Oral History of Charles Ingerham “Chuck” Peddle

Interviewed by:
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Doug Fairbairn: OK. So it's June 12, 2014. We're here at the Computer History Museum. I'm Doug Fairbairn and we're talking with Chuck Peddle, who's the creator of a number of very important things in the microprocessor and personal computer and other things we'll be discussing as part of this oral history. So Chuck, we're delighted to have you here. And thank you for coming over and spending the time with us.

Chuck Peddle: Yeah I'd like to go on record right now saying what you guys are doing-- the idea about getting all the old men to come over and talk-- is a great idea. I don't know who came up with it, but it really is something that needs to happen. And it's consistent with--

Fairbairn: Well thank you.

Peddle: --it's consistent with what you're doing with the museum. But catching these guys while they're still alive-- I suspect you thought probably Jobs brought it home to you.

Stephen Diamond: Well we actually didn't get Jobs in an oral history like this--

Peddle: That's what I'm saying. That's what I'm saying.

Fairbairn: --but that's an example.

Peddle: Yeah, I think that may have been one of the things that triggered you starting it. Because he died pretty young, right? And all of a sudden-- Noyce was dead. Right? You got Moore, though, I hope.

Fairbairn: Yeah, we got Moore.

Peddle: OK.

Fairbairn: The museum actually started 10 or 12 years ago collecting oral histories like this, long before the physical museum was here. But it becomes clearer and clearer as time goes by that we're trying to accelerate the pace because so many of the early pioneers are passing on.

Peddle: Yeah. It's just such a great idea that I'm glad you thought of it. Thomas Edison is a hero, right? And we don't have enough film of him, right? We don't have enough. And is it Steinmetz that invented-- I think it was Steinmetz that invented the AC. I was trying to remember the guy's name.

Fairbairn: Yeah I think so. We'd love to have all the recordings of that story, wouldn't we?

Peddle: Yeah there's no question that Edison was wrong. And he was educated badly. He had no education at all. And so for him to guess that DC current was a solution was just a guess. Right? And he was just wrong. And Steinmetz was a mathematician and enough of a guy to be able to understand why alternating current was the right answer.

And then of course at GE they did all of the things-- I don't care which segment you want to put that in, but I want to talk a little bit about having to create all of the other pieces.

Fairbairn: OK. Let's start with you.

Peddle: I think we-- OK.

Fairbairn: So let's just go back to the beginning. Where were you born? What year were you born? What environment did you grow up in, in terms of family and brothers and sisters?

Peddle: OK. I was born in Bangor, Maine. And when I say "Bangor" you'll catch my Maine accent. It's one of the few things-- Bar Harbor is the one that I can't say without admitting I'm from Maine. And I grew up outside the capital city. My father had a large piece of land that ultimately became the first shopping center in Maine. That was his development over a long period of time.

My father was a very successful farm machinery salesman right after World War II. And then he was ill-- right after the war all the doctors had come back believing penicillin was a wonder drug. And they almost killed him because by that time they discovered that maybe penicillin was good for about 90% of the people and the other people it was literally a poison to.

So my father never really recovered from that. So we kind of grew up poor. But we had farm equipment around.

Fairbairn: So you were born in what year?

Peddle: 1937.

Fairbairn: And do you have brothers and sisters?

Peddle: Three half-brothers and sisters older than me. And then four brothers and sisters.

Fairbairn: Wow. So you had a pretty large family around?

Peddle: Oh my father-- my mother was his second marriage. All of the sisters and brothers lived with us at sometime or another. And one sister lived with us for a long time. So I kind of always had six-- well I didn't have six because my younger brother wasn't born until 14 years after I was. So we really grew up as four kids. And then the tag-along.

Fairbairn: So what were your early influences? And what got you on a path?

Peddle: A couple influences which I was kind of proud of-- we were poor and so we had to make a living off the land that we had. And so this is Maine, and my father's furnace quit working when we were about seven or eight. And so we had to use wood.

And from nine 'til 15 my brothers and I cut the entire wood for a Maine winter and sawed it up. We sawed up an old barn. So you learn hard work pretty early, right?

Fairbairn: It was survival.

Peddle: What?

Fairbairn: It was survival.

Peddle: No, we just were poor. And my father was-- he's long dead so I can say it-- my father was a guide for the sheriff's company, and he was a serious poacher. And we would go out hunting, and my father taught most boys how to drive deer. And he was a great shot. And he one time dropped five deer crossing the road with a five-shot rifle.

And just to finish this story, only because it's kind of something I like. My father, as I said, was a great shot. And because we had some tricks-- because you had to register the deer. And so we had a deal with everybody in town, the watchmaker, the shoeshine guy, and everybody. My dad would call them up and say, go hunting tomorrow and if you shoot a deer you get one. If not, you got a deer, because we've got it hanging in the woods.

And so we would then get half that deer. And we existed all winter-- because we had a couple freezers and Maine got really cold. And so we existed all winter with our only meat coming from the rabbits we shot. The only other thing I did learn during that time is I managed my father's kennel of beagles, hunting beagles and such.

Fairbairn: But he was also a salesman in the [INAUDIBLE]?

Peddle: Well he was a salesman. He was trying to make money doing the thing, and he did it. But he finally ultimately got a deal worked out where he was developing the shopping center. He developed it for about 20 years with a guy that helped fund him. But we were really poor.

So my point is we learned about hard work, and we learned about survival very young. So now when I work 20 hours a day or something or other doing computer and typing, Rick says, you're working hard. And I said, no. You don't understand.

When I got out of high school, I'm 17. And I wake up the day after graduation and my mother says, OK you've got to get out, go get a job. Because we can't afford you. So I'd always had a job up until then, I was working as a theater usher and a bunch of other stuff.

And so I went out and got a job doing pick and shovel on the road. And I was really good at it because I worked hard. And they treated me really nice because I was good at it. But 12 hours a day at the dumb end of a shovel is hard work, OK? Working on a computer for 24 hours a day is not hard work.

Fairbairn: Well said.

Peddle: So I'm sorry, but that is my background. For me--

Fairbairn: Yeah, well it's important to know, to understand.

Peddle: --this ethic of being able to get something done, and you have to get it done and you have to make it happen, is something I'm sure I learned then.

Fairbairn: So during high school did you have any interest in technology or electronics or any of the--

Peddle: Yeah. From the time I was about 14 I wanted to be a radio announcer. The guy who was my-- this is back, you guys are too young, but before television, disc jockeys were rock stars. Really and truly. People in town worshipped them, the big stations did them, they were rock stars.

And my neighbor where we lived ran one of the stations there. And at school they had arrangements. So with speech class we could go down and do our own shows. So I actually worked with this neighbor's place all during high school. I was working jobs and everything, but I got to do it.

And I was convinced that was what I was going to be, I was going to be a radio announcer. And television was just now starting to get serious, and we weren't sure what the transition was going to be. But if you kind of look at it, some of the early shows were really just disc jockeys. Ed Sullivan was kind of a very special kind of disc jockey, right? And so I'm convinced--

Fairbairn: Can you move over here? So that when he looks at you--

Peddle: I'm sorry, should I not be looking at him?

Fairbairn: No, it's fine. No, you're doing fine. It's only natural.

Peddle: I'm sorry, I guess I have to speak to both audiences, I should be looking at the camera. I try not to look at the camera.

Fairbairn: No the camera's actually fine. Between the two of us it'll be fine. OK. So you are convinced you're going to be a disc jockey.

Peddle: So now I'm convinced I'm going to be a-- so the technology that you had to do a radio was not very hard. But I did go through chemistry and physics in high school, and I had a really good instructor and a really good partner when we went through the labs. Two really good partners. So, we did very well with that.

And my buddy was in charge of projections-- again, you guys don't do these anymore, but film projection was a thing that you did to educate children. In high school, you would have projection classes. Well somebody had to run the film. So, we would get out of our class to go run the film.

Fairbairn: I remember those things.

Peddle: And I also worked as the sound guy for all the shows. We did two or three shows a year, the acting kind of thing. Because again no television, you could get away with that stuff. And so my buddy was the guy that ran the lighting, my partner. And I did the sound. So we found ways to get involved with quote, "technology" so we could get out of class. So we spent all of our time-- and I did really enjoy the engineering work in the labs and did well at it.

But I was convinced-- and so my speech professor arranged for me to go to Boston to try out for a scholarship for one of the top disc jockey places there. OK? Best thing she ever did. Because what I did is I suddenly saw what talent was, versus me.

And I came back home and sat down to talk to her and my neighbor. And my neighbor says, look, we were just waiting for you to figure it out. You can work for me and make a living. You're never going to be great as a radio announcer.

We've talked to your professors and we really think with television coming on and all the new-- transistors really hadn't happened, but-- we think you should go to school as an engineer. And you can do the stuff with TV. You can learn how to do that. But come on, why don't you just give up this idea of being a radio announcer?

So that was an important influence because I did go on to engineering. But the most important influence to me in going on in engineering was working pick and shovel. Because the guys who were older pick and shovel guys didn't have a life. And I could see that I should go to college.

But I really didn't have an idea what engineering was about, what I was going to be doing. I mean I knew I'd done OK in school. And I did dean's list stuff when I went to college. And I went to a land grant college where the--

Fairbairn: Now you went to the Marines before that, right?

Peddle: No I was a Marine reserve.

Fairbairn: Oh, a Marine reserve. OK.

Peddle: Right. Yeah. We were right after Korea. My brother was a Marine in Korea and got shot. And the group I joined had just come back from Korea. They were assigned as a group to Korea.

But what most of us were doing was going into reserves and then going to school at the same time. And then there was a program. They didn't need active service. As a matter of fact, I think after Korea they cut the actual installed base down and depended on the reserves.

And so we got trained in all the proper ways. We were actually on duty for summer camp when Eisenhower was going to invade Lebanon. And they told us, you guys are going to be extended, like these guys are today. You know that all the reserve guys now have had to do tours of duty, right?

But they told us, you're going to be extended while you're here. We're not going home. And then something happened and they didn't invade. I don't remember-- it was a part of history that's not very well documented. But I just remember that.

So I did some camp during the summer once a week, some training. And in the Marine job that I was in I was always doing something with electronics. We were anti-aircraft guys. And I was studying the radar and things like that. Although I was a gun crew chief and a fire team leader when we swapped over to be an infantry. And I really enjoyed that.

Fairbairn: So what got you into college? Did you have enough money?

Peddle: No I didn't. We really didn't have enough money. My father was able to arrange a couple people he knew to help me some. And I actually got through-- the bank in town had a program where some guy had given them a bunch of money and said, just do good with it. And so they decided that helping me to get to college was just good.

But my father had an influential friend who knew the president of the university. And I went up there thinking I can get signed up and all that stuff.

Fairbairn: This is the University of Maine?

Peddle: The University of Maine. I went up and started signing up and discovered I didn't have enough money. And this guy had told me to go by and see the president of the university. And the president of the university gave me enough of a scholarship out of his fund to get me into the college.

And I always remember that. I will absolutely find a way to take care of those guys. And then they helped me along after that. I got better paying jobs in the summer after that.

Fairbairn: So you went in thinking, knowing that you wanted to be an engineer?

Peddle: Sort of, right? Because these people that told me I should be an engineer. But the reason I want to stress this a little bit is because I didn't have a clue what kind of engineer I wanted to be.

So I signed up for engineering physics, which was a new course being taught at the university, as opposed to being an electrical engineer, chemical engineer, so forth. And it was mostly aimed at the guys who wanted to go on to get PhDs in physics. But it was engineering physics, and we got a lot of the same classes that the other engineers-- we took classes with them. And what it did for me is it let me postpone what do I want to be when I grow up. Because I still didn't have a clue.

I had then done good grades the first two semesters and I got kind of cocky. And so I signed up for this extra course my junior year just because it looked interesting. And it was called Information Theory. And I think I may have told this story, but if you don't mind I'm going to tell it again--

Fairbairn: No, go ahead.

Peddle: --because it's really important. Claude Shannon, which hopefully you guys respect. I don't know if you have much about him here. Because he was more telephone, right?

Fairbairn: Right. Telecommunications.

Peddle: But Shannon invented the bite, invented the bit. Those words were Shannon's words. Because he had to find something to talk about.

He had a small team at MIT. And this one guy was on the team and had a break down, a nervous break down. And they told him, I remember talking about the [INAUDIBLE]. They told him, you can't do this anymore. You just can't do any more.

So he applied to the university to be a professor. And they were so happy to get a guy with that skill at MIT that they gave him-- he only did four classes a week. And two of them were this class and there was some other class.

But so I signed up for this class not knowing what information theory was about. The physics guys didn't pay any attention to those kinds of things. We talked about why the sky is blue, but we didn't talk about information, because it wasn't important back in those days.

When Shannon started, a telephone connection was made by some young lady taking a plug and plugging it in. And Shannon's the guy that found a way to automate that because of what he did with information theory.

So we go into this class and this guy says, I know you guys are here wondering, and I did work with Shannon and we'll talk about it. But we're going to spend the first four weeks learning about the eye and the ear. Because he says communication only occurs when you can see it or hear it.

And so he made us really learn how an eye works and how an ear works. And there were some important lessons there that you don't know about. The fact that you see by inverting what you see. And I'm watching you with two kinds of lenses because my mind can put the two together and I can read and see-- those are all things that happen in your brain. They're part of the information system that your eye has in your head.

And then he started us off with class, and now he's starting to move into information theory. So he says, I'm going to write a letter on the board-- A. Guess the next letter. And we had to sit there and guess the letters.

Well what he was showing us is that the English language, which is highly redundant-- which is one of the bases for the phone system, because they go in and they compress it. And so he taught us that. And then he went in and taught us Boolean algebra. And then the fundamentals of binary arithmetic and so forth.

And somewhere in that time, I fell in love. Totally, absolutely knew that what I was going to do for the rest of my life was that work. Something he said or somewhere along the way I went from not knowing anything to knowing exactly what I was going to do.

So I struggled through the fourth, the last year college. Only interviewed with companies that would agree to put me on a training program. Because I knew I didn't know shit. And secondly, that would give me a job in California. Because I had been in California with the Marine Corps and had decided-- we were out in Camp Pendleton our first year.

Fairbairn: That was better than Maine, huh?

Peddle: Yeah, well no-- my aunt and uncle lived there. And I'm going to live in California and I'm going to work in computers. Those were the two-- and I only interviewed companies that would agree to do that.

And GE was one of those companies. They had a great training program. I'm so glad I did that. Because for the first nine months of my life with GE I was working for missile and space vehicle and working on Gatling guns and reentry nose cones.

And I was troubleshooting. We had to run a test in front of the tests that they were officially-- and you got paid big money if you made the test. Because remember, the Russians were ahead of us. And we were really frightened. This is a time when the US was truly frightened.

Fairbairn: So what year did you go to work for GE?

Peddle: It was 1959, it was 1960.

Fairbairn: So Sputnik was up and we hadn't really-- we were struggling.

Peddle: Yeah. I had done a speech class on what happened to us and why we got so devastated. And luckily, Brant von Braun remembered his days from living in Germany and put us back in the system.

But the nose cone thing-- they had to figure out a way to deliver a hydrogen bomb across the long miles. And so it had to work. And it was up in the air, and there's pressure. So we were given tests in pressure chambers and so forth. But before we ran the tests we ran our own tests. And if you passed the test you got several million dollars which, back in those days, was a lot of money.

And every failure that happened in the test, I would get them. And it was my job to go in the lab, figure out what the failure was, and then go to the supplier. Because we were starting to build an industry. So we had all these suppliers that didn't know shit. And we didn't have all the QC stuff that you guys grew up with. We didn't have any of those things.

