?

Page: Czech.

Spicer: Czech. Oh, yeah.

Page: In Prague.

Spicer: Oh, yeah. That's right. <inaudible>

Page: And I don't understand the business goings on that made LEO ship several machines to Czechoslovakia but they-- they had somebody that was Czech on the board, I think. And he had contacts and they-- but I-- it was the last machine I had to do. So the funny thing was that that machine was on the six floor of some government. Some Soviet era <inaudible> and we couldn't get it to work reliably. The whole time we were there. I mean, it just-- it just ran us around the block, until one day, it would just be operating away and it would just stop. Until one day, I was sitting there, drinking coffee, looking out the window, just like this. And it-- and it <inaudible> you could hear they static on monitor speakers.

Spicer: Oh yeah.

Page: Tied to the next instruction fetch. Since it's a variable length instruction, makes different noise depending on which program it's running. You can actually hear it. Ad I heard it stop, and I thought not again. And as I-- as I saw that, heard it, simultaneously, a tram went by and emitted this giant arc spark off the power lines outside. Turned out, that's what was stopping the machine. We followed up and it turned they'd connected the machine to the same power system as the tram.

Spicer: Oh my gosh.

Page: --in the basement but it didn't matter, it's just lights, right?

Spicer: Yeah, Even the lights probably dimmed--

Page: Oh, they flickered a bit, yeah.

Spicer: Yeah. Yeah.

Page: Yeah, so that was that.

Spicer: Well, that's a good one.

Page: But there were other problems too. I was having dickens of a job getting this thing passed its acceptance test. It would run for a couple of days sometimes. But-- anyway, my boss contacted me and said, "You have to come home. You've been there too long." I said, "Oh, I don't want-- I really don't like quitting before I'm finished. There's something still wrong with this bloody machine." And they said, "Oh, you got to come." "Next Monday, you're back here." I said, "Oh, okay." But I didn't make the trip. I just kept going. I got to fix it. Next thing I know, my boss is in-- in the building. He's coming-- he's flown over from London, he said, "I'm taking you home." And I said, "What." He said, "Come on, we're leaving." So anyway, we got on the plane, as soon as the plane was airborne, BEA, British European Airways, as soon as we were out, he said, "The Russians are going to invade Prague tomorrow."

Spicer: Oh my God.

Page: This was 1968. The so-called "Prague spring." I didn't know anything about it because it wasn't being carried in the local papers. So that's why they wanted me out of there.

Spicer: I guess.

Page: Screw the machine.

Spicer: Wow, that's pretty amazing they heard about that.

Page: Well, it was all over the news in London.

Spicer: I see.

Page: It was on television, in newspapers, everything. They could see the tanks massing on the border. But in Czechoslovakia, you're in this news vacuum because it was all state controlled.

Spicer: Oh, yeah, of course.

Page: That was interesting.

Spicer: That's a great story.

Page: My parents were frantic.

Spicer: Oh yeah. And did you get these, sometimes they're called Heisenberg, remember Heisenberg, when you-- the mere act of observing disturbs it.

Page: Makes it go away.

Spicer: Yeah. Directs the whole system.

Page: Oh, sure.

Spicer: So that-- in computer science sometimes they talk about "Heisenbugs".

Page: I've never heard that term.

Spicer: As soon as you try to find it, it's gone, and it's-- then it shows up at the worst, most in-- inopportune moment and you can never track it down, it's elusive. Anyway, I hope you got the Czech computer running eventually.

Page: I don't know.

Spicer: Oh, you don't know. It didn't matter after that.

Page: I never went back. As far as I know, it's still there. It might be-- knowing the communist <inaudible>, I've often wondered if there's a LEO somewhere that we might resuscitate one day.

Spicer: The Science Museum managed to get a BESM-6 which is the classic Soviet-era supercomputer.

Page: Oh, really?

Spicer: From the early ‘80’s. They managed to get one out of the country before Putin-- this was when Russia was our friend.

Page: <inaudible>

Spicer: Briefly, after the fall of--

Page: In that, narrow window.

Spicer: Yes, that’s great. Okay, well, is there anything else about LEO, your time at LEO that you’d like-- you’d like to discuss, or bring up. What did these things cost, for example?

Page: You know, I have no idea.

Spicer: Relative to-- to your wages, let’s say.

Page: I have no idea. I have no idea what they paid for them. I bet you it’s like Boeing, everybody gets a different price. I simply haven’t the faintest idea. It’s an interesting question. Actually, in the LEO books, it lists some prices.

Spicer: And what were you-- if I may ask, what were you earning as a technician? Do you remember, a year? Just to kind of get a sign post as to when we do go and see what it was-- what it cost.