You'd start in your little garage and you could wind up this motor and send it to us. And we would stuff it in a multi-billion dollar nose cone to protect our lives, and it didn't work. So I would have to go in and literally teach most of these little companies how to do quality control.

Fairbairn: So this is the electronics or whatever that failed inside the--

Peddle: It's inside the nose cone. And by the way it wasn't so much electronics. Because remember, transistors were barely there. This is motors and switches and--

Fairbairn: Mechanical stuff, right.

Peddle: Yeah. All the timing was done by motor timing. But it was a great, great experience for me. I got to see the country, I got to see all these things. I got to do this great thing.

I spent three months building something for the fighters, the fire control system. And then I went to Phoenix to be in computers. And that was when I did my Remington card reader thing.

Fairbairn: Tell us, what was that?

Peddle: Basically there were two punch cards, which most everybody's forgotten because IBM conquered Remington. But Remington Rand, which was a big competitor to IBM way back when they were both making calculators and other things had a round hole and it had a different coding than the IBM card, which you have on your floor downstairs.

And so I was given the assignment of taking the code, which was the IBM code, starting with that program and turning hardware in that could read the-- and it was a great assignment. I was working for a really smart project engineer. And I learned a lot from that time.

Fairbairn: So you're doing electronic design.

Peddle: Yeah, we were doing--

Fairbairn: Or mechanical design, as well.

Peddle: Yeah, fundamentally. It was mostly electronics. Somebody else was doing the mechanism reading. And this was back when I was telling you-- flip-flop we're the first guys making transistorized computers.

And the transistorized computer was a flip-flop and a card this big with a whole bunch of transistors and stuff on it. And a NAND gate was two of them. And then you put them all together and you put them in a rack. And then you wired them up with, originally just hand wiring, and then somebody invented the Gardner Denver machine which wired them automatically.

But we shipped a lot of computers. I think the whole 94 series was all built that way. IBM made that change when they went to the 360. But until then-- I expect if you open your 1401 up down there you'll see wire-wrapped panel in it.

So I decided that I wanted to try-- I had wanted to go to California. And they had an advanced engineering course in California. And we had a computer lab in California-- Palo Alto, just up the road there. So I signed up for the advanced engineering program, which is like a master's degree, as far as GE was concerned.

And I went and got a job in the computer lab up here. And that's a one-year assignment. And the nice thing about the computer lab is I got to meet guys like Bob Schreiner, who later on was the guy who second sourced the-- I met Joe Weizenbaum, who was the guy that headed Project MAC at MIT. Bill Davidow, who was the guy that made the 8080 happen. So I was with some really smart guys.

And spent a year in the computer lab, knew that I didn't want to do research again in my life. I wanted to go back and do what I was doing before. Moved back to Phoenix and went into designing at the beginning of what we call the common peripheral family.

And the first device I worked on was a paper tape. I was given the assignment to do the paper tape for this common peripheral. And I was also given the assignment to work with another guy on the first hard disk system.

Now I want to stress this first hard disk system. It's got platters this size. It's got six of them. I guess we got five megabytes.

Fairbairn: Yeah, we have the ones like that downstairs.

Peddle: Do you? Yeah. And the way you accessed it is you shorted out a coil on an electric motor. And that's how you positioned the drive.

And the most interesting thing to me-- I learned a lot. I learned to respect disk drives and have been with them ever since. But I actually invented the concept of zone recording, which is used in all drives today, in 1961, filed the patent. We couldn't make it happen. It takes a microprocessor and a bunch of other stuff. You couldn't build the electronics, because we didn't have the right kind of electronics.

Fairbairn: They were too complex?

Peddle: Yeah. Think about it. It's a pretty complicated calculation and everything. And microprocessors just eat it up. But this is flip-flop. We just didn't do it. We didn't finish it. And ultimately the patent ran out and guys like Seagate and everybody else use it without any patent.

But it stuck with me. And we used that same zone recording technique to make our floppies four times denser than IBM on the Victor and on the Commodore. We put that technically.

Fairbairn: We'll get to that later.

Peddle: Yeah but I'm just saying, basically I carried that technology over. And I was approached by the group that was setting up the design automation group. And the guy said, look, you're doing a good job on design. But we're trying to design three new computer systems and we need some smart guys to sit down and figure out how to automate design. Schematics, equations, all that stuff. And so I wound up doing that and managing programmers.

Fairbairn: What year was that?

Peddle: Probably '63.

Fairbairn: Wow. Very early for design automation.

Peddle: Oh yeah. me and Peter [INAUDIBLE], who did the PET with me, one of our first joint assignments after he escaped from Czechoslovakia was doing one of the very first board layout systems. Laying out PC boards, instead of people doing it.

OK. I'm sorry this is taking so long on the history, but there are two or three things in this background that you'll see were very important that we used later. And then I'd moved up the chain to a certain level and the design animation job was now dead-ending. And so I got a job as the systems manager for our jet engine business, which was based in Evendale. And we had 94s, and one of the things we had to do was prove a GE-600 was better than a 94, which is what we had was the GE machines.

And the thing that I got the most out of that was that we had invented BASIC at GE, or the computer for the BASIC. And the first guy, [? Lyle ?] [? Hiddle ?], did the first online system doing teletypes, ahead of IBM, ahead of everybody. And we put that into BASIC. And so I taught the very first BASIC class in GE.

But now Wang had just come out with a BASIC computer. And we had like six of these 225s. And every one of the jet engines was being designed by engineers running their own programs in BASIC and using the 225. It really made an impression.

Fairbairn: 225 was a Wang machine or a GE machine?

Peddle: No, no, our GE machine. It was the heart of the BASIC system that we sent to Dartmouth. And then we just carried it over. It was important because it had lots of ways to--you could hook up a lot of teletypes in.

But we were designing jet engines using BASIC, which nobody thought was possible. We had a COBOL group that was doing the payroll and a FORTRAN group that was doing an analysis of everything. But the engineers were running BASIC for their own work. And a lot of the managers would make them then go back and run FORTRAN something to compensate. But it came home to me that to these guys the ability to write their own code and to use BASIC was really important. And you'll see how I use that--

Fairbairn: Great. Good insight.

Peddle: --experience later. What? I decided that it was fun, I was living in Cincinnati, Ohio. I didn't want to keep living in Cincinnati, Ohio. I wanted to go back to Phoenix. And I was going to start my own time-sharing company.

And I went back to do that. Went to work for a guy who had the assignment of working on the electronic cash register system that GE was doing, which was a very online system called Tradar. And in the course of sitting there and thinking about what were trying to do, cash register.

Because this group was kind of an advanced group we had somebody from Exxon come in and tell us, I want to automate every gas pump. Because, he says, we're the biggest companies in the world and we're represented by a pimply-faced kid who's pumping gas. We want to get rid of-- we don't need that guy, right? We want to automate all that stuff. And of course he was right. That was the idea.

So I had all these inputs. And I also had interviewed to go to work for-- what was the company-- Fairchild just before Noyce had spun out with Schreiner. And I knew that LSI was coming, that it was going to happen because Schreiner was telling me about it.

And so I sat down with a small team one day and I said, we're doing this whole thing wrong. What you want is distributed intelligence. You want to put the intelligence as close to the application as you can.

The Tradar[??], you punch a key and it went all the way to a server someplace else and came back and put it on the screen. I mean that was the way people were thinking online systems. And I'm saying, what the fuck? What are you doing that for?

Fairbairn: Now what year was this?

Peddle: This was 1969, 1970.

Fairbairn: OK. So you're still working for GE.

Peddle: I'm still working for GE. But I've just given up on the time-sharing thing because I didn't think it was going to work. Actually a buddy of mine who was the first guy to automate McDonald's, who was the guy who had taught me computers in 1961, did one of the first McDonald's automation systems. And he kind of explained to me where he was going.

So he kind of put it in my head. But I concluded-- so from that point on I'm fighting only to do [INAUDIBLE]. And I gave GE a proposal, which they should have taken. Because we figured out what a credit verification terminal-- like you have today in every store-- should look like, what a cash register should look like, and what an automated gas pump should look like. We had those all locked in. GE says, no, we're going out of the computer business. Shut it down.

Fairbairn: So the things you designed, this proposal that GE relied on remote computing, you didn't--

Peddle: No. I was saying remote computing is not so important. What you want is distributed intelligence. You want intelligence in the devices. You want an intelligent card reader, you need intelligent--

Fairbairn: But this is before a microprocessor was available?

Peddle: No, no, no, no. You'll see why this is important for the microprocessor. OK. So I had worked for GE for a long time, had a high level salary, so they gave me a big retirement package.

Two of my other buddies took retirement packages, and we started a company called Intelligent Terminal Systems. And we actually designed a good little point of sale system. But my memory was dynamic shift registers, my computer was made up of MSI circuits, and it was just obvious that in order to make this work I needed LSI. And I didn't have the money because we weren't able to get it funded, didn't have the money to do it.

So I took a short-term assignment to design a typesetting system for a friend of mine who had thought that typesetting was the new future. And so we put a typesetting system on a PDP-11 and started doing the local town Cave Creek newspapers and everything. So the PDP-11 was an extremely good eye-opener for me. Because it showed you that memory registers and memory addressing was important.

That was DEC's idea, not mine. I think it's partially Carnegie Mellon's idea. Because remember I told you I was working on 94s and we had to prove 94s were-- and Carnegie Mellon had done this study on 94 instructions that were useful, and it came down to a small number. And we're going to talk about that when we're doing the 6502.

So I'm now in a situation-- I finish-- this other time-sharing system company didn't have the money to go on. They were making a little money, but they didn't have money enough to afford me. And so I was looking for a job.

And Tom Bennett, who is the guy who started the 6800 project-- and if you don't interview him it's because you are not listening. He actually took-- and I'll give you the reason why. He was a calculator guy. And almost all of the computers were coming out of guys that were calculator guys.

Because they kind of had an idea-- and they'd done the LSI for calculators. So they had a feeling for registers and putting stuff-- the calculator was a long ways down towards being the computer. But he was working on a thing for a company called Viatron. And I don't know if you even mention Viatron in your Computer History Museum.

Viatron is the company that announced they could build intelligent CRTs and lease them for $10 a month. There was a great big stock hype. And they went to all the semiconductor companies and said, we can't do this unless you do this LSI for us. And people like Motorola said, oh shit, we finally found somebody who can do it. And they'd also read all the hype.

So this company was a stock fraud. They didn't have it done. The whole thing collapsed. And so here's this guy running this thing at Motorola. He's got this thing kind of done, he knows how the CRT should work and everything. He's got a design team--

Fairbairn: No customer, yeah.

Peddle: --and the works over. And so he said, we're going to go build a microprocessor based around the calculator. And he talked to some guys in marketing who had come out of GE in Phoenix. When GE had broken up some of their marketing guys had gone over.

And those guys thought that what he was talking about was letting him build a cheap minicomputer. That's really what they thought he was talking about. But he wasn't. He was talking about, I want to build something that's small and inexpensive and that can sit on people's desktop. Because he's a calculator guy, right? OK.

So he said to me, look, you need this. You need a microprocessor, you need all this stuff. Come to work for me for two years, make it all happen, and then you can go do your company. OK. All right. So I sat down and helped make the 6800 work. Because there were some things that had interrupted.

Fairbairn: Because it had some architecture, but the design--

Peddle: It wasn't the way it should have been done. And I put some stuff in, but it was a little too late in the program. The chip was already done.

But the most important thing I did at Motorola, and the most important thing I ever did for the personal computer industry, was I knew that this thing called a microprocessor is just a power burner. You can sit there and make it run power, but it doesn't do anything. If you want to make it do something, if you want to make it run a copier, if you want to make it be a cash register, you need an I/O function.

So we invented a thing called a PIA, which had programmable registers. And it was in memory-mapped space. And we put the structure in we needed to get an interrupt in. We made the interrupt 6800 work on it pretty good. And we could get an interrupt off from the edges, and you could make one edge drive another. We put some really nice programming features in it.

And we did that, they patented it, and everybody in the world still uses that structure, programmable input/output registers. If you look at almost all the architectures today you'll see a piece of PIA.

Fairbairn: So there's a PIA that's Programmable Interrupt Adapter?

Peddle: Programming Interface Adapter, right. And it really and truly was the thing you needed. You needed memory, ROM, PIA, and done, right? OK. ROMs were starting to happen, memory was pretty slow.

Fairbairn: OK. So we're getting into the Motorola stuff. Do you want to--?

Peddle: No, no. This is-- OK.

Fairbairn: I'm just going to switch.

Peddle: OK. You can, but I just want to make the point that because I had done this computer and knew that I didn't have the right technology, I went to work for Motorola to create the technology.

Fairbairn: Right. So you'd already designed what the microprocessor needed to drive, so you knew exactly what it needed to do.

Peddle: Yep.

Fairbairn: And so then you went to Motorola--

Peddle: --and did it.

Fairbairn: And did it. OK. Well that's a good segue to--

Peddle: I'm sorry, I guess I forgot. I've been doing history.

Fairbairn: No. That's fine.

Diamond: OK. So I'm Steve Diamond, this is the Computer History Museum. Its part two of the Chuck Peddle oral history on June 12. Let's start with your involvement with the 6800 at Motorola. Take us through the development of the 6800 chipset and tell us about the announcement and what led you into the 6501.

Peddle: Well, it's really the 65-- by the way, I want to go on record now and continue to go on record-- we built a few 6501s, we never sold one. We sold a few the first day at the show, but it was never intended. It was just an in-your-face to Motorola.

Because it didn't have the single voltage, it was doing all of the things that we didn't want to do. 6502 and its derivatives, the small versions of it, was where we were going. We put all that address space and everything. But for a normal controller the small package one was the right thing. And that's what everybody used, Atari used, everybody used.

So the 6501 was not really what I was designing. I was designing the 6502. We did the 6501 just kind of in case we needed or something or other. But the 6502 was the thing we went to Motorola. And one thing

about my personal history before. I was in the computer lab in Palo Alto. And I worked with Schreiner. And we worked on stuff that didn't happen. But it was very informative to me.

But the computer lab was a direct result of a guy by the name of John Paivinen, who worked with SRI to create the magnetic ink card reader system, not the card reader, but the check system. SRI designed that system and GE implemented it. And the guy that implemented it was this guy by the name of John Paivinen.

Diamond: The OCR code.

Peddle: Was it OCR? No, it was magnetic.

Diamond: Well that was the font, was called the--

Peddle: No, it was actually-- it was a pseudo-OCR, but it was sensed magnetically. It was sensed magnetically. OCR wasn't ready yet. We didn't have the technology.

You've got to remember, the semiconductor industry has driven all of these major breakthroughs. And we didn't have the ability to do the optical reading at the chip level when he did those checks. And that actually was a technology that stuck around for almost 10 years. And then they finally figured out that they could read them all with OCR, and then they quit making them in magnetic ink.

But that was a major, major step in automation. I mean absolutely major. And John Paivinen led that. And then they started a computer lab as a result of that. And then he went on to work for somebody else and then came back to Phoenix. And I worked for Paivinen in Phoenix, which is going to be an important part of this next discussion, OK?

And I worked for Bob Johnson, who was the engineering manager. And then Paivinen and Johnson's work got broken up. But these were all guys I knew. I was doing design automation and I was therefore dealing with the top management. And it was a smaller group, so I knew them both.

OK. So we wanted to talk about the 6800. Why did I deviate off that deviation? I just want to remember it because we're going to need it in a minute.