Page: Gosh, I honestly, don’t remember. It wasn’t very much. I mean, I remember when I started, I was earning nine pounds a week. But I don’t remember after-- it wasn’t a lot.

Spicer: That’s fine.

Page: It wasn’t a lot.

Spicer: Yeah. Okay, well. Tell us what happened next when you-- you got laid off, I think--

Page: Made redundant which is a terrible British term. So degrading. Yeah, basically what’s happening, the worldwide computer industry by then was waking up. Especially the American companies. It was _____, CDC, IBM, a lot of them were in it. And, the British industry was under control of the labor

government largely, they-- they called the shots, strategically. And so they were put-- the government were pushing all these small computer companies together. There was Elliot Brothers made the-- the peripheral equipment, like paper tape drives and stuff. And there was-- Ferranti made a small industrial control computer. And Marconi, of all people, they had a computer. And there was a company called ICT, which was the closest to IBM, started up after LEO, a lot after LEO, but it was called, International Computers and Tabulators.

Spicer: Oh, yes.

Page: And it was sort of-- they positioned themselves like the IBM of England, but they didn't have the market. The common market didn't exist, so it was really the English market plus a few exports that you might be able to get. So it was a small market and just couldn't stand up. So basically the governments, forcing them together. It's a bit like nuclear fusion, trying to get things to fuse against their will.

Spicer: And, create a national champion, probably like a one computer company.

Page: Yeah, so the thing at <inaudible> there was a company called ICL, which was actually fairly closer to where I grew up in Putney, but they-- they decided that the LEO brand was done for. They had a whole new technology. The main ICL or ICT group, which was the controlling group, was in Kidsgrove, near Birmingham, no Manchester. It was sort of spin off and Manchester University was heavy into computer research. Still is actually. And so, just like Stanford spun off Silicon Valley companies, Manchester University spun off companies local to there too. And that was where they did all their research. And they had this new fantastic machine and this-- LEO isn't the future, so they wound it up. So anyway, I had to find another job. I spent a year working-- one of the guys, the managers there, by the name of Tony Barnes went to a company called, Mollins which of all things, made cigarette making machines. Automating-- automating production of cigarettes.

Spicer: Somewhat niche market.

Page: Yeah, but-- but lucrative.

Spicer: But very lucrative. I'm sure, yes.

Page: They got to keep working. But they were very mechanical.

Spicer: Oh yeah.

Page: But what they'd done is they'd got a contract from the research arm of the government. A bit like DARPA, to build factory automation systems. They're called System 24, which is all computer controlled. It was Ferranti _____ computers, and hydraulic controls, and conveyors, and-- it was all pretty futuristic. And so it-- but it was so badly run, I mean, the guy that I followed there, turned out to be not such a clever manager and it was just dreadful. And the commute was awful, it was right across the other side of London. So one day, I couldn't stand it anymore, I just-- what with the commute and the mismanagement, and I was walking out of the cafeteria, it was a fairly big company, out of the cafeteria and in a trash can, there was a Financial Times, open at the jobs page. And on the jobs page-- on the thing it said, Hewlett Packard is looking for people with computer knowledge. I said, "that could be interesting." So that's what happened. So just because you pick a newspaper out of a trashcan sometimes, you change jobs and change countries.

Spicer: Well tell us, you've intrigued me now. What happened?

Page: Well, the-- what happened was that--

Spicer: This was a job in the United States they were looking for?

Page: No, it was in London. So, no, HP had an office in a place called Slough, which was near the airport. And they were selling instruments. I mean, HP was known for instruments. That's how I recognized the name. Being in electronics, they made-- top of the line, quality--

Spicer: Absolutely, yeah.

Page: --<inaudible> anything you wanted anything measured, that's it. So but because they were doing-- what's the word they were using, they were using computers. They made their own little computers to process--

Spicer: Automate, test equipment?

Page: Test equipment automation, you've got some here, the HP 2115, 2116.

Spicer: Right.

Page: That's right. So, what they decided was that maybe computers are getting pretty popular, maybe we can sell those as stand-alone. So they started off a little division called Palo Alto Division, PAD, that were selling them. So, you know the way sales offices are they get a quota. And they said, "You have to

now sell so much of this computer equipment." They said, "What's a computer?" So they advertised for somebody that could work in the sales office to-- who knew computers to help the sales people meet their quota basically, is what it boiled down to. But so, so it was easy to be a hero there because they-- electronics, we both-- them and I knew. And there's the common bond of the electronics. But I had a background in computers, which was very unusual. So they hired me instantly.