So Tom Bennett, as I said in a previous discussion, was the guy who came up with the concept, was the project leader that drove it through to its end, and was abandoned after he did that. And if you guys get a

chance to interview him, you should interview him. Because he really and truly was the guy. And he's probably still in Phoenix.

There was another guy in Phoenix who was our high-level technical guy called Dr. [? Boroza ?]. And he may be dead, but if he's still around he would be in Phoenix. He lived around Cave Creek. And [? Boroza ?] would know where Bennett was, and Bennett would probably know where [? Boroza ?] was.

But you really ought to talk to Bennett. He has totally been missed, but it was his energy, and he had the design team, and he hired me, and he supported me. And we were being dramatically attacked by the marketing guys who wanted to make a minicomputer, and we didn't want to make a minicomputer. And we knew why we were doing it. I had to explain the PIA to them about 20 times.

But because we had the design group we could do it ourselves, and did. And that's where I first met Bill Mensch. I just want to go back and comment. Bill Mensch was a bright young engineer from the University of Arizona, and he was working on the process engineering side.

And Bennett brought him in, and Bill and I designed the PIA together. Because I would say, this is what I want, and he would come up with a way to do it. And he came up with edge-detecting stuff that hadn't been invented before. He came up with the bi-directional devices. So what it was I knew what I wanted, I knew how to get it logically, and he's figured out how to get it physically.

Diamond: And what year was this?

Peddle: It would have been-- we announced the 6800 in '72, I think. So it would have been like '70, '71. I think. I'm a little fuzzy right about then. We launched the 6800 and the PIA at the same time, because we did the PIA faster than the 6800. The 6800 was being done by the design team, and Mensch just did the 6800.

And Mensch has this great ability to do chips that work the first time. And I claim it's genetic and that he can see the whole chip. And his sister could, too. She just did great layout. The two of them--

Diamond: So what tools did you have to design the 6800 chipset?

Peddle: Nothin, nothing, nothing.

Diamond: Nothing?

Peddle: They were doing simulations, but basically you had a set of designers that drew them up on big pieces of paper. And then the engineers set down and colored the big pieces of paper to make sure it worked. And then those big piece of paper were turned into a mask. And remember, at that time they used to wear contact masks. So they would make a mask that would last a week, and then they'd make another mask that would last a week.

Fairbairn: They weren't digitized, they did hand-drawn layouts.

Peddle: Yeah you had to hand-draw everything. I don't think there was one bit of automation in that, except the simulation.

Diamond: And how did you do the simulation?

Peddle: I didn't. Mensch and those guys did that. That was the team, the project engineers who were from the design group. Buchanan's team, Rod Orgill was involved with that a lot. Rod is one of the key guys for the 6502. They had a job, and they had some simulations.

Mensch actually claims he wrote most of the simulation programs himself. They said they weren't good enough. And I believe him. He had just come out of university, he understood FORTRAN, and he understood what he needed. And back in those days you kind of invented your own tools as you went along anyhow. Nowadays I don't think anybody thinks about doing that.

Diamond: So when was the 6800 announced?

Peddle: OK. OK. Let me go back. So Bennett has the plan to do the 6800. He puts together the design team and they start configuring the device. And Mensch came in to work on some of the process stuff so that they could to do some of the-- it was a new process, and so he came in to help do that.

And then he was assigned to work with me because Bennett knew I needed somebody who-- and he was smart enough, and he was willing to learn. And so we really were a great team. And so when we're all done, Mensch has created this circuit that does what I want it to do, basically.

And that was what I was doing with the 6800. I put non-maskable interrupt in because I knew you had to have non-maskable interrupt. You shouldn't do a computer without it, but they did. IBM did the PC without non-maskable interrupt.

But you can't do a copier without the ability to get control right now. I'm talking about any mechanical device. There's always a time when you want to tell this program that's working, too bad for you, Chuckie, I'm here. Because I got this amount of time to respond. And that was the concept behind non-maskable interrupt.

Maskable interrupt came from DEC. I don't know if you remember, but your DEC-- if you wanted to turn the interrupts off, you just went in and inset a bit. So you could turn them off in the computer, but you could also turn them off in the devices. So that not all of them were interrupting at the same time. But they were all maskable.

And the concept of a non-maskable interrupt I didn't get from the [PDP] 11. I got it from what I knew needed to be done. So I put that in. And we put some addressing stuff in to make the memory addressing more easy in the 6800.

So now we're doing those two projects in parallel. The first 6800 didn't quite work. They had to make it twice. The PIA worked the first time.

So now we've got something that works. And everybody wants to figure out what they're going to do with it. So the minicomputer guys are off trying to build this minicomputer based around it. And they didn't really have a good feel for what they were doing.

And I took some of the stuff I'd done for my computer-- my old company-- and I built a board out of it, that I could type in onto a Burroughs self-scan display. Messages. Because I didn't have a-- I was using Burroughs self-scan displays for all my-- you may remember Burroughs self-scan displays. I don't know if you do, but there was an important transition before everybody got CRTs.

And so I made this little keyboard thing up where I could keyboard in everything that was going to show on the screen. And we got it set up to introduce to the chairman of Motorola. And these guys had brought in their emulator thing that they were doing, which didn't exactly work. And I had done this thing all on my own at my house. Because I wanted to show everybody what you could really do. So here's a device that I could say, hello, Bob Noyce I'm a 6800 and a PIA, and here's how we work.

And they didn't want that to happen at this meeting. So just before the meeting they unplugged my design, my device. And I'm-- we probably should edit this out, but I'm going to tell you about it any how. I'm relatively strong. I was sitting in one of these chairs-- the classroom chairs where they've got this side arm-- and I ripped the arm off the chair to get up to turn this thing off.

And I had this in my hand for a minute. And everybody in the room thought I was going to kill the guy that turned the power off. They really and truly-- the way I stood up with the look on my face. All I was doing was just trying to get to the keyboard so I could get the message in in time, which I did. And we did show it. And their thing didn't work and ours did.

So now we'd shown the 6800 to some management. And the marketing guys-- these other guys were kind of marketing, but the sales marketing guys-- realized that in order to sell an idea like that in the world, they didn't have a clue. So I did a class for the internal guys about why a microprocessor with the I/O and what you could do with it.

And in that class there was a guy from Iowa State by the name of Roger Camp. And he was there on a sabbatical. And I made him a convert in that one meeting. And he later on when on to consult for that, and he also fed me all my engineers out of Iowa State that did all my other stuff.

So now I've trained a salesman. And the salesmen that went out to the field said, shit, we still can't do this. So my job for almost six months was I would go to a location. They would set up these seminars with Hewlett Packard or Tektronix or Ford Motor Company, and so forth. We would go in and I would give a lecture. And they would bring guys in from all over the company.

Because the press had said, you need to know about this. It's going to happen. They weren't even totally sure why it was going to happen, but the 88 was coming. And people knew that they needed to do something.

So I would go in and I would give a seminar. And I would explain how the PIA worked and why you could use the 6800 to replace logic, that's all I was telling them. This is a logic-replacement device, it's a controller. You can do things you didn't think you could do before like control a car.

And every time we'd get through the meeting, and somebody in the room-- smart guys, remember, I've got the smartest guys in the company in this room-- they would say, $250 for that controller isn't going to work. PIA's going to work, and we agree with your logic, but this isn't going to work. And I knew enough then about processing, I said, well, OK, I've got to shrink the size.

Diamond: And what was the future size and the dice size, if you remember it at that point?

Peddle: Oh it was big and it was multi-voltages.

Diamond: Impractical.

Peddle: No. They're starting from Viatron. The process development was happening at an incredible pace during this time.

Diamond: And what--

Peddle: This was N-channel.

Diamond: Right. And what companies did you visit in those days?

Peddle: HP I sold. Tech I sold, Bradley Instrument I sold, Ford Motor Company I sold, Remington Rand-- the offshoot, whatever it was Sperry Rand I think it was at that time. I remember those. There were others, but I specifically remember those.

And in each of those sessions I would go up to the blackboard and say, OK, you've got to give stuff up. Let's start from the bottom. What instructions do you absolutely have to have? And they would always come up with this small set. And all the engineers in that room would kind of agree. Yeah, I can build what you want to build-- they understood the PIA enough-- I can build that without all these fancy instructions that don't do anything. We need the "and" and we need the "or"-- those functions.

And the Ford Motor Company-- I think if you don't mind I'll do that one and then we'll talk about what happened to Motorola. At Ford Motor Company we were in, using [? Dr. Boroza ?]. He knew Bob Johnson from the old days. And Bob Johnson used to be the engineering manager in Phoenix. And he's now the manager for Ford Motor Company's automation of their engines.

He's a smart computer guy, right? So I explained to him what we'd done. And he said, what you've done is interesting. We're going to take a good look at it. And they ultimately selected the 6800 and Motorola to do all their engine control stuff. But remember, Motorola had a big history with the automotive companies, because they were making all the radios for them. So there was a tie there.

At the end of the meeting he says, do you remember John Paivinen? And I said, of course, I worked for him. And he says, well you know John Paivinen went to-- I think it was-- General Instruments in New York and taught himself semiconductor processing. And he was running a semiconductor company, building the biggest, smartest calculators in Valley Forge, Pennsylvania. And he said, you ought to talk to him.

So when I went back to Motorola right after that trip or a trip right after that, Motorola got upset with me-- the marketing guys that were trying to shoot us all down-- and the marketing guy says, he's out trying to shoot down the 6800. wasn't trying to shoot down the 6800. I was listening.

And I got a formal letter saying you have to stop work on your low-cost microprocessor. And I wrote a letter back to Motorola and said, that's called project abandonment. So all of the work I've done up until now belongs to me, and I will not do anymore development work for you. I'll go out and do classes for you, but I won't do any more development work for. I'm going to go do it for myself.

And I went out to raise money. And they were moving our group in Phoenix to Austin, and a bunch of these guys didn't want to go. So I was able to scoop up the best people from the Motorola design team.

And the guy I went to build first was L.J. Seven at MOS Tech. And L.J.’s comment to me much later was, “I didn't do the deal because I was afraid Motorola was going to sue you, and I didn't want to deal with Motorola”. And he was right, they were going to sue me.

Fairbairn: What year?

Peddle: What?

Fairbairn: What year was this?

Peddle: It would have been early '74. And then I went to Valley Forge to talk to John Paivinen. Now here's the guy that knew computers better than anybody. He did all this stuff. He caught it in about 20 seconds, what I was trying to do. He really did understand why that made sense, particularly after I explained the API and stuff to him.

So even though he was doing these great big calculators, he could see that the microprocessor was the future. Because of his computer background. All the guys I talked to that had computer backgrounds immediately got it. And so he says, we're going to go do it.

And I went, put together the team. We moved across country, we did the entire design. Paivinen had to invent the process. And if he's still around here and you don't talk to him, you're crazy.

Because John Paivinen, he was the magnetic ink guy, but he was also the guy that made our first 5 volt n-channel [process] work. And he did that in the same amount of time it took us to design the processor. And it was his motivation and everything that made that happen. And then he sold that company to Commodore and made some money on it. And then he helped me start Sirius.

But he liked to think he was as good as Moore, and a whole lot of other people thought he was as good as Moore. Really smart guy who had taught himself. Moore wasn't born knowing how to build semiconductors.

So they agree that we're going to do it, we bring the team back. They agreed they'd have the 5 volt process ready-- it was a brand new process. So in order to make the cost point, we set down and did a calculation. And the chip has to fit in this area. Period, end of discussion.

Fairbairn: Certain die size.

Peddle: Certain die size, yep. Yeah, this wide, this high, was all you could have if you wanted to make the price point.

Diamond: And what was the price point at that point?

Peddle: Well, we knew we had to make $5. We were going to introduce it--

Diamond: $5 in volume.

Peddle: Yeah. We had to make that, probably better.

Diamond: For the CPU.

Fairbairn: As a cost or as a price?

Peddle: Well cost that you could sell at a price. You could sell it at price at that price. Our original quote to Atari for the RAM ROM I/O chip, which we invented, and that chip was $12. And they were happy putting it in the video game.

Diamond: The RAM ROM I/O and the CPU.

Peddle: The RAM ROM and the processor was $12.

Diamond: 6507, was it?

Peddle: Yeah. Small 6502, right. And then Schreiner did the-- at Synertek you designed the adapter to make it work with the TV, right? That was the work that you guys did there. And we provided those two and you did that.

So the point is the RAM ROM I/O came out from the discussion of, if we're going to build something really small, let's put all our RAM and ROM small enough into the package so that we can do one. And a couple guys had done single computers during that same time when they put RAM ROM I/O and everything on the chip. But that wasn't flexible enough to do most of the stuff. I/Os beat them whenever we were doing design contests. Because you need more pins than that. And you can do one of these RAM ROM I/O chips and still do a PIA on the side.

And then we did the last thing, which I wasn't allowed to do at Motorola, the interval timer at MOS Technology. Without an interval timer you can't do real-time control. If you want to make your arm come out this much, you turn the motor on, you time out how long you've applied the power, turn it off. That's how you make your copier work, or that's how you make your paper-- you have to have a real time base. And you can't do it by counting program cycles.

Diamond: So when you were making me these architectural decisions that led to the 6052 did you have--

Peddle: Well the 6502, we had a thing-- the VIA-- we put the interval timer and some other things in the VIA. Mensch did that over on a napkin at an Arby's just before we came to the West coast. Because we knew we wanted to do that but we didn't have time.

So we're going on the 6502 and Mensch is helping Paivinen. And he's working on the ROM instruction decoder part. And Orgill and myself and Will Mensch did the register structure. And remember, we had to make the registers work in this space. So we figured out the ways-- if you look at the 6502 it's got some clever things it does with the adder and the registers. And it was done because we could only get that many registers.

I remember we were sitting at Orgill's party one night when we came up with the idea that we're going to split the bus in half. By the way, this is a single metal process. Nowadays it's what, 550 metal layers? Back in those you had to lay your chip out with a single metal process.

So if you wanted to get a signal from the edge all the way to a register, you had to run a metal line-- that's a data bus line--and you can tap off of it. But we discovered that if we broke it at this point, we could get some additional lines into the adder. And I remember that was a really important thing that happened at a party.

So the register thing fit. And we had done the instructions and wrote the logic for it. And Mensch came in and said, I just put your logic in the ROM, into the instruction register. And your five whatever they are too wide.

Fairbairn: Mils in those days.

Peddle: Yeah, whatever it was, you'll five mils too wide. So myself and Will Mathis, who had joined us in Phoenix and then came with us-- and he was a logician. His job before he joined us was making the systems in the bank where you put money in, auto deposit.

Fairbairn: ATM.

Peddle: No. Before ATM. Remember there used to be a thing where you could go in and deposit money from a business or something or other, and it would go into this big honking lock box. It was the predecessor of the ATMs. But remember, ATMs didn't happen 'til people had credit cards. And they didn't have credit cards yet.

So he worked on that. But he had a pretty good feel for why we were doing this stuff. And then, once he came out and joined us, he absolutely knew why we were doing all these things. And he was very helpful.

And he and I sat down and we said, OK, we're going to make the number, and we're going to not give up any instructions. So we actually had to adjust the addressing modes and timing so that we would make the chip that wide. And I always tell everybody, that's the perfect discipline to get you a very good product. It's because you have a physical constraint you've got to deal with, and you have to keep optimizing until you get there.

Fairbairn: So you were tweaking the architecture to fit the space?

Peddle: No. We were really tweaking the opcodes, the way the opcode works and everything. No, not really so much the architecture. More making it all tight enough. So we moved some of them in different spaces. And the addressing map and things like that.

So that was where the optimization happened. And we did it, we got it done in time. And it worked the first time.

Diamond: So it worked the first time, the first silicon.