Spicer: This is so-- people just forget is that the British were ahead of us. Us, the Americans for quite a ways. And unfortunately, I guess, I put the blame, maybe on the-- the government, the British government, maybe or--

Page: Well, that's a-- that's a whole separate conversation. I think, that's what I call a three whiskey discussion.

Spicer: The thought that they would-- a three which?

Page: A three whiskey discussion.

Spicer: A three whiskey discussion. Three, oh my goodness, that is a long one.

Page: It's from Sherlock Holmes, when he says-- there's one line there, he says, "Oh, Watson, I think this is a three pipe problem."

Spicer: Oh, good. I love that.

Page: But, I just borrowed that. But, sorry what were you saying?

Spicer: We were talking about HP and--

Page: Oh, yeah.

Spicer: --there was a-- I don't know based you're-- the one case of you, was there kind of a brain drain from the UK to the US? Because in computing the UK was--

Page: There was in aerospace, I know.

Spicer: Yes, yes.

Page: Big time. I mean, there was a time when half the people who worked on the 747 were British ex-pats. But, whereas, it might-- I don't know it's half <inaudible>, some number, a lot. But so what happened then was I worked there for a while and just working on these computers, actually in sales support, basically. And somebody came along and said, you know, "Got this thing from the States that says where they're going to produce a new computer with the HP 3000. It's going to be a big time, but they want somebody to-- they're going to put one in Geneva, and they're going to have one person for each country go there for a year, and that's going to be the demo center for this big new machine. So looking for volunteers and everybody kind of went, "No, no, no, not me." But I thought that sounded fascinating! So I get an all-expenses paid trip to Geneva for a year, you know, Switzerland, it's a pretty place. So I talked to my wife and we said, "Well, let's do it!" So what it involved was coming to Cupertino for four months to learn the machine, to work with the developers. So the office was on-- where the Apple Campus is being built now.

Spicer: Oh, yes!

Page: On Homestead Road in Cupertino.

Spicer: The Spaceship.

Page: The Spaceship. They didn't preserve my office. I was so shafted by that! <laughter> I think it would have been a shrine.

Spicer: Yes, exactly! <laughter> Right.

Page: But yeah, so I got to know all the designers of the machine and everything else, and went back to Geneva. And did the same thing I did in London, basically was sales support, but at a much more dignified level. It was this-- you were now at the Corporate Headquarters, which was-- that was the Corporate Headquarter of HP in Europe. And so, you know, and this new machine was quite expensive, and so it was a big deal. And so we were golden boys there for-- everybody wanted our attention to help the customers understand this machine.

Spicer: Did you feel better supported by your company at HP than by LEO, in the sense of what was behind you when you went on the road like that? The knowledge and the support?

Page: Well, I did, I mean, not really.

Spicer: No? Okay.

Page: It was about the same. I guess I didn't feel like-- I felt pretty self-confident about what I was doing. And when things went wrong, you'd just belly-ache, and then somebody fixes it, you know? But no, not really. But anyway, to cut a long story short, after that was over, I got a phone call. I was back in England, got a phone call one night from somebody in Cupertino saying, "Hey, we got this job open, we want somebody to run the support organization worldwide for this new machine. Are you interested?" because they saw that I was pretty good with customers. So I thought, "Wow, we could go-- let's go take the job for two years for the experience of being in California." And I forgot to go back! <laughs> That was basically what happened.

Spicer: Yes, and what was that, 30 years ago or more?

Page: Yeah. Forty.

Spicer: Forty.

Page: '75. So yeah, so but I didn't really enjoy being in sales, it's not what I really wanted to do. I sort of used it as a stalking horse really. And I wound up in the lab doing database management systems. And that's when I switched to software from hardware. And they let me work in the lab for a while. And we built database management systems.

Spicer: Where'd you learn how to do software? <inaudible>

Page: Nowhere really. I mean, I just took to it. It's like back in the very first day of that aptitude test. They were showing me how programs were-- computers were programmed. I instantly got it. I just got it. I mean, it just seemed, "Of course!"

Spicer: So you didn't feel like it was too much-- you'd bitten off too much when someone asked you to write a database?

Page: Oh, I often feel like I've bitten off too much. <laughter> But I learned from California, you don't let that stop you.

Spicer: Oh, yeah.

Page: It's one of the big things about this place. It doesn't let anything stand in its way. And if it doesn't get it right, it just does it again. And if it doesn't get it right, it does it again. You know, it's like-- so Winston Churchill once said about the Americans-- he said lots of interesting things, right, but one of them was, "You can always count on the Americans to do the right thing. But only after they've tried everything else!" <laughter>

Spicer: That's right. <laughter> I know that one. That's a great one, yeah.

Page: Yeah, but so you know there's definitely a can-do attitude here that's-- in fact, that may be the big difference. You were asking earlier about the big difference. Why did the pioneering English inventions not succeed when the American ones did? I think it's just courage. It's just courage and determination. You know, in England, there's a very-- and all through Europe-- I don't meant to belittling them. This is true in many European countries, people find it far easier to criticize something than actually do it. And they'll try to pull you down all the time. And in some situations, it's even malicious. They'll actually deliberately impede you, because-- and I think the reason deep down inside is they don't have the courage to try it themselves. And but that's what's different here. If you try something here and it screws up, you say, "Ah, I screwed it up!" And they'll say, "So what you going to do about it? So what's the next step? You know, how are we going to fix this? Keep going, keep going."

Spicer: Well, also I think the tradition of venture capital versus federal funding in Europe, for example, there's so many strings come with government funding that-- whereas, here, it's like, "Well, I'm sorry I blew five million of your dollars, but can I have some more? I've got a better idea." <laughter>

Page: That's right. "This one's definitely going to work!" <laughter> "That's what you said last time." But yeah. I see that happening here. I think that I was reading an article in the paper that just shocked me the other day. It was in *Roadshow*, you know, that thing in the *Mercury News*, the traffic thing? There's a particular intersection in Campbell that's been known for a long time to be very dangerous and it needs a stoplight. And the answer was, "Our federal grant didn't come through, and so we can't do it." It's like, "You need a federal grant to put in a traffic light?"

Spicer: Really?! Yeah. <laughter>

Page: You know, it's becoming, the federal government is getting more and more power over everybody, and it's not in a creepy sense, but in a sense of money power. So all the tax dollars flow to Washington and then they dole them back out according to the largesse, and then I think that's a very bad thing. But anyway, it's one of the things that went wrong in England, so watch out. But so yeah.

Spicer: Okay, well, let's see. Okay, HP Cupertino, we've got that. Let's talk about 1980 when you left HP to start SPC.

Page: Yeah, that's right. Three of us, Fred Gibbons, myself and Janelle Bedke. Janelle was the Division Manager for the Terminals Division. Of course it was horribly called the Terminal Division. <laughter> That's pretty tasteless. Anyway, but she was the-- actually she wasn't the Division Manager, she was the Lab Manager, she was the Engineering Manager for that one. And I was in the lab doing database management systems, and Fred was actually an up-and-coming guy. He was earmarked for greater things. And but I remember he came into-- we met in the bathroom one day. And he said, "You know, I'm do--," he was doing market research, and he said, "HP doesn't get the fact that personal computers are going to be a big thing. And I tried to persuade them, but nobody wants to do anything." So this is an Apple going--

Spicer: How did he mean, "No one wants to do anything,"?

Page: Well, they didn't want to get into business. They didn't see it as a business that they--

Spicer: HP didn't.

Page: That's right. They didn't see it as a business that made any sense for them to be in. They thought it was a hobby. And it was actually.

Spicer: It was, yeah.

Page: It was the hobbyist--

Spicer: They were toys at the beginning.

Page: They were! And so he said, "There's a group of guys called-- they call themselves "The HP Poker Club," which was a bunch of high level people in Palo Alto that wanted to start new companies along their way. So they put together a very small fund, money. And he basically was Jack Melchor was his name who ran it. And he said they'd finance us if we wanted to go off and to do-- "What would-- if you wanted to build something, one of these machines, what would you do?" And I said, "Well, I know database management systems. They'd be great for filing. You could, you know, and people--," "But how would you do that? Like the average person isn't going to understand how to write programs." And so I said, "Well, we can put a nice friendly user interface on it, and have them design it, maybe as a form model that came to mind. So the user form is the interface for everything. Search and everything. Maybe we could do something like that." Said, "Well, maybe." To cut a long story short, we decided to do it. So we all three quit. And they were very annoyed at Fred leaving. They had him earmarked for other things. And they were quite angry about him quitting. They didn't seem to care so much about me. I don't know why. <laughs>

Spicer: Did they try to interfere with you three--

Page: Just engineers, you know.

Spicer: -- at all?

Page: No.

Spicer: No.

Page: No, no, they're decent people.

Spicer: There's nothing they can do anyway.