Peddle: Yes, the first silicon. Mensch is really proud. Between Orgill, his half worked the first time, Mensch's half worked the first time. And the VIA worked the first time.

Diamond: And did you have any better tools--

Peddle: Nah.

Diamond: --than you had back in Motorola?

Peddle: No, no. We have a picture, if you could ever find it in the EE Times, that they took of the office where the engineers are. And it's got the colored chip all around the room. We brought a couple good designers with us. And they would draw up the design, and the guys would paste it up on their wall. And then they would have to hand color the entire chip to make sure it was laid out. There was no simulation.

And then Paivinen had fallen in love with PerkinElmer mask set He was the first customer.

Fairbairn: 10x.

Peddle: The guys that made the whisper [INAUDIBLE], wasn't it?

Fairbairn: Yeah, but I wondering, the 10x projection printers?

Peddle: Yeah. They were only projections. PerkinElmer were the guys making the first-- and Paivinen said-- and he'd used that to make big calculators. They had a guy there that had this process that gave them a color picture of the thing, and they could totally check it.

But once they made the mask set, it stayed. And that was a big deal. Everybody else was making throwaway masks. And that was one of Paivinen's major contributions.

Again, industry's coming together, and we were a real pioneer. That's why I'm saying, talking to him would be very interesting, too. Because he made that decision, and it worked. And he was able to make bigger calculator chips that worked better than everybody else at a good price, p-channel, and then he was able to make the 6502 and the other stuff work.

Because we were using projection alignment. Is it projection alignment? Was that the word? I can't remember.

[INTERPOSING VOICES]

Diamond: How did you test these chips?

Peddle: We made two or three little test machines out there that you could type into and, effectively, little computing devices that went to all the instructions. And the guys at MOS Technology came up with the idea for the KIM-1. And their argument was you need a little keyboard-- if you look at, they're calculator guys. And they basically build a calculator on a board that you could type in and put instructions in and make it run. And the KIM-1 did very well for us. Because it was really a usable device that you hand programmed.

Diamond: So how did you test the chips on the wafer?

Peddle: Not very well. We had some programs that were written with whatever test equipment existed at that time. We were lucky we were just building-- the yield was very high. And mostly we had to test them after they captured their package finally.

Diamond: Do you remember the wafer diameter at that point?

Peddle: No. It was small, obviously.

Diamond: And gross die per wafer?

Peddle: I don't remember that now. Both of those numbers came out of this work that Paivinen was doing, and I just lived with them. And then he told me what things cost and we went off to sell them.

Diamond: So final test is you disassemble the ones you thought were working, put them in a package, and plug it into a little system--

Peddle: To a better tester, yeah, a better system tester.

Diamond: --that you had developed.

Peddle: Yeah. Yeah. And you had some pre-test capability, but mostly it just made sure everything was there and did what it was supposed to do.

Diamond: And the yield was pretty high?

Peddle: Yield was pretty high. John and those guys and Terry Holdt, who later ran the company that makes chipsets for PCs here in town. The first guys that did it, he wound up managing the company.

Diamond: Chipset Technology.

Peddle: Chipset Technology? He wound up managing that company at the end. He was really good. He was our process guy that we brought from Motorola. And he was more of a manager than a process guy. But he and Paivinen and Mensch did a great job.

Diamond: So the architectural changes between the 6800 and the 6502--

Peddle: 6502 was starting all over.

Diamond: Did that come from your experience at GE, did you have specific applications in mind?

Peddle: No, no, no, no. I knew that we were going to make a controller that did things, and I had all this input from all these people about what I should be doing. So I just optimized the registers. And, as I said, if you were to go through it, you'd see some 11-like stuff there. Because I wanted to have everything memory mapped. Because I felt memory map was the right solution, and it is.

And the rest of it, we had simple registers, and you'd add simple instructions. And we pipelined them so that they were fast. And you had to teach everybody what pipelining meant, but you could do it. And then the I/O instruction decoder, rights which we had to optimize.

And no, I was probably more influenced by trying to make it better than an 11 than anything, I think. I knew that once I had it we had enough to go do what we wanted to do. Remember Carnegie Mellon had done this study, which they used at Deck to do the 11. And then I had this other study. What I had done on was I got on the tool, almost had a 100% match. So I tell everybody I used Carnegie Mellon's study, but really I had already had all this great input from all these people. And it was just obvious.

You saw we had an ICE, big honking ICE. It was done by [? Lyle ?] [? Hiddle, ?] who did the first career terminals. But it was good enough so I could go write any code I wanted and get it debugged quickly.

So I used to make a deal with companies that wanted to use the microprocessor. I would come in for a weekend, they'd give me their engineers for the weekend and Monday they'd have a computer that worked, a system that worked. And I'd just work hard all weekend.

And because I got its engineers to come in on overtime. They were involved learning how to do it. So we would do a design a week. Because the structure was that way, we could really do that.

OK. Let's get the manuals out of the way because it's a funny story. OK. So now we've got chips. Paivinen and I talked our way through it, said, Motorola still selling them for $250, Intel's still selling them for $250. We're going to announce $25 for one. And we're going to do it at a place where people pay attention.

By the way, we didn't have a lot of money, so we took ads in two or three of the engineering magazines. Come to the West-Con, or whatever this show was, and we'll sell you a microprocessor for $25. And we went over and finished the development system. We got the TIM going there, we got the KIM going, all down in Schreiner's shop just before we're going up to the show. And we get the message from the show that says you can't sell on the floor.

So we took this big suite called the MacArthur Suite at the St. Francis. And I got my wife up, and she had this barrel-- we'd planed the barrel sale-- she's got this barrel of processors and another barrel of PIAs, [INAUDIBLE], and RAM ROM devices. And before we're going to introduce this-- we know we're going to do this thing, we know we're going to do this at this show-- my buddy who had worked for me in Phoenix came in and he said, look, people don't know how to use this thing. He was a programmer out of a Czechoslovakian institute, he was a really smart guy. He says, people don't know how to use this thing. Unless we write a really good menu it's not going to get used.

So I said, OK, we'll sit down and write it together. Well I was too busy talking to people on the phone and everything else. So Peter walked into the president, John Paivinen, and he says, if you don't throw Chuck out of here and make him write these manuals, they're never going to get done. So Paivinen calls me in his office with the guard captain and says this guy can't come through the door again until I let him come through the door. And I sat at my house, and Peter would come back and forth, and that's how we wrote those few manuals.

And because I'm sitting at home and only focusing on the manual, we did a good job. And Peter was also a really great editor. And Paivinen also edited for us, too, because he knew what we were trying to do. And then a couple of the other engineers edited it.

And what we were trying to do is make it so anybody could read it and do it. And they did. Those manuals, really and truly we were proud of them. But Peter deserves the credit. Because he was the guy that kept me out of the company until we got it done.

Diamond: And what year is this?

Peddle: '75? '76? Yeah, '76.

Diamond: So tell us about that show and what the response was. You have Intel and Motorola--

Peddle: No, we weren't paying any attention to them. Well because we were kicking their ass on price.

Diamond: Plain order magnitude.

Peddle: Yeah. Yeah. Because I wasn't trying to make a minicomputer. I was trying to make something that was a logic replacement. And I understood that, and the guys at Intel didn't understand that, and the guys at Motorola didn't understand that. I'd taken all the guys that understood it at Motorola to work for me. So nobody understood it, except the customers understood it.

So we're told we can't do it on the showroom floor. So we've still got some guys on the floor. And we took this nice suite. And the way we had it is we had the KIM station and showing people, we had the ICE station, we had the TIM, which was developed by Manny Lemas and those guys. It was very, very helpful. The guy who did the online time-sharing system that lets you write the code in time-sharing was there.

And so you went down the wall and you get to see all the development stuff. And in front of Shirley are these two manuals, which he says you should buy, for--I can't remember-- $5, $10 a piece, it was cheap. And here, I'll take one out of here and sell it to you. So Steve Jobs bought one and a whole bunch of other people bought them.

Diamond: I bought one.

Peddle: Did you? Were in that suite?

Diamond: I was.

Peddle: Do you remember the suite? Do you remember how--

Diamond: I remember the manuals and the color of the manuals.

Peddle: Yeah. You probably don't remember my beautiful wife who was selling.

Diamond: I remember there was a nice person there.

Peddle: Yeah. She got to do the same thing--and I'll tell you this story when we're doing the PC-- and she got to do that again for the patent.

Diamond: And it was very crowded.

Peddle: Oh. So what happened-- and you probably were one of the guys-- if you went to the booth, they told you, you have to go to the St. Francis. People were getting on the bus saying, is this the bus to the MacArthur Suite? Because everybody was excited at the show. This was the most exciting thing at the show.

Diamond: It was the most exciting thing.

Peddle: And they wanted to get there. And so they got shuttled over and came up. And before they walked out we had their money. And more importantly we had their mind.

Because they'd gotten to see that we had all the support systems there. Synotech was our second source. We had done everything we should do to be a viable microprocessor company. Synotech was a very important step.

Diamond: And I want to get to that. But you also had the KIM and the TIM.

Peddle: Yeah. We had all of them.

Diamond: Tell us about that.

Peddle: Remember I told you the KIM was designed by the guys who were calculator guys. And it became the single-board computer that a lot of people did experiments with.

Diamond: Right. And what was on that?

Peddle: It was basically a processor, a keyboard, and some IOPS capability. And that was it. And some little bit of memory. It wasn't pretty spectacular. But it was ahead of everything else at the time.

Diamond: And it was inexpensive.

Peddle: Well it was also ahead of everything else. You could buy an Apple I shortly thereafter. And Suiting had started. But they were more expensive systems.

And it wasn't designed to do anything. When you were all done with it all you did is learn how to program. And the TIM was the same way, only it was teletype input. And the online system was you literally went online and wrote your code and then got an offline print-off and took it over to your computer somehow or other.

So we had all three of those there. And the ICE machine.

Diamond: And the ICE, which is something, by the way, that Synotech never had.

Peddle: No, no. Well we offered it to them, right?

Diamond: No.

Peddle: Huh?

Diamond: Long story.

Peddle: Well anyhow, I actually took the ICE machine to the garage and brought the Apple I up. We would take the ICE machine anywhere. Our brag was I can get any microprocessor system you want done in a week. I failed with a pinball machine, it took me three weeks. Because so many things had to happen on a pinball machine.

Diamond: So what was the press coverage like of that announce? What did you hear back?

Peddle: Well no, we had pre-done it. We'd actually supported EE Times and what was the other? EE Times was the big one.

Fairbairn: Electronic [INAUDIBLE].

[INTERPOSING VOICES]

Diamond: EDN.

Peddle: EDN, yeah. Those guys had been down to the place, they'd taken pictures. We involved them from the very beginning, before the announcement. Because we wanted them to understand it so they could write about it.

And they all came down and we spent a day or so with them. And luckily they were all up in New York-- they were all in East Coast cities, so they could swing down to Philadelphia for the day. And we'd teach them the whole thing. So we got great press. Just unbelievable.

Diamond: So what did they say?

Peddle: They said it was doing what we wanted it to do. You can build a computer with, you can build anything you want with this. That was the message that we were trying to get-- you can build anything you want. Because that's what it was for. This was your intelligence, that was your I/O, and then you put all your other crap around, and it was there. And we had a complete system.

And the end of the week that were in-- we drove up to Grass Valley and signed up Atari, which of course was the major driving force at the beginning. Because they bought a lot of them, if you recall.

Diamond: So tell us more about the Atari decision.

Peddle: Well I was in charge of marketing. I had this pretty little lady that was taking all my stuff, and every so often I'd go do the marketing. Because I didn't have anything else to do because we had the chip done. And she'd get me this list of people that had called in, and I would decide who I was going to call back.

And I saw this guy from Grass Valley, California. And I say, I've got to gall the guy in Grass Valley to see what the hell he's doing. Well it turns out it was the R&D center for Atari.

And Joe Dakota, if you haven't talked to him, he's the guy that did all that stuff. He was the guy you worked with at Synotech. He was the senior developer for that. And he's still around doing things. He's available.

He said to me-- we had two or three phone calls-- he says to me, if you can make $12 I can go sell it to my management. Because they wanted to do their own custom chip and everything. He says, I don't want to do my own custom chip. You've got exactly the thing I need.

Diamond: For the chip set?

Peddle: Yeah. I just need to have somebody. And Schreiner had already volunteered-- what's his name? Jay--? What was the guy that did that? Jay? Jay [? Meiner ?].

Diamond: Jay [? Meiner, ?] right.

Peddle: Right. Jay had committed and told him he could do it, and the two of them had reached a simpatico discussion. And so he went to Atari's management and said, we're going to do it this way. And then they did this really bad thing. They told Motorola they were designing them in, they told Intel they were designing them in--

Diamond: Designing you in?

Peddle: Designing them in.

Diamond: Oh. Designing them in?

Peddle: Yeah.

Diamond: Oh.

Peddle: And they set up a separate project team to design the Motorola in and a second team to design Intel in.

Diamond: So there were three teams?

Peddle: Yeah, yeah. But the other two teams were known fake. They were only doing one. What they wanted to do was consider-- because they got ripped off by Allied Leisure in Florida, who I did the original pinball game for. Allied Leisure ripped off their idea for the pong game that was in the bars, because they were a better game maker. And they took all of it.

And so Atari had this absolute secrecy thing that was totally important to them. There was only a certain number of guys knew what was going on. We had to sign death letters and all this kind stuff. And so we didn't talk to anybody at Atari except Joe and the sanitary guys.

And then they announced it one day and Motorola sued us the next day. They were so pissed because they wanted that business.

Diamond: So there were two decoy projects.

Peddle: Two decoys. One 8088-- I don't think the Z80 was there. If it was it would have been the three. They conned all the semiconductor guys in, I'm designing you in.

Diamond: And then you announced--

Peddle: No, they announced.

Diamond: Or they announced, and the next day Motorola sued you.

Peddle: Sued us. And they were so pissed.

Diamond: So tell us about that.

Peddle: Well Motorola sued us because they're a big company and they thought maybe they could intimidate us.

Diamond: And did they?

Peddle: Well no. We had one guy do something stupid, which caused us some heartache. I spent a year defending against that, and we won. We were able to demonstrate the architecture. If you've seen the two architectures, there's no similarities. There's nothing similar.

Diamond: Well the only thing-- getting back to the 6501 interesting part of the story-- was the '01 would plug into a 6800 socket.

Peddle: And we had to give that up--

Diamond: And you gave that up.

Peddle: --under their contract.

Diamond: But you said--

Peddle: --we never intended it anyhow.

Diamond: --didn't intend it either way. Just a shot across the bow.

Peddle: I'm giving the sleeves under my vest. Yeah there was never any intent. But they wanted to get rid of it. That's how you reduce the amount you have to pay.

And so they have this big lawsuit. And of course there's this big company throwing money in, and luckily--

Diamond: And you're a little company.

Peddle: And Allen Bradley threw Paivinen out at the same time because they didn't want to fight with Motorola. But they had enough money between them to afford the good lawyer. And we had a lawyer named Charlie Bradley who was spectacular.

And Bradley basically said, we're going to have to defend this by showing you guys didn't do anything. OK good. I get served. I'm the lawyer contact.

Diamond: Showing you guys didn't do anything--?

Peddle: I get served in Phoenix. Now I had told everybody the day before they joined us in Phoenix-- we loaded up the trucks together. When they unloaded the trucks, because we all went in the same set of apartments-- I said, if you've got anything that's from Motorola in there, throw it away. You don't need it. I'm not going to use anything you've ever done. Stop it. Don't even think about it.