Page: Well, maybe. I don't know, it was after that that they passed a law that said you can't prevent people working on their own time on things the same as your company. Because a lot of companies tried that. So I started working on the PFS, was it turned out to be. And we went down to ComputerLand in Palo Alto, in Los Altos, on El Camino there, and got a big configuration. Had four floppy drives. <laughs> But you asked before, like, "Are there times when you have self-doubt?" It's like, once I realized what it took to get this machine to do anything, I did have doubts, I have to say.

Spicer: Now, what kind of hardware was it? Was it an Apple--

Page: It was a Motorola. It was Apple II. Yeah. It was a Motorola 6502, 8-bit machine. And it came standard with 16K, but you could increase it to 32, if you were really--

Spicer: Flush with money. <laughs>

Page: Yes. But what happened was-- it was kind of interesting. We simply couldn't get the thing to work in 32K. It sort of worked, but it was useless, because it was storing so little data that nobody would want to use it. And I remember going into a meeting one day at SPC after we'd been going for about three or four months, and we're about to get ready for launch. I said, "It needs it the extra 16K to take it up to 48. This extra board took up a whole slot in the machine."

Spicer: I remember it.

Page: And it was quite expensive.

Spicer: Was that the Z-80 card with the 16K? Or just the 16K extra.

Page: I think it was just 16K.

Spicer: Either way they were expensive. They were hundreds of dollars.

Page: Yeah, they were. And I remember Fred throwing up his hands, said, "That's it! It's all over! We're never-- it's not going to sell. We can't sell software that requires it." So anyway, in the end it turned out that it was a mixed blessing, because I did in the end get a version to work in 32K, but we wound up not shipping it. But the computer dealers loved us, because they liked the PFS software. And not only that, they got to sell an extra memory card at the same time. So they were pushing it like crazy!

Spicer: Oh, I see.

Page: "You should get PFS. It does need this extra card, but it's worth it!" You know? So because all the dealers were like gung-ho to sell extra stuff, they actually sold more of our software than they otherwise might have. It was a bizarre turn of events. Yeah, and so-- but in the end, they became standard 48. Everything there went out with 48. And it became a non-issue very quickly. It shows you, "Don't panic," right?

Spicer: It's interesting, there was another chapter like that with, I think, VisiCalc that actually promoted the sales of Apple II. So once VisiCalc came out. Many people just bought it just to run that.

Page: Oh, yeah.

Spicer: And I imagine with PFS <coughs>-- it might have been a little much the same.

Page: For different reasons, I think. The VisiCalc thing was the automated spreadsheet appealed to accountants so powerfully that they just wanted-- in fact what they were doing-- I got to know the computer dealers around here quite well. What people were doing was saying, they'd come in and say, "I want to buy VisiCalc." And they say, "Fine. Does your machine have 48K?" Say, "What machine?" <laughter> "Well, it needs a computer to run it on!" <laughter>

Spicer: That's right. Yeah.

Page: They wanted VisiCalc and, "Well, if it needs a machine, I'll take that, too." But with us, what was happening was that they were getting so many people coming in the stores that had heard that these computers are the up and coming thing, and they'd be useful and I want one. And then they'd take it home, and it didn't do anything. It's just that basic, you know?

Spicer: Yeah.

Page: And so they'd bring them back. Say, "What am I supposed to do with this?" So the dealers rapidly got the message that the second question is, "What are you going to do with it?" "Well, I was thinking of keeping my patient records," like doctors or somebody saying. "Well, you need PFS. I won't sell this-- in fact, I'll throw it in, because I don't want you coming back here telling me this machine doesn't do anything." And so they were using it as a--

Spicer: It's very true. You remember the first ads for the Apple II always advertises tours. They always touted the programming-- programmability, like the buyer of the Apple II was, of necessity, a programmer. And that was natural and normal.

Page: Yeah, yeah, that's right, for a while. Didn't last long. <laughs>

Spicer: There was no consumer market, really.

Page: No, no, no.

Spicer: Even though they were marketed kind of like that, you know, towards consumers, it was inappropriate. I remember when the Mac came out, I was shocked at how little it could really do.

Page: Well, it at least had Paint and things, right?

Spicer: Yep, but it could almost do nothing!

Page: Yeah. Yeah, I know.

Spicer: I mean, like really, it was a toy, almost.

Page: Well, that was another experience, too, when the Mac came out, as software publishing, we had to deal with that. We had an interesting situation with that, because we'd rapidly realized that the

consumer model was more like CD player and CDs. You know, the computer is the player, and the software you buy, in the same way you buy packaged goods. Like CDs or tapes or VHS tapes or something. And so Fred was like, "We've got to be able to run on all the popular players." And I was like, "You don't know what you're saying when you say that!" But he insisted. He was the President, "Yes, sir, we're going to make it run on those." So we made a tremendous amount of effort to produce CPM versions and Apple II and Apple III, and all this stuff. And we also were getting into international, so we had to localize it in something like five-- we chose five or six things. We wound up with-- and we had five products in the product line now. So when you did the multiplication, you wound up with something like 250 SKUs.