These are very young naive people. So I had to shout at them about 10 times to get them to really understand it. And we had parties and everything. And we always told them, we said--

OK. So now I'm served in downtown Philadelphia. I call these guys up and said, you haven't been served yet. Because it's my job to serve you as an officer of the court-- the lawyer has delegated me to serve you. I'm going to be driving up the Schuylkill, which takes about an hour and a half.

You've got anything that you don't want to have to bring to court, bring into the office tomorrow, you've got time to go home and get rid of it. But I don't want to hear about anything. And I'd never let them bring anything in or anything. And I think two or three guys went home to throw stuff away.

We took one layout guy with us and we hired another layout guy because we thought we needed a second guy. And he was young and pretty good at it. And he was working for Motorola. And they knew he was coming to work for us to do a microprocessor.

So they took him into their office and they browbeat him. They said, you can't take anything. If you do anything, we're going to sue you. They beat this little kid up.

We brought him in, and before he walked in the door we took him and beat the shit out of him and said, do not bring anything. We don't need you to know anything, don't bring anything. And he would swear to us, I didn't bring anything.

The day we serve everybody, the next day he walks in with all their work he'd done on the 6800, all the drawings. And he said, I'm not showing you Motorola's stuff. I'm an artist and I'm showing my artwork. And he really in his heart believed that.

But we had to go through this whole bullshit of, in this defense room is all this crap which we'd never seen until after we brought it into it. And he had to swear to it, and we got everybody else to swear to it. But it cost us six months and probably half a million dollars to get rid of his bullshit.

Just, if you don't mind me telling this story-- when I started my next computer company, [INAUDIBLE], I made everybody sign a letter which I had written and designed that says, you will get sued by me if you bring anything from a previous. You have to swear that you're not bringing anything. And you're going to get sued by us if you bring anything. And I made them sign it.

So that the next time I got sued by that kind of suit I just brought the letter out. And everybody said, yeah we signed the letter and we really understood you meant it. Because I'd told them the story about [INAUDIBLE] and about this kid.

And we never brought any-- when you start a new company the smartest thing to do is not take anything from the old company. Because you're not doing anything like the old company. If you're starting a company where you're just ripping off the old company, go do that. But you're not me. I don't need it.

The thing we were doing for the microcomputer, we'll talk about that. It's totally different. And the same thing with this. I knew the microprocessor was different. I was going to create something different, I wanted something different.

And I did. And I didn't need any of their crap. And I didn't want any of their crap. Because it was nothing that great. And it really pissed me off. It took me another six months to win that. And we lost the lawsuit.

Because in the course of doing the investigation Paivinen, who didn't pay enough attention to patents in the industry, had used something in his process that was covered by a Motorola patent. So they didn't have us on the microprocessor, they didn't have us anywhere. But they had this one patent that we were building with.

So now the lawyers finally said, shit, we forgot we got something. And they came in, and we had to pay them a couple hundred thousand dollars and agree to give up the 650--. But the most important thing we had to do, which really is one of those life lessons, when you get sued like that. you sign a paper with a defense lawyer who's defending you in the company that you will accept whatever settlement the company is paying, agrees to, period. Right? They'll defend you 'til the death. But if they come up with a settlement, you are automatically a signator. So Motorola made him say that they'd caught us.

Now a lawyer walks in and presents me this piece of paper and says, you and all your guys have to sign this. And I said, I refuse. I didn't do that. He said, let me show you a piece of paper. And if I have to, I can get a judge in the next 20 minutes that will tell you that you have to sign it because you signed this piece of paper, and I spent at least $200 million defending you.

And so it was an important life lesson, right? You let the settlement be whatever it is. So there's always been a little bit of story around that we stole something, but it was because of this.

Diamond: What--

Peddle: Can I finish the lawsuit? I mean--

Diamond: Yeah.

Peddle: I mean, they never had anything. They never got anything. But we did two stupid things.

Diamond: But it did take a lot of your time.

Peddle: Oh yeah, yeah.

Diamond: At a critical point. So in addition, other than the litigation, what did Motorola and Intel do as a result of your game-changing pricing?

Peddle: I think they were both hung up that the Z80 happened. And Intel was more responding to the Z80, right, because Faggin went off and did the Z80. And remember, as far as I know, the 8080 never got sold anywhere. Right. Very few number of sales.

[PHONE RINGTONE]

Peddle: Go ahead. Sorry about the interrupt. But--

Diamond: Well, actually, Doug had a question about, to back up for just a second. You started with a cost number, which led to a die size, which led to a bunch of--

Peddle: Decisions that made--

Diamond: Decisions about what to do.

Diamond: So where did that number come from?

Peddle: Paivinen's estimate and Mensch's estimate and Terry's estimate about how big they could make the die and still make the number.

Diamond: So the number came-- your competitors were an order of magnitude more expensive.

Peddle: No, we knew nothing was going to happen. You know, all this feedback we'd gotten. Nothing was going to happen 'til you could do a $5 microprocessor.

Diamond: From talking to customers.

Peddle: Yeah, from all those customers. They all said the same.

Diamond: So you had the customer data, which said, logic replacement market--

Peddle: Is $5.

Diamond: Is $5. So you were responding to your customer research and your gut feel.

Peddle: And my own design work, right, that said-- I mean, I never agreed with the original 6800 pricing or strategy or anything. I mean, that's why I was out telling everybody, let's do a cheap one. Because the market needed a cheap one.

Diamond: So in addition to sort of the architectural, visionary stuff, you also had a lot of insight into what it would take for the customer to [INAUDIBLE].

Peddle: When we started the 6502, Paivinen I both had an agreement. We've got to be able to make this thing really cheap because that's the only way we're going to get logic replacement.

Diamond: So let's then jump ahead to how did Motorola and Intel respond. You said Intel was focusing on the Z80.

Peddle: Intel was more worried about the-- Faggin decided the 8080 wasn't right and went out and did the Z80. And he started getting sign-ups for it. So I don't think the 8080 went anywhere. But I think they were more focused on Faggin and the Z80 because they were stealing stuff.

Motorola got the automotive guys, and they had some of the carryover stuff we'd left them with, HP and all those other guys that didn't care about the price so much. And so they, neither one of them responded. The most important response was done by Signetics, I think it was, who did the one-chip micro--

Diamond: 2650?

Peddle: Yeah, I think it's 650.

Diamond: 2650.

Peddle: 2650.

Diamond: Yeah, right.

Peddle: And they did a one-chip micro and hired this guy by the name of Van [? Lewing ?], who I knew really well, to run that program. And I would talk to him occasionally. And he'd say, you son of a bitch. We went in to try to knock you out of these companies, and I would send a design team in. And two weeks later, they didn't have anything working.

And the guy said, but he did. He got it working over the weekend. Because it wasn't a strong enough product.

Diamond: And I don't think they had the suite of tools to work with.

Peddle: No, they didn't.

Diamond: I don't think they had an ICE.

Peddle: No, no. They didn't, any of them. The point is it that was the most significant response. And then of course, the four, is it-- what's the product that ultimately Intel came up with that sold jillions?

Fairbairn: 8085?

Peddle: No, no. It's smaller than that. 40 something or--

Diamond: 4004?

Peddle: Yeah. No, not the 4004.

Diamond: 8008?

Peddle: No, it's a new-- it's a thing that they sold millions of. Maybe it's a 80--

Diamond: 8085? 8086?

Peddle: Maybe-- no, no. It was nothing to do with the 8080 series. It was another product that was-- they used it as a controller product. Everybody used it.

Fairbairn: That was much later.

Peddle: What?

Diamond: That was way, way later. We'll think about this.

Peddle: It really is, it's a 400. It's a 4-something series product. And it just went everywhere. People used it for everything.

Diamond: Are you talking about the bit slice?

Peddle: No. No, this is a one-chip micro with some I/O and capability, and people used it in everything. They used them in printers. They used them everywhere.

Diamond: So you mentioned--

Peddle: So Intel got the message and created a new product that did very well later. I don't know. They didn't do it in the same time frame as we were, but they did a product that was very strong.

Diamond: So you mentioned Synertek as a second source. Can you tell us more about how you arrived at that?

Peddle: Yeah, very simple. I knew that we needed a second source. I knew Schreiner had his own company working. He was an independent company. It was before he was acquired by anyone. And Schreiner knew the computer business, and he knew Paivinen and I. So it was easy to show him why it made sense for him to second source it, right?

And then we got Atari. And of course, that now made really good sense to him. So he said, yeah, I'll be your second source. And then he got into it in and saw that he had Atari locked up.

And he made most of the sales to Atari because Commodore didn't. By that time, Commodore had been sold, and we sold a lot of product to Atari. But most of the product was sold by Synertek.

And so Schreiner sold it almost immediately. Because remember, he's a computer jock. He was a circuit designer in the computer business, but he was enough of a computer-- so we never-- it didn't take any long time at all for him to say, yeah, I'll do it. And then after he got into it, he really get into it.

Diamond: And then Manny Lemas.

Peddle: Lemas worked for me in the design automation in Phoenix. And so he came up-- he and Holt. You know their thing was called a Jolt because of Terry Holt.

And he saw what the architecture was. And Terry also saw the architecture. And they saw they wanted to do something with it. And so they did it. And you guys supported them a lot.

Diamond: I think we acquired the company.

Peddle: Is that right? But anyhow, my point was is that Manny was a guy out of GE Phoenix, actually, that I knew. And Holt was just a smart guy, Terry Holt.

Diamond: So you mentioned Apple I and the 6502. Can you tell us more about that?

Peddle: Yeah, if you want. OK, sure, because I think it's an important step. OK, right after we went out and sold Atari the computer, I flew to Denver, Colorado and went into the basement at Dr. Suding's place, who was making one of the very first-- it was a Suding computer. I can't remember what the-- one of the very first kit computers. And he was doing very well with it. He had built stuff.

And I went and talked to him about-- but I think he was probably still at that point may have been using 8080, may have been using 16-- I don't know what he was. It didn't matter. But so he was my introduction to kit computers and that they were doing very well.

And then after that, we got to meet Byte guys, who were starting to sell those. And when we get into the computer, I want to talk about that some more because there was a reason. All of that was very important in terms of what happened in the personal computer industry.

But the point-- let me think. You asked me a question about--

Diamond: Apple. Apple I.

Peddle: Apple II. OK, so Apple I. Peter lived in the Bay Area, and he was my salesman for the Bay Area. So he was selling Atari and all that sort of stuff. And we went to two or three other of his customers and helped them with the ICE. And he called up and said, hey, we got these two young guys working on this computer in their garage, and they can't make it work. So Peter and I took the ICE down, and we made it work.

I don't know if you ever-- there's some stories about that they didn't put interrupts in because Woz [Steve Wozniak] doesn't understand interrupts. And there's a whole bunch of--

Diamond: He told me that.

Peddle: What?

Diamond: He told me that.

Peddle: Oh did he? Yeah.

Diamond: He told me he didn't understand it, and anyway, he didn't need them because there was enough time to go all the way around.

Peddle: Yeah, right. Anyhow, the point was is that Woz was a technician, and Jobs was a promoter. Right. Jobs was not technically very smart then. If you look at his background, he'd gone from being whatever he was to doing over to India and then came back. But he was a great promoter.

And oh, by the way, he had great artistic sense when it came to packaging and things like that, which you see in Apple. It's carried over into all of Apple's stuff. But Steve's ability to know the difference between something that people like and don't like and that you can package. That was Steve's contribution. But he didn't know anything about the computers and everything. He depended on Woz totally for that.

And so we got it up and got it working, went away. And they sold a few, right? And we'll talk about this in the second round of Apple in the other conversation. OK? But so we just brought it up.

Now the story that I walked into his-- that Woz has now published-- that I went into there with a cowboy hat, like I'm wearing now, was totally untrue. I didn't start wearing this hat until years after. And the reason he remembered it is he saw the YouTube with my hat on and apparently put it together in his mind. And I wasn't dressed up in a suit because I didn't ever dress up in suits.

We went in, and Peter and I just went in as casual guys. Went in and plugged the ICE in and made it work. But there was nothing memorable about the way either one of us was dressed or anything.

And we didn't see these guys as that important. They were just another guy doing a kit computer. And we felt that the guys in Ohio Scientific did a much better job with the 6502 kits than Apple did. And I met with those guys two or three times. They were really good. And then Peter Jennings did-- no, that was different, something later. Anyhow-- no, Peter Jennings did get involved because we built a calculator based chess game around his work.

Diamond: So I want to talk chess games, too, because there seems to be a connection between the architecture and some of the chess games. Before we get off the Apple, any thoughts about the Apple design, the Apple I design or the Apple II design compared with some of the other customers?

Peddle: I don't think-- I don't remember the Apple I was even packaged, right?

Diamond: No.

Peddle: I think it was just another kit computer. Right?

Diamond: Right.

Peddle: And we had the KIM in that market, and we had other products in that market that were outselling those guys. So they were just a non-event. Apple I was a non-event to us. And it didn't do as well. As I said, Ohio Scientific was probably the bigger customer.

Diamond: Mhm. How about the Apple II?

Peddle: OK, different problem. And I'd like to get into that when we do the computer part.

Diamond: OK. You mentioned chess games.

Peddle: Yeah, we did-- Jack Tramiel was a calculator guy, right, and he'd bought the company. And--

Fairbairn: We didn't cover that acquisition. There's a whole story there.

Diamond: Right, right.

Peddle: If you want to do that, we can do it. It's all right about now.

Fairbairn: Why don't we break now?

Peddle: Yeah.

Diamond: We can? Do you want to take a break now?

Peddle: I don't care.

Diamond: For lunch?

Peddle: If you want, why don't we just get rid of the Tramiel, what happened to MOS Technology? Because that's kind of the end of that era.

Fairbairn: Good, good.

Diamond: OK, well--

Peddle: It'll only take a minute.

Diamond: Sure.

Peddle: It's really short. Remember, I said, we'd been sued. We had to spend a lot of money. The calculator business was going through this tremendous transition because of the Japanese.

You know, the Japanese had invented the digital watch by that time. They invented the digital watch. And they decided to do-- and they had done CMOS memories. They were focusing on CMOS memories. So they had better CMOS capability.

So even though Tramiel tried to buy a CMOS company, CMOS was really a Japanese leadership thing forever. And the combination of the CMOS-based calculator and the LCD just put the calculator guys in terrible trouble. So MOS technology was surviving and Commodore was surviving by doing the high end stuff, effectively competing against HP, the better performance thing. More limited market, but they were able to somewhat survive during that time.

And Tramiel was trying to buy that stuff from the Japanese, and they always told him no. It was the Japanese basically refused to sell the Americans any of that stuff. They knew they had a leadership position, and they knew they were going to destroy TI and Commodore and all of the guys who were in that business. And they did.

Commodore had an LED watch, right? And of course, pow, goodbye. I mean, it was a-- so Tramiel had taken his company, and his company was transitioned from a mechanical calculator company into an electronics calculator company because when he got into trouble in Canada, the guy who bought the company was a guy who was very Japanese-oriented. He had a Japanese girlfriend he kept forever. And he was a container guy. He was the guy that actually invented the container concept and sold a container concept, a guy by the name of Irving Gould.

And he told Tramiel-- Tramiel actually had a factory in Germany making mechanical calculators. And he said, forget it. Irving said, forget it. You've lost. You're not there. Get your ass over to Japan. They're making calculators with electronics that'll kick your butt. OK?

And they did. And then, of course, HP came out with a product. And we'll tell that story when we get to that.

But fundamentally, the point was, is all of a sudden, Tramiel was in a situation where TI was just-- he used to buy from TI, and he used to buy from the Japanese, and they were kicking his butt. So he came up. He had a guy working for him that was a process [INAUDIBLE] guy. And they came up with the idea of designing their own chips and building them here. And they had a team that was building them here, and they stayed alive for one more year in the LED calculator business because they were making their own chips.

And then he looked at where the market was going, and the only hope he had was to be in the higher end stuff. And he knew that Paivinen and those guys were in financial trouble. So he went in and offered to buy the company so he would have a processing capability for the high NP channel, which Paivinen was

better at that. He knew that, or his guys knew it. And he bought the company because of the calculator business, because it carried on his idea about I'm going to integrate the calculator.

And of course, he carried that concept finally over into the C64 and everything and kicked everybody's butt. But the point was, is he was in an integration mode. I want to integrate the technology. And MOS Technology didn't have the money. And Atari hadn't turned on yet. We were making a little bit of money selling KIMs, but we didn't have the income that would justify where we needed to go. And so he made him a good offer.

Diamond: Do you remember what he paid for it?

Peddle: No, he didn't pay shit for it because what he did is he sold them Commodore stock, which at that time went from $1 to $500 over time. So he paid a lot, but he didn't know it. Nobody else knew it. For a while, Commodore stock was the fastest growing stock on that alternate exchange. What was the other exchange that--

Fairbairn: Over the counter?

Peddle: No, no, no. This was before over the counter happened. There was the New York Stock Exchange and another-- the American Stock Exchange.

Diamond: And this is before Atari had really turned on.

Peddle: Yeah. Yeah. We were a year away from having that kind of volume. Yeah. And so he bought it because of the vertical integration. And so he gave him the money, bought the company. I will explain how I got there as a side deal. But we want on to do the computer as a result of that sale.

Diamond: Was that an issue with any of the existing customers, that Commodore was a potential competitor?

Peddle: No, I think everybody was so getting terrorized by the Japanese-- I mean, this is at a time when all those guys are getting thrown out of business. I mean literally. The Japanese did some terrible things to this market with the LCD calculator and LCD watches. Just changed the world.

The companies that used to be around vanished. TI got out of the business because they didn't have the CMOS technology and the LCD technology. And Tramiel tried to acquire both, but he didn't go hard enough and didn't have the right people to do it. So he didn't make it in either one of those.

Diamond: You want to take a lunch break?

Peddle: OK. But so that's why Commodore acquisition occurred. And it was because he wanted to have vertical integration of the high-end calculators.

Fairbairn: So did the chess stuff come along before the computers?

Peddle: Oh, I'm sorry, I'm sorry. I'll just finish the chess story. OK. Jack now has his company, right, and he has the calculator. But he's got a microprocessor. And chess, somebody had made a calculator that ran good chess. And he wanted to use, to make our own chess game-- because it was starting to, you know, it looked more like a calculator. Remember? I don't know if you remember those original games. But they were--

Diamond: They looked like calculators.

Peddle: They were like calculators. And so he wanted his own, and we got this guy back East who was-- and you had to have done business with him. He was with-- he was one of the guys that went and bought VisiCalc. Anyhow, he was a really famous guy. I won't forget. I'll remember before we get done. And he was a really good guy with chess. So we helped him make the chess game for the 6502, built into a board.

Diamond: And that was a Commodore.

Peddle: Yeah, it was a Commodore product. Commodore calculator. And I did-- they actually formed a couple companies around that for a while. It really did well for quite a while. This guy's famous.

Fairbairn: He started VisiCalc?

Peddle: No, no, no. He did the chess thing. He was really well known as the guy who really drove chess.

Diamond: We'll think of it.

Peddle: Yeah, I'll get it. One of us will forget it. And--

Diamond: So one of the things I remember from Synertek was that one of our customers was an international grandmaster who started a company building chess computers that competed with

Commodore, I think. But he did an analysis which showed that the 6502 architecture was superior to the competitive architectures for building just machines. And so he'd chosen the 6502 not because of the price, but because of the architecture.

Peddle: The architecture was totally simple, but you could do anything with it. That was the whole idea. It was the ultimate tool. It was the universal solvent.

Diamond: Some people used to call it a RISC machine, although it doesn't--

Peddle: It wasn't. It was a reduced instruction set machine before that became a popular term at Stanford. It did have a reduced instruction set, but so did the PDP-11, if you recall. Right? A small instruction set, great addressing, was the model for the 11 that came under the Carnegie Mellon study, and we did the same thing.

Diamond: Now did you, over the history, the development of the architecture, did you add opcodes into the space?

Peddle: It went the other way around.

Diamond: The other way around.

Peddle: I was trying to keep the opcode small and efficient. Yeah, I used to win all the benchmarks because I did my own benchmarking. Remember, I had a programming background as well as a computer background, and so I could out-benchmark anybody. And again, I also had my little ICE system to play with, too, which other people didn't have.

And I tell everybody my first personal computer was a GE-400, which is a bigger version of the 225. It had 10 tape machines and four disks. We were the first guys using disks in Motorola.

And that was my personal computer because we were doing our design, our BASIC stuff on it. And I got to think about the ways to use my own computer. So I just always used my computer. Bill Gates and I both believe you can write any good program in BASIC, period, end of discussion. But we're going to talk about that when we get to the--

Diamond: Well, we'll save that for the [INAUDIBLE].

Fairbairn: [INAUDIBLE], and then we'll come back.

Peddle: OK. But I just wanted to make the point that the 6502 was specifically designed to be the universal solvent. It's just enough, and it's simple enough, and it's cheap enough that you can use it for anything.

Diamond: So we're back. Let me bring us back to the Apple II discussion we were having over lunch. You were talking about the Apple II design and how that evolved.

Peddle: Apple II, not Apple III? You and I were talking about Apple III at lunch.

Diamond: Apple II, Apple III. What was your involvement there?

Peddle: Well, Apple II was we, as you may-- do you want to do that because it's kind of a transition into the other one, in the sense that we looked at buying Apple in order to be able to get a quick jump-start on doing the patent, and we didn't buy it.

Fairbairn: "We" Commodore.

Peddle: "We" Commodore. Andre Sousan set that up. So I'm going to get that story in because it's an important part.

Diamond: OK, well, we'll do that in part three, then.

Peddle: Yeah, if you don't mind. It just makes sense because I want to explain why the PET worked and why the whole thing worked, and it's not for the reasons people give credit.

Diamond: So the 6502 was an NMOS processor. And--

Peddle: Then we started-- Bill-- I'm just going to talk about Mensch for a minute. We started him in to be able to have some design capability. Bill was available, and Jack made him a deal to start Western Design center. And then the product we were going to put in there, I was at Apple and came back. And we were going to build a, what we call a macro micro, which was going to have macro commands that let you do calculators. And so we could do a CMOS calculator much smaller than the normal calculator chip. And they didn't have the capability.

But so at that point, Tramiel basically told Bill, too bad, goodbye. But luckily, before that, I had gotten Rockwell to be the third source. Rockwell had wanted to be a third source.

Diamond: For the NMOS 6502.

Peddle: For the 6502, right. And they were very useful because Synertek didn't have the big company sales force, so Rockwell was chasing more of the big companies than Synertek was. And Commodore wasn't chasing anybody. They weren't really pushing the chip at all. So Rockwell was a really good second source addition. And we needed the money at the time. We got it, too.

Diamond: And was Gil Emilio the CEO at that time?

Peddle: Probably. That wasn't the guy I dealt with. I dealt with another guy at Rockwell.

Diamond: So tell us a little more about the CMOS 6502 and then the 16-it version.

Peddle: OK, so I started to make a-- OK. I"m going to let Bill tell you about those because I'm only doing what I know. At that point, we had-- once we started the patent, we stopped doing any development on the processor. We tried to develop RAM and ROMs and didn't them very well. And we finished up an analysis that says we needed an Atari-like Interface, too.

And [INAUDIBLE] Technology had some guys that had done an Atari similar interface for games. And [INAUDIBLE] and Cromemco actually used that product. I don't know if you remember Cromemco. They used that product as part of their game.

But I couldn't tell anybody at MOS Technology, stop developing this, because Atari's got a better one. Because I was bound under this-- remember, I was telling you about this really tight. So nobody at MOS Technology other than Paivinen knew that we were going to sell to Atari because we had to keep it quiet.

And so these guys were off developing this chip, and I couldn't tell them, stop, Atari's doing a better one, until after they came out. They finished it. And it never did well because the thing that Jay did just kicked everybody's butt. The combination of those three kicked everybody's butt.

And Cromemco had the 6502 and had the other code. But they just had an inferior video capability. And we basically redesigned that video capability twice, once for the VIC-20 and once for the Commodore 64, at MOS Technology.

But we weren't doing any other development. There was no processor development. There was nothing going on because Tramiel didn't see him going there, and because we felt we had to make a major step up, not just an extension of the 6502, but a major step up to a product like the 8080 or the 68000. That was the next generation because of the memory addressing capabilities. The structure that was in those machines were quite better than 6502, which only had a 256-byte stack.

OK, we're talking about that. We were talking about the process. What were we doing with that? And so we just weren't spending any money on developing at all.

And Bill was now cut loose, and so he went to Rockwell and got support from Rockwell and I guess from you guys at Synertek. And he convinced himself that he could build a CMOS version, which he did, using, I guess, Japanese rules because the people who bought that product were the game guys. And then the 816 was done with Apple, providing the guy who did the Apple 3 actually was a real contributor to the 816, for Bill. And then they sold that to Nintendo and Sega, and owned that. Bill effectively owned that business forever, until they finally swapped over to whatever they're using nowadays, but he-- it was the-- and so-- and we still kept it alive, right? You could still buy it from Rockwell, you could still buy it from-- so the market continued to grow.

And Bill was trying to just-- he built these little development systems, and everything else, and whenever he could, he'd try to convince somebody to use it. But fundamentally, the game guys were the primary buyers, and as you know, they bought a lot. And that was all Bill. That's what I'm saying to everybody. And the CMOS version, which he had put some extensions in, is exclusively done by Bill. He did not do very much with the architecture of the 6502, because we did it-- myself, and Rod, and Bill. And Mensch was helpful, but he wasn't involved in the-- any much of the architectural of, why you put the registers in.

And then he took a look at the instruction set, or basically, Apple took a look at the instruction set, and said it would be nice if you had these instructions. And so he put them into the C, he and Rockwell, but they really did it in response to Apple. So Apple kind of designed the 6502 C. And the features that he put it were good, and then the 816 was designed in conjunction with Apple and the guys at Nintendo. But I think it was more the other way around. I think the Apple made a major contributor to what was the instructions and everything for the 816. I don't remember where they even used it. They It definitely helped with it.

Fairbairn: Was the decision not to extend the architecture, when Commodore was in the lead, influenced by the competition that was looking for architectural extensions? Like for example, Apple wanted a 16-bit processor?

Peddle: No. We were so totally focused on going where we were going, from Commodore PET, to the CBM, to the C64 that-- and when I was at Apple, we didn't think about using a new processor or anything

for the Lisa. We were basically looking for "What's the functions?" Everybody was looking at functions-- hard disks, better printers, all of those sorts of things. So we really focused on that.

And Tramiel is not an investor. He never invested in any development activity. The activities I'm talking about were trivial, one or two people for a period of time. He never invested. Which is what it takes to get a new high-capability processor. And I don't think, if anybody asked me, if we really should do it, I wouldn't have felt that much, because I felt that between Intel and Motorola, they were going to do a next generation, because now they were trying to make a product that was a computer. They were truly-- and that was OK. That's what those were. You don't use an 8088 as a logic replacement. You don't use a 68000 as a logic replacement; you use it as a computer. And that's a different architecture. And we weren't capable of going there, without a major investment, and all of us that were capable of doing it were tied up doing the PET. So it was just a walk-away. And Synertek didn't invest in that either. And I don't think Rockwell really invested-- other than supporting Mensch.

Fairbairn: Right. I think neither of those companies felt it was possible at the point, to drive the kind of investment needed to do a new architecture.

Peddle: So Bill did it, under contract, he came up with a great product, it was used-- remember, it's the heart of all those video games that everybody fell in love with. I mean, truly it was a major-- he did a major job.

Fairbairn: Are you surprised, looking back at the conception of the 6502, at the incredible volume of 6502s that are out in the world, or--

Peddle: That's what we were designing. It was supposed to be.

Fairbairn: Were you expecting that to happen?

Peddle: It's supposed to have been in every cash register, it's supposed to have been in every intelligent thing on the airplane, it was supposed to be everywhere. It is a lot of everywheres. But the idea was-- and Intel came out with this really good product that they sold, which wasn't as good as 6502, but it was good enough that Intel sold it, and the low-end machines are the ones that carried the volume. That was not the computer.

We sold more-- I think we sold almost as many Commodore 64s than we sold MS-DOS machines, for a long time. I mean, they are a different market, totally. And so the answer is, is a little controller like that is very useful, and so that's why I put all of 11 of them in my controller, because they go there, because they're so inexpensive, and they're so capable of the function that we designed them for-- do one job well.

That's why all the Commodore peripherals were another microprocessor outside. Everything we did was, you don't worry about minimizing microprocessors.

And I'm not a strong believer-- for a big computer, you need the 8088, and the Z80s, and all that stuff. But for most control applications, it's a bad use. I think that's the stuff that ARM has done is the wrong direction, and I might prove it this time. I'm not-- because I'm not trying to just compete with ARM, I'm just saying that 16-bit wide, and 32-bit wide, implies that your multi-timesharing and all that stuff, and that's not the right use of a microprocessor.

Fairbairn: So you conceived of the 6502 as a logic replacement that would show up everywhere?

Peddle: General control, yeah. And you need-- to do logic replacement; you have to have a logical function and a I/O function. And we had the I/O function, and we just needed a logic function.

Fairbairn: But it turned out, in addition to doing that, it also was the, arguably the catalyst for the personal computer industry.

Peddle: We can talk that whenever you want to talk about it.

Fairbairn: So, I think we're going to deal with that in the third phase of our discussion. So before we switch gears, is there anything else that we should say about the 6502 as an architecture, as a product line, et cetera?

Peddle: Remember, it kind of died back. Bill has made money off of it, and everything else, but you don't see anything new 6502, for some time. We're going to relaunch a new USB chip, based around Bill's architecture, here, shortly, which is very low cost USB. And then we're going to do other products, based around 6502 derivatives.

Fairbairn: So would that involve architectural extensions? Or--

Peddle: Other way around.

Fairbairn: Ah.

Peddle: Go back to the basics.

Fairbairn: Basics.

Peddle: Yeah. For control. We could spend so much time about the new architecture we used for reading and writing flash, but you don't need anything fancy to read and write flash. What you need is DMA, you need devices that do that well in speed. And then you just control those devices. A processor shouldn't be involved in data transfer. A processor is OK for looking up some data, and putting some data out to a screen or anything, but fundamentally, if you want any kind of speed, you can't do that with a processor, I don't care who's processor it is. The concept is against processor's thing. So you put a DMA device in that's really smart, and you just program the DMA, a la PIA, a la everything. And you let your DMAs do the work, and the processor is making the decisions. And it doesn't need to be very big, or very wide, or very fast, to do that.

Fairbairn: Looking back at the incredible history the 6502, with the benefit of 20/20 hindsight, is there anything you wish you'd done differently?

Peddle: No, I tell everybody that the 6502 is the best single project I ever worked on. In the sense that it was the team, we went there, we did it in the time we said we would do it, we got the results we expected it to do. I mean, it's hard to-- the constraint of having to squeeze it into the box helped us.