Spicer: Oh, wow.

Page: It was ridiculous. They're all different. And every CP/M machine was different. They all wanted some feature. And then MS-DOS came along, and now it's got to run all those. And additional, like the DEC Rainbow. So IBM had the PC.

Spicer: That was a weird machine.

Page: There were a lot of weird machines! <laughs>

Spicer: But it had-- it's like they couldn't decide, "Is CP/M going to win? Or is MS-DOS going to win? So let's put in a processor for each."

Page: That's right.

Spicer: For each one, because the 8080 and the 8086.

Page: "We'll do both."

Spicer: Yeah. <laughs>

Page: Yeah, but the network was the-- so this is going to be awful. I don't know if you're interested, but so, the IBM PC came out. And Microsoft could sell DOS to other customers. But the other customers said, "Well, there's no point in us building a machine exactly like that, because otherwise why would they buy ours? We have to differentiate ourselves." So they all came up with some differentiation. And then, of course, they would call us up and say, "You've got to support our differentiation in the software. You've got to make use of it."

Spicer: What were these kind of modifications?

Page: Oh, god, they were like-- some of them were like illuminated function keys, and/or it might be they'd put a special thing on the bottom of the display as a help thing, or-- they were kind of fairly-minded, but they all started, adding, multiplying SKUs, you know? And so in the end, it came to a crisis, because we missed a couple of ship dates. And I remember putting the spreadsheet on Fred's desk. I said, "Our effort is proportional to the number of SKUs. But the SKUs are growing faster than sales." So--

Spicer: That's not good.

Page: "It's not going to work!"

Spicer: <laughs> Yeah.

Page: And at that moment, Steve Jobs walks in and says, "You've got to support the Mac."

Spicer: Really? He came to your company?

Page: Yeah, yeah.

Spicer: Oh, wow.

Page: Says, "You've got to support the Mac. Come on over. I'm going to show it to you." So we go to Cupertino. It's standing at this thing, showing us this thing. And I think I'm honest to say that hardly anybody in the software industry understood that machine when it first came out. They didn't understand that you couldn't just port your software to it. It was a different architecture-- it was event driven. And it was graphically interfaced, and everything about it was different. It was like, "Start again!" So Fred committed us to putting our software on that machine. And he said, "Well, you do each machine. Now you've got this down cold! It takes you about two weeks to do each new machine, so four weeks." And we got laughed out of court. We just did a straight port, and got laughed out of court. I think that was the beginning of the end of the company, actually, because it was technologically a huge mistake! And there's a video--

Spicer: Now what was the mistake, again? That you didn't--

Page: We just more or less did a straight port.

Spicer: You didn't do a good enough port?

Page: We didn't support the interactiveness of it.

Spicer: Like the Toolbox in the native Mac.

Page: Yeah, it just came up like in emulation mode.

Spicer: I see.

Page: So, I don't mean to blame Fred, but I mean, it was a misunderstanding of what that machine really was. We weren't alone in doing that. In fact, a good friend of mine that used to work at Symantec, and they did the same thing when the Mac first came out. They just, they blew it. They came out with a very poor solution that didn't do it. But so, yeah, so that was not a happy time. That was-- in fact, there was one episode that where-- there's a video of it around. You may have it here. And it's called, "The Dating Game," and they had Bill Gates, Steve Jobs and Fred Gibbons onstage emulating "The Dating Game." And that was done at the launch of this terrible software we did. And we got so badly dinged after that, that that video sort of got seen as like a bit of a laughing stock. Because we never appeared in any videos after that! <laughs> So that was the big--

Spicer: So this was Apple doing a launch of the Mac--

Page: No, it was something like, it was an arranged thing at somewhere like Comdex, or something like that.

Spicer: Right. As some kind of platform for Mac software.

Page: Some trade show, yeah. Yeah, *Macworld*, or something.

Spicer: I wonder if that's on YouTube somewhere?

Page: I wouldn't be surprised. I can't watch it anymore. It's too embarrassing. <laughs>

Spicer: No, I know it must be painful or something.

Page: I had a run-in with Steve Jobs just the end of his life, actually.

Spicer: Oh!