So what would we have done? you don't put a 256 stack into a computer, and we're going to talk about that, right? But for control, what do you need the stack for? You handle the interrupts. You jump to some subroutines. Subroutines-- maybe on C, you go 28 deep, although we've been using the 6502 for a bunch of C stuff for a long time now. But for normal code, two or three levels of subroutine is about all you ever need. And that's what, a few bites? So 256 works, has worked, for years and years and years. But it doesn't make a good computer, except for one thing.

SPEAKER 3: OK.

Fairbairn: All right. That's great. Let's move on.

Peddle: Was there anything you would like to have heard that I didn't cover? Is there anything-- did I put all the lies to bed, anything you might have heard?

Fairbairn: I think we covered--

Peddle: By the way, you didn't-- I didn't need to refute the lies, because you lived there. You already knew the answers, right? Because you lived through it.

Fairbairn: I'll -- I think it was the most fun I had, too, back then. OK. Let's move on to the world of personal computers. So, let me see if I can set the context here. You'd been sued -- you, Commodore, had been sued by

Peddle: Not Commodore.

Fairbairn: I'm sorry.

Peddle: MOS Technologies.

Fairbairn: MOS Technologies, correct, had been sued by Motorola, took several months, a couple hundred thousand dollars to--

Peddle: No, no. A million dollars, and almost a year.

Fairbairn: A million dollars and a year. OK. And out of that-- and in-- part of your transition, you had been visiting with and helping customers who were, despite your goals, were using the 6502 to build into microcomputers, the Apple 1, and Atari, and so forth, and game computers. So tell me what happened--

Peddle: No, I didn't-- I think the game machine is the perfect application. It's a single function, it's doing control and making decisions, but the thing that makes it a game is the controllers-- that video controller that they put on.

Fairbairn: OK. That's a good point.

Peddle: I'm not trying to be--

Fairbairn: So Commodore had come in and basically bought up MOS Technology from Allen-Bradley. After--

Peddle: No, from the partners. They had actually-- they did a leveraged buyout with Allen-Bradley first.

Fairbairn: So, I'm obviously getting the story wrong, so why don't you pick it up at that point.

Peddle: Let me make it simple. Allen-Bradley helped them start. They felt that John Paivinen was hard to do business with, which is kind of-- [CHUCKLE] when you've talked to him, you'll see it. But it wasn't that. It's just that when they got sued and everything, it was just too much. So they basically told the-- owners were just walking away, "We'll sell you the company back for a peppercorn," and the guys who had MOS Technology now owned the company, and they borrowed some money, and they had some houses-- they were able to effectively fund their way through the suit. And they were still selling a lot of product during that time, but they were walking off the cliff of the LCD CMOS product, they were not going to make it that way. And so, selling it to Jack made sense to them.

Fairbairn: Jack Tramiel in Commodore.

Peddle: Jack Tramiel for Commodore, because he was willing to give them stock and money, and take it over, and make it happen. And they knew the microprocessor thing was going to happen, they knew the Atari thing was going to happen. They just didn't see that they had the funds to pull it off.

Fairbairn: So pick up the story there. What happened? Commodore takes over, you guys were thinking you were walking off the cliff. Tell me what happened?

Peddle: There were-- Commodore's walking off the cliff of the CMOS. Jack went out and bought a CMOS company in Southern California, and he bought an LCD company, and he was trying to fight back, but he just-- it just wasn't happening. The Japanese were just-- Tramiel never would have made the kind of investments the Japanese made in getting there. And the kind of focus, right? You need the long term focus. Japanese are willing to spend two years getting a program to work,. Tramiel is-- if you don't perform in three months, he doesn't want you. He's been known to fire a bunch of people that don't perform in three months. So just not the right mentality to compete with them, but he tried. But it didn't work, so the calculator business basically went away for him. But by that time, the KIM had picked up, because we're selling a bunch of KIMs, because the KIM was a thing that you could use to play around with 6502s. and So it was a nice little profitable product, because it didn't cost much to build, because there wasn't much. And so we sold a whole bunch of them. And then we took the Rockwell money. So we effectively kind bridged our way into the Atari program, within Commodore. But that wasn't my relationship with Commodore. I made the Rockwell sale, but-- and I'd done the Synertek thing.

Fairbairn: Rockwell's second sourcing and the second source--

Peddle: Second source thing, which we got money for, right. The thing I joined Commodore for, is I actually had made a presentation to the guys at Allied Leisure, who were the guys who had knocked off Atari, and were in the game business. And I had told them I can build a personal computer that will sell. And the reason I decided to do it was that every time I would go to a show, or go to some place, a whole bunch of programmers would walk up to me and say, "We don't want to build kits. We don't-- it's not our

thing. We want something we can plug in and program." And I knew what they meant. And so let me-- if you don't mind, I'm going to put--

Fairbairn: Please do.

Peddle: The BASIC in place, OK? Remember I told you we designed-- we did the computer for the [INAUDIBLE] BASIC. I watched engineers use BASIC to design things with. GE had this enormous time-sharing company, and every kid going to accounting or engineering in every school, for a period of time, had to learn BASIC. And they would go online and do time sharing. So they learned how to do their own programs in BASIC, because they had to, the universities made them. And then, when they went on to business, they were getting these programs done, and people were writing good BASIC programs, and they were using them for everything.

And the problem was, is GE was making a ton of money off the time sharing, and people sat down and figured out they couldn't afford to keep paying for that kind of online access. So they stopped it. So now we've got this whole generation of very smart people, educated by their universities and educated by their businesses, that BASIC language programming that is personal, "I want to do," but it's gone.

This is during a time when the US government stopped the supersonic jet, stopped MOL, the manned orbital laboratory, because it was this reaction in the country against technology. And literally, people went into Berkeley and smashed computers. I don't know if you remember that, but that was a period-- and if you don't put it in your history museum, you should, because it was a-- they were smashing, because they said technology is bad. We're all going to go back and live real lives and everything. So we kind of froze technology right then.

And so, the guys who had to have computers, which by that time was all the businesses in the world, they barred their computer rooms. They put security systems in, the only way you could get a computer program into the room was to take a punch card deck down, put it in, and two or three days later, you got a run back. There was no-- all of these friendly typing and doing all this stuff had gone away. Gone away.

But the programmers that came up to me said, "I want my own computer, but I don't want a computer that I have to make." So, OK, so I've got strong input from the market that says they want a computer they can make-- this is why we're going to talk about Radio Shack for a minute, who by the way is now on its way out, I'm sorry to say. But Radio Shack at that point had kicked Heathkit out of the business. Radio Shack stores were the place you went to get electronics, except for one new startup, that was doing very well, called Byte stores. The Byte stores were becoming-- because in order to build your computer, you had to go down and get the parts for it, you had to buy the soldering-- and so Byte was--

Fairbairn: This is '76, '77 times, right?

Peddle: Yeah, '77, yeah. Byte machines, Byte stores are a legitimate competitor for Radio Shack all of a sudden with a reason for people to walk in the door. We are giving them the reason, the kit computers gave them a reason. So John Roach was given the charge to stop it. Make it happen, stop it.

Fairbairn: He was president of--

Peddle: No, he wasn't president, yet. He was like a-- he was not-- I think old man Tandy was still the president. But he was

Fairbairn: Of Radio Shack.

Peddle: He ultimately became the president of Radio Shack. But at that point, he was-- and he was told, stop it. And so he come together with his guys, and they said, "If we're going to compete, we can't teach our computer stores how to sell computers. It's just not-- remember a lot of those are franchises and so forth, and we can't make them-- so what we want is something that's absolutely plug-in, turnkey. And so they published a spec that says we want a built in CRT, we want a tape drive built in, we want people to be able to load the programs, and we want them to be able to run.

Now, there was no specification about BASIC or anything. It was just, we're trying to stop people going into those stores, and we can't compete by trying to show people how to build computers. So we're going to give them a computer that they don't have to go build for themselves. That was Radio Shack's idea, it was actually Roach's and his team's idea. They presented that idea to Commodore. And a guy by the name of Andre Suisson who worked in a calculator company before then, and who had made Jack successful with all these vertical integration things, was an engineering head at Atari. And he and I--

Fairbairn: At Atari?

Peddle: I mean Commodore. And he absolutely believed, like I did, that a packaged device was what people wanted to buy. If you listened to these programmers and everybody, they don't want a thing that you have to put together, at all. So OK. So the spec is integrated video, integrated storage, integrated keyboard, integrated computer. That's was the spec.

Now I decided, because I talked to Sousan, and I get Tramiel to agree that we're going to go do this product. So instead of going to Florida, which actually, one of my daughters thought she was joining me to do, she suddenly discovers we're coming across country. And I knew what I wanted. I absolutely knew what I wanted in the machine, because I had all this experience with Basic.

So I stopped at Albuquerque, sat down with Gates and his team, which were in a two-room over, and said, "I want a BASIC that does what I want it to do. If you let us get together in California, you send your guy out, and we'll give you a spec. And Peter and I put together a spec, and basically what we did is we added I/O capability, we put in the I/O instruction. And we made a decision to put in the IEEE interface, it was a interface that Hewlett Packard had come up with, and you could license it, and that all of the instrument--

SPEAKER 3: This was before [INAUDIBLE].

Fairbairn: Yep.

SPEAKER 3: Attribute 488.

Peddle: 488. And it's in-- all of the instruments in the world were running this. And people were starting to sell a BASIC computer that drove those, because it made sense.

SPEAKER 3: HP IB.

Peddle: HP IB. Is what-- I wouldn't even call it that, because obviously I'm not trying to help HP. [LAUGHS] It was an IEEE standard. But I put that in, because I said, "I have to get dignity into this product. We're going to be selling this thing for $500, and everybody else thinks computers are $20,000.00, and it's got to have dignity. So putting the IEEE and 488 in give me dignity, and also give me a guaranteed market of people that would buy it, if nobody else bought it, right? Because I wouldn't be able to sell it against HP and Techtronics and everybody that were selling them for thousands of dollars.

So, I have an absolute plan. I'm going to do this in Basic. And the reason for the BASIC was because there's this whole generation of people I'm talking to who want a computer that they can program, in Basic. So we defined the new Basic, Microsoft agrees to do it, Gates took a look at the 6502 and says it's a piece of junk, because it's got a 256 byte stack. And he sold-- bought it at a ridiculously low price, which I'm not allowed to tell. [LAUGHS]

Fairbairn: Still can't tell it, huh?

Peddle: No. No, no, no. I have great respect for Bill Gates, I'm hoping to do some business with him here soon. And he had his reasons. He was 20 years old, and he had a reason. He really did know that 256 stack doesn't work. Except, let me make a point-- that Bill Gates had the solution for the stack problem.

He wasn't paying attention to what he was selling. BASIC is an interpreter. It does one instruction at time. You don't need a stack heavy to do one instruction at a time. It doesn't generate stack commands.

So he was offering me the solution to this 256 byte stack, without realizing it. He didn't-- it didn't come together with him, that was enough. And that's why the 6502 worked as the computer for the PET, is because the BASIC didn't need a bigger stack. And all the other cost structures, we were able to make the computer as good as we make could make it, low cost, because we had that. So we took the Basic, and I had the plan to put the BASIC in ROM, because up until then, Gates was trying to sell the RAM, trying to sell the ROM.

And the reason that I knew all of this, is when I was down in Florida doing this pinball game, this young man, who was writing-- doing-- an engineer who was doing car noises for the arcade games, was sitting there taking one of Suding's machines and bringing it up. And I was there, I was working nights, he was working nights, he brings it up and plays the Star-Spangled Banner. I said, "OK, now what are going to do with it?" "I don't know, I don't care. I just want to build one." This is his response. Now that person went on to develop the PET and come up with the idea for the VIC-20 and the Commodore 64. A guy by the name of Bill Seiler. But--

Fairbairn: Bill Seiler?

Peddle: Yep. Bill Seiler. But he's local, and you should probably talk to him, he's not a good interview, but he's a great guy. He absolutely was done. He had done it. but he said, well-- because he belonged to a computer club-- and he-- they said, well you should put BASIC on. And so he went and got a stolen copy of Basic, and put it on and started playing with it. And Bill Gates remembers Bill Seiler's name, at least he did a long time ago, because Bill Gates is the only guy that ever wrote him and sent him a check, and said, "I'm using your Basic. I feel bad that people are stealing from you." And so Gates remembered that guys name and everything.

But he's the guy that did the hardware for the PET, and helped with the programming, too. But the point was, is now I saw that the kit guys were going nowhere, without having this focus on integrated Basic. So I built-- we built a really nice little screen operating system-- did you ever use the PET? And if you did, the screen-- remember you could go up the screen and go back, and call commands up, and things like that. It had a really nice little screen editor, much better than MS-DOS editors.

And I made it very human-friendly. I personally wrote the code that made the cassette work, and it really worked. And I think somewhere they've quoted me, and saying "According to everybody I know, that's the-- I had to write it with my eyes, but my eyes couldn't print it." Because we-- the teletype machine couldn't work while we were doing that, well enough, so I never documented the code for this. I literally wrote the code with an oscilloscope in my hand, because the cassette tape was hard to to. And when I

was all done, I promised I'd go back and document, but I never did. And I had three engineer programmers assigned to go document it, and they never could. So it's one of the world's best piece of undocumented code, because it worked. Anyhow, it went totally history as soon as disks came along, but it was important for a while.

But the point was, is we were designing a machine that was absolutely turnkey. Plug it in. Now, this is 1976, fall, right? OK, that's a long time back. Adam [? Osman ?] had written a book, a story, about how do you make a CRT. He'd given you a little set of kits that you could build a CRT with, and so we took his kit, and we got--

Fairbairn: A CRT for a computer?

Peddle: For anything. For anything. Just a CRT-- intelligent terminal-- anything. Here's how you make to the screen work. And so we did-- we paid attention to that. Our Japanese guys went over to the Japanese companies, and we got a flyback and a yoke, and a circuit that they gave us, and we plugged the two together, and that's how we got-- But the point was, is we were standing on the back of what was starting to happen. So, new Basic, new screen, new price point.

We went to the CES show in-- this would be '77, in Chicago. The last CES show in Chicago, during January, because it was minus 50 degrees wind chill factor. And the lake-- I remember that morning, I'm sitting up, working all night, trying to get this thing running to meet with Radio Shack the next day, and I look across the lake, and there's this ice fog. I'll always have that in my mind, it was this ice fog on the lake. And the guys at CES voted, that trip, that they were going to move the CES show to Vegas.

Fairbairn: (LAUGHING) That's kind of cold.

Peddle: (LAUGHING) Because minus 50 was not a way to get people happy. John Roach comes up, and we show him this machine, sort of working. I mean, I think we got the CRT right side up just in time, or whatever. And he and Tramiel had a discussion. Tramiel says I'll finish this for you, but in order to do that, you're going to carry my full calculator line. Now Roach was a believer in the fact that he wasn't going to carry anybody's calculator line. He could see the handwriting on the wall about the CMOS, so he told Tramiel no. So Tramiel said OK, well then you can't have my computer. So Roach went off and went to the West Coast Computer fair, you guys must have read about that, the one that was there in March, right? And by that time, we had the PET working. We had actually shown it on IEEE. One of the magazines had taken a picture of Shirley with the computer working and we had the computer working.

Fairbairn: What did PET stand for?

Peddle: You knew to ask that question. The time, which is Andre Sousan, very important guy at this point. He's helped us get this thing going. He's found out we're doing it. He's tried to get Apple in. We don't get Apple in. We'll do that story in a minute.

In Los Gatos, this guy that Christmas was selling a thing called a pet rock, and all it was was a rock and a little note in a case. And he said, that's brilliant. We're going to make a pet computer. Now, it's a funny story. This guy's French. "P-E-T" in French is a swear word. I think it means "piss" or something like that. So when we sold it in France, they had to call it "pay-eh-tay," never called it "Pet."