Page: Or, at least I think I did. So what happened was fast forward, one of my retirement projects, I got re-interested in education. And I decided to figure out what an interactive electronic textbook would look like. And I did an experiment, like people saying, "You know, computers are good for education," and, so but you can't just put a textbook on a screen. A lot of people try it still. It doesn't work. It's just reading it in a different place, and you're not using the machine. So I did this thing. I started with geometry, so that you've got geometric figures you can drag around and interact with and they change. And they teach you things in the process. So it was a lot of work, actually. The thing is it became so successful I couldn't give it up. It's still running. It gets about 3.5 million page views a month. It's integrated into lots of school's curriculum.

Spicer: Well, tell us about that! What is--

Page: Math Open Reference, it's called.

Spicer: It's a math reference--?

Page: Math Open Reference is its name. Yeah.

Spicer: And what does it let you do when you go there.

Page: You should take a look.

Spicer: No, but just for our interview.

Page: It has interactive-- do you know in education there's a term called a manipulative. Which is something they use to demonstrate, it might be knitting needles or a piece of string, or--

Spicer: Yep, we use that in Museum World, too.

Page: Yeah. So what they are digital manipulatives. They're things that the teacher can use to show things on class by using a projector, or there are things you can play with yourself. And you do both, because what you do is you use it in class to illustrate some function, and then the kids can go home and

use the same manipulative on their computer at home. And so it's a very-- takes full use of the machine. Like, for example, if you-- simple case. The isosceles triangle. It allows you to drag any of the three vertices around, but it will change other things to keep it being isosceles. So if you change one of the base vertices, the other one will move over to make sure it stays. So it's what you might call the principle of invariance. Like you can ask, "What's always constant about this? No matter what I do to this, there are some things that never change. What is it?" And it makes the kids thing like, "Why is it that those two sides are always the same?"

Spicer: Right, yeah. Well, that's amazing. Yeah.

Page: So yeah, anyway. So it was a lot of work. And it was all done in Flash animation.

Spicer: Oh, wow.

Page: And I--

Spicer: What grade levels does this cover?

Page: High school.

Spicer: High school. High school math.

Page: Yeah, everybody uses it of all ages, it's used a lot in community colleges, too. Remedial math, that kind--

Spicer: Yeah.

Page: But anyway, so along comes Steve Jobs and announces that on the new iPad, which was outrageously successful initially, especially in education, "We're banning Flash."

Spicer: That's right! Yeah, I remember.

Page: So I thought--

Spicer: Big announcement.

Page: Yeah. So there was always an address you could write to called, sjobs@apple.com.

Spicer: Oh, yes.

Page: So there was-- I said, "So, you're--, " I wrote him an email, "Dear Steve: We go back a long way. At the Open Reference, PFS, do you remember? I got this math thing. It's going to take me two years to rewrite all this stuff in Javascript. Is that what you're saying I should do? Really?" And I got a response, almost immediately that said, "Yes."

Spicer: Wow!

Page: And I did! I had to. I had no choice.

Spicer: So that-- wow, he actually got--

Page: I don't know if it was him.

Spicer: Got your email. Well, probably.

Page: It sounded like him! That was the kind of reaction you would get.

Spicer: Kind of dismissive thing that he would say. <laughter>

Page: Yeah, "Eat your heart out." <laughs>

Spicer: Oh, my goodness.

Page: Yeah, so that was funny. But I did.

Spicer: So did you have to do that?

Page: I did.

Spicer: Oh, man!

Page: But it turned out.

Spicer: Flash is still around, right? But it's not-- well, it's never been on the iPad. Yeah.

Page: And it's being dropped by a lot of browsers now.

Spicer: Yeah.

Page: Some browsers won't--

Spicer: Do you know *The Register* that British IT--

Page: Yeah, kind of snidy.

Spicer: Oh, yeah! That's part of their charm.

Page: Irreverent. <laughter>

Spicer: Yes. I think they identified 34 major Flash vulnerabilities in an article this week. I just remembered reading it, 34. And they're saying that unless you're going to patch all of these, we really should stop using this.

Page: That's right, that's right. Well, when Adobe took it over, too, it wasn't very popular inside Adobe. It was sort of an ugly stepchild type of thing.

Spicer: Because it came from Macromedia, right?

Page: Yeah. Macrome-- yeah, Adobe bought Macromedia.

Spicer: Yeah, right.

Page: And so that group moved into the bowels of Adobe. And from what I gather, they were not welcome. They were always the poor stepchild. And so there was that, too. So they were-- I don't think

they had their best people working on it. And so but it was kind of funny that that was the last interaction I ever had with Steve Jobs, as far as I know.

Spicer: Well, getting an Adobe Flash update has become kind of an inside joke now for me now, it's like, sadly--

Page: But you know, it was a surprisingly good system. In fact, you can still do a lot of things in Flash that you can't do in Javascript. In fact, I'm working on one now that is driving me crazy. It's-- I'm putting together a system for-- people can create their own tours of cities and museums. Like you could use it to create a tour-- or an exhibit guided-- it's an audio tour with pictures and stuff. And I needed people to be able to create their own content. So there's an authoring tool that runs on-- it's a web app that runs on the web. And you can create the content online yourself, if you want. But it needs an audio recorder. You still can't record audio in HTML5. You can, but it makes a very poor job of it. And so I still-- I do have a little Flash plug-in still. Because it's the only way you can record decent audio.

Spicer: Wonder how they missed that?

Page: It'll probably be fixed.

Spicer: Yeah, I guess so. Well, anything else you'd like to wrap up with?

Page: Yeah, time's flying.

Spicer: The time is flying, yeah.

Page: I think that one thing I was reflecting on, on a more philosophical level the other day, about that my days at LEO was relevant to here. And it applies to my experiences in doing educational software, too, which is that it was very good that LEO took me on out of high school, and let me do important things, and gave me time off to be educated. I think we didn't talk about that. I think I put it in there. But essentially they gave me a day a week off to go to, it was essentially community college, and I got HNC, which is like an Associate degree, I think. But it was useful to have. But that's very difficult to find here. I mean, you-- a lot of kids don't know what they want to do when they leave high school. The graduation from high school. They have no idea what they want to do. And they should be allowed to go out in the world and do things and try things. And only then should they come back and get education. And I think one of the-- you can do that here in the sense that you can go to college anytime. There's no age limit. But--

Spicer: Oh, it certainly gets harder as--

Page: It does get harder. Yeah, Stanford's not going to admit you when you're 50. So but they should. But--

Spicer: I think if you pay your way, they might. <laughs>

Page: That's true.

Spicer: They might listen to you.

Page: Yeah, but it's more to the point of giving somebody an employment opportunity in serious industries early on, so that you can work out what it is you love and what you want to do. You know, you can't get a job in Intel from high school. But you should.

Spicer: Yeah, I agree.

Page: You should just be able to rub elbows with the engineers and scientists and do what you can. You don't have to be paid much, but that notion of serious apprenticeship is missing here. Another country that does it well is Germany, I think.

Spicer: Yes, they do. I've heard from many Indian software engineers that they really hate their discipline. They went into it because that's where the money was. And that's what all their friends were doing. They were about as interested in the discipline as they would be in the price of tomatoes, and whatever they just-- they're very instrumental about it. You know? It's like, "I need to make a living. Everyone's going into this." The LSI designers--

Page: But it's a culture that's--

Spicer: -- for example, in the '80s and '90s where there was a massive influx of Indians, because they were being trained in India for this one specific niche, you know, to operate CADs and do the LSI software and stuff.

Page: Yeah, that's right.

Spicer: And there've been successive waves of this.

Page: But it's a culture, too, that's driven a lot by parental pressure, right?

Spicer: Yes.

Page: It's like a lot of the Asian cultures are that way.

Spicer: But by the time they work in the field, it's too late.

Page: Then they're committed to it.

Spicer: It's pretty hard to retool once you've been I the discipline. And there's, you know, maybe you have a family, and you know, that's--

Page: That's right. Yeah, it's hard to switch.

Spicer: Yeah.

Page: Yeah, but I think that, you know, there needs to be an unbundling of education, I think, into its component competencies.

Spicer: I actually don't think everyone here belongs in University. Not by a long shot.

Page: No, that's-- or when they know what they want to do, maybe it's appropriate.

Spicer: Yeah. But we've kind of made it unappealing to--

Page: It's the minimum.

Spicer: -- just go to community college, or to get a two-year, you know, and it even shouldn't be at all.

Page: That's right, that's right. So I think the apprenticeship scheme is a good one. And it worked for me. I'm not sure how it would have worked out if that hadn't been the case. It would have been very different, I think. So that was the thing that saved me, in effect. Or gave me the correct leg-up that I needed at the time I needed it. I think that should be more widespread. This notion of everyone going to un-- it's

inflation, isn't it? Everyone's got to get a Bachelor's, and everyone has to get a Master's. And it's, you know, you'd be 30 by the time you can be employed. So anyway. So that was one thing.

Spicer: All right, well, I think that's it for today.

Page: Okay!

Spicer: Let me turn off our recorder here. Let's see what we got. That was an hour and thirty-two minutes. Fantastic! Oh, I forgot to hit record!

END OF THE INTERVIEW