But it was his idea. It was a great idea. Legend is that it stands for Peddle's Ego Trip. We called it Personal Integrated--

Fairbairn: Electronic?

Peddle: No, translator or something, or integrated. Anyhow, we had to come up with a way to justify the initials.

Fairbairn: But it really started with just pet from pet rock.

Peddle: It was just pet. It was just supposed to be a pet. We kept talking about the computer is going to be warm and friendly. That was the idea. So the word "pet" really translated to that.

So if you don't mind, we'll get rid of a part of the Apple story right now because I'm sitting in Palo Alto and I've got three months-- otherwise, Tramiel fires me-- to get this thing working in time for the show. So Peter, who's my salesman, says, look. In this box, which we've created, we don't need to have the final computer. We don't need to do that. We'll just go get somebody's, and we'll will put it in, and we'll make it work, and then we get the computer designed over the next few months. So he wanted to use Apple. Sousan really wanted to get Apple into the fold.

Fairbairn: Apple 1, the design with the board?

Peddle: Well, Apple team. He thought Jobs had some good ideas on product packaging and so forth. So he said to Tramiel, I'm going to introduce you to these two guys, and we'll buy this company, and we can use an Apple 1, and we'll put an Apple 1 inside the case and modify it and it will work. Tramiel and Jobs have a meeting. Now, this is a key meeting because I want to tell you the other half of the meeting.

During the time when Tramiel, who wants to deal with Jobs by himself, and Woz doesn't have anything to do with the money. Jobs, that's your job. So Tramiel and Jobs are having this discussion on which it came out that Tramiel wasn't going to pay him what he wanted, and Woz and I have this discussion about this computer we're building. Woz told me, this is what I'm trying to do. I'm trying to build a computer which will satisfy the guys at the accelerator. What's the name of that?

Fairbairn: Slack?

Peddle: Yeah, but it's not Slack. The computer club that was there. That was one of their--

Fairbairn: Oh, they had a computer club at Slack.

Peddle: That was the big computer club that met, and that was one of the premier computer clubs in the United States. Everybody went there. And Woz was building a computer that would impress these guys, and he wanted to make it integrated because Jobs had said we should integrate, but he didn't want to put the CRT in, and they didn't.

And I said, well, what are you going to use for software? He says, I've written this program called Sweet 16. It's a nice little assemblage. I've used it. Maybe you saw it. Nice little assemblage for the 6502. And he says, that's all they need. These guys only want that. And I said, but Woz, we're selling a BASIC product, only computer that's basic. He didn't get it. He said I was wrong, walked out of there to go off to do Sweet 16, and the original computers did not have Microsoft BASIC built in, period. The original machine for several months were being sold as the Sweet 16 machine from Woz.

So to say that Woz invented the personal computer is just not possible. He just couldn't have because he didn't even yet what people are going to buy. People are going to buy a machine that worked like the PET because we'd taken all this time to do all the research and we knew that it would sell. So he didn't invent it. He didn't have the machine.

He says that I learned something from him. I didn't learn anything from him. I need to learn anything from him because we went out and bought another little board from somebody, and then we went back and designed the board from scratch up. Oh, by the way, I probably had the ability to do my own 6502 board at that time, and I also had some good engineers working for me, so we didn't need anything Woz had told us.

And in fact, the original Apple 2 had a major design flaw in it pointed out by EE Times, and they had to redesign it, and then there was another problem that they had to fix. And it wasn't until after [INAUDIBLE] took a look at what was going on that he said, we've got to go buy Microsoft Basic, and they did put it in.

And so the machines that they sold in volume were like the PET because it ran this Basic, which we'd given to Microsoft. I'd given-- bought from-- but we'd basically given them the specs. And everybody took the same. That was the idea with Microsoft, they should try to make it standard.

RadioShack, same thing. RadioShack, same issue. John Roach, said I'm going to go build this. He went to some guys that liked the C-80. They put the C-80 in. The problem was when they were doing the ROM, they said, we don't have enough space to put BASIC in, another Basic, so they put Tiny BASIC in. Did you ever hear about Tiny Basic?

Fairbairn: Yeah.

Peddle: Yeah, Tiny Basic. They put it in. It was built into the original Atari machines. Not Atari. RadioShack machines. And we kicked their ass again. It was not as good as-- priced a little more, but it wasn't as good as. And so Roach goes down to Gates, tells Gates, I don't want to pay you a bunch of money for this. I want to give you a royalty per machine. And Gates said no. I need the money. So he takes the money upfront. That was the last time that Microsoft didn't take a royalty.

I'll just finish part of that story. A guy by the name of [INAUDIBLE] Ishii, who wrote a magazine. [INAUDIBLE] was, like, 19, who invented this computer magazine in Japan. And he originally built it around the PET, but other things.

And he got really tight with Gates and he said, “listen, we're going to take your Basic, and we're going to build a machine around the Basic. We're going to bring it in at much cheaper than the PET and much cheaper than these other guys, and we're going to kick everybody's butt.” Gates had a deal with all these Japanese companies that they would pay him royalties.

The problem was they delivered that product into the United States head on to the C-64. It was more expensive, it didn't have anywhere near the visibility of the C-64, it didn't have the programs of the C-64, and it died. And [INAUDIBLE] and Microsoft--

Fairbairn: We're getting a little ahead.

Peddle: No, I'm just trying to show that the BASIC was absolutely the essential behind all of this. It was the tie that did all that. One last part of the story, and then we'll come back to it. By the time IBM is coming out with the PC, you have to have Gates BASIC built in. Nobody is building PCs without Gates. Everybody's got it.

So they go to Gates to buy the Basic, tell him that Kildall won't sign a contract, and Gates said, I'll do to the operating system. That's how he got DOS. Kildall chased IBM out of his shop. We can do that part of the story later if you want, but fundamentally, because I know the guys that were in the room. They work for me.

But the point is that BASIC was the reason that IBM was up to talk to Gates because he had to have his BASIC. BASIC became the driving force. We'll just finish BASIC and I promise we won't come back to it again. Since then, Gates has done this Advanced Basic.

I don't know if you realize it. I don't know if maybe the computer [INAUDIBLE] knows it, but there's a lot of people writing code in that Advanced BASIC for business applications still today, a lot of people writing in it rather than writing in C, a lot of applications. And Gates has made the statement and I've made the statement that we can write any program in BASIC and beat C every time, and we have some good reasons for that.

BASIC was essential to the creation of the personal computer, and it's a good thing to use from now on. I've done some great programs in BASIC and so has everybody else. It was the integration function, and Bill doesn't get a lot of credit for being a visionary because he didn't see these things coming, but he did it and he made it happen. And then, of course, he did have the vision about MS DOS and did it. Let's go back to the original personal computer now.

Fairbairn: So we were on the PET, basically.

Peddle: I'm trying to explain. So BASIC was one of the keys. We then made a small mistake on the original PET, but it was a legitimate marketing mistake. Tramiel didn't have the money to tool a nice looking case, just didn't have it. He had a factory in Toronto that made file cabinets. So if you look at the original PET, it's made of these guys who make file cabinets banging it out of metal. He calls these guys down here and says, this is what Chuck wants it to look like. You make it look as close as you can, but he has to make it out of the metal because he could afford to tool it.

Fairbairn: Just sheet metal.

Peddle: Yeah. He couldn't afford to tool it. So now we're showing him a typewriter keyboard because we say all computers need a typewriter keyboard because we had all grown up with them like that. And Tramiel says to me, I want to tell you a story. He says, I was making calculators with the 10 key adding machines, whatever that number is. Everybody had to have one. So he said, I did all my calculators with 10 key because they know they needed them.

HP comes out with this crummy little thing with 25 million keys on it as a scientific calculator and kicks everybody out of the business. You couldn't make a calculator without enough keys, period, end of discussion. He says, how do you know that computer guys don't want that keyboard versus the touch type keyboard?

And I couldn't answer him. I said, I don't know. We can find out, and we put it in. So the original PET, if you look at it, has all these great keys, and you can draw pictures with it and everything else because we put this character graphics in.

Another thing to prove that we were there first. If you look at the ASCII character set today and look at the second half of the ASCII character set, you'll still see diamonds, clubs. All were put in there for the PET so we could do character graphics. We redefined the entire second ASCII character set, and over time, people have been eating it away. And the keys were such that you could draw directly on the screen.

It was a good idea. My stepson, when I went to the other keyboard, said, what the fuck did you do that for? I was having much more trouble. And of course, nowadays, all kids use the text and everything else. But at that time, we got a universal rejection to the small keyboard, so we put the big keyboard in and then kept making it better.

Now we've learned the lesson. So the big 20 and the Commodore 64 were a keyboard with a computer inside because we knew now people wanted the touch type keyboard. And it wasn't until the phone guys changed everybody's mind that that was true. All the computers for 20 years had touch type keyboards, and most laptops still have it. I'm just trying to give you some of the history of the decisions that were made and why they were made. They were all economic.

We finally got the machine working. We've got some demo machines. We've got the software running, sort of. Software's never really perfect, but it was running good enough. And we're ready to launch the product.

Diamond: What year is this?

Peddle: '77, right? Yeah, '77. And there was a big computer show in Dallas. It was almost the end of the big computer shows. Remember all the computer guys would get together once a year. I can't remember the name of it, but I think they'd do one on the east coast and one on the west coast.

And these guys got smart because now computer shops were starting to happen and everything, so they took the basement and they turned it into what they called a computer boutique, and you could buy space in that to do personal computers. So we took the entry place, walked down, put our five demo machines

up. My wife's standing there with her notepads and receipt book, and we told people, because this is what Tramiel said to me.

He says, I want my computer to be like HP. I kept thinking, you know, Jack, do you really mean I put an HP interface over it? He says, no, I don't that. He says, when HP first started selling calculators, you had to pay them in advance for 90 days. And he needed the cash to start the business. So he said, we're going to do that.

So my wife is sitting there saying, OK, here's a register. We're taking the checks in order. We'll write your name down. You give us the money now. We'll ship to you in 90 days or give you your money back. We didn't always ship in 90 days and we never turned back a penny because everybody wanted to--

Fairbairn: [INAUDIBLE] machine.

Peddle: But that boutique we took over. People are standing there handing checks to the front, complaining that the check wasn't getting there in time. Hey, I was the one that was going to be next. So for the rest of the two days of the show, we're the only show in town. People are giving us money.

And I walked upstairs almost at the end of the show to see what was going on with the big computer guys. There wasn't anybody on any of the floors up there. Everybody had left the floors and were downstairs buying computers. It was the end of the big computer time, and it's kind of fun to have lived through that. We had absolutely wiped them out. We didn't physically wipe them out, but we had actually got the customer interest.

So we started delivering computers, and we had a couple small incidents about the [INAUDIBLE] time. This guy flies in one day. He says, I'm a major stock analyst, and I think you guys are cheating us. We think you overrated what you're doing. He had a whole bunch of things we hadn't done. And we listened to him for a little bit, and we said, isn't your problem that you're too far down the chain? Do you want us to give you a computer early? And the answer was yes.

We have a computer show in Palo Alto early that next year, and I make all my engineers always go to the first show so they can see the joy that people have in their new products. And I make them go after people have bought some, and they have to handle the customer complaints because I tell them, I want you to understand what people are going to complain about.

So we're at this show, and this woman comes up and says, you've got to help me. I said, well, we'd like to help you. What can we do? She says, you've got to sell me my next computer out of sequence. And I

said, well, we really can't do that. It's kind of against the law because we've taken the money and everything else.

She says, you've got to do this. We have one computer at home. There's four of us using it. We drew to see the time that we get to use the computer, and I'm the housewife, but my time is from 2 o'clock in the morning until 6 o'clock. She says, I have permission to buy another one so I don't have to get up those times to use the computer.

One reason I'm telling you these little stories is they show what happened. Everybody suddenly decided they wanted a computer. We went from, why do I want a computer, to a whole bunch of people who had bought machines before or who now saw people using the machines. They put them in schools and everything. It literally was an explosion. We couldn't keep up with it. Nobody could keep up with it.

Fairbairn: Now, was there any application software? It had Basic, but there was no word processor, no anything?

Peddle: No. People wrote software later, like the chess program they wrote early, relatively. So there was a bunch of programs that came out. Remember, the first market was from people who just wanted a computer.

Diamond: You mean they wanted to write Basic.

Peddle: They were going to write in BASIC because they knew how to do that.

Fairbairn: They were willing to write in Basic.

Peddle: And we made it so that any kid plugging in the machine could use the video and make their own the lunar lander in five minutes. What I was doing was creating computer literacy. The market thought they were buying Basic. I was trying to get everybody computer literate because I knew that they would keep buying computers if they were computer.

I used to give a lecture where I would compare computing to sex. Everybody thought I was crazy. I pointed out to people, I said, I think that once you're computer literate and you've used a computer, you will come back to it, and it's true. And then people would laugh a little bit. I'd say, OK, you guys. You're all out there. How many of you guys-- because they're early 30s-- how many of you guys have stayed up all night having sex versus how many of you guys have stayed up all night working on a computer or playing a video game? Of course, the answer was they were too old to be staying up all night anymore.

Fairbairn: They were playing computer games.

Peddle: They were playing computers or playing computer games because it was that way. It was something you wanted to do, and because you wanted to do it, we kept building more of them and selling more of them. And ultimately, I think maybe a genealogy fits here. We'll talk about Apple in a minute and I went to Apple because that's when the Lisa happened and when Windows happened, things like that. I like to do the linearity.

We knew that we started out with a $500 computer, but we wanted a $100 computer. So the VIC-20 was a $100 computer and there were some peripherals to it. The C-64, which was a perfect computer-- it was big enough on the screen, you could write programs in it. Oh, by the way, a lot of video games have been written for it during that time.

We designed it-- remember the thing about design for the price?-- we designed that product so it could be sold for $100. Now everybody says, why would you make a computer that sells for $100? And the answer is it's called a razor blade. Remember the razor blade idea?

Everybody who bought a computer was going to buy a disk drive, but we had a proprietary interface, so you had to buy the floppy disk from us, and it was $200 or $300, and the printer was $400, and nobody ever complained. Nobody ever complained. They just walked out of the store and bought the disk.

So it was a $100 computer, but we sucked you in for $800, and it worked. They sold millions of them per month. I would go in stores with K-Mart and talk to kids that never knew the machine, and they would sit and show me about BASIC and everything. So they were becoming computer literate, but more importantly, we made Commodore a $1 billion company because of that.

Fairbairn: So things were exploding, but things blew up also with you and Commodore.

Peddle: So now, if you don't mind, I'll go back to that period. So we got the PET done, and I had just finished the first printer for personal computers. If you don't mind, I'm going to tell you a little story that goes along with that. There's an official interface that every printer had to go through. It wasn't Printronix.

Diamond: Centronics.

Peddle: Centronics. That was it. It to be the Centronic interface if you wanted to have an interface, and the guy at Centronics was on top of the world. And I went to him and said, look, nobody's going to pay

$2,000 for this computer. You have your nice, fast one. Help me build a product that will sell for $100 to $150.

Fairbairn: A printer?

Peddle: Yeah. And we'll sell millions of them. He says, I don't have to. I'm Centronics. People will come to me. And I said, let me just tell you what you said today. I'm going to go out and do a $200 computer with somebody in Japan--

Fairbairn: $200 printer.

Peddle: $200 printer, and I'll do it with somebody in Japan, and you're going to be out of the business, and of course, we did. We did it with Epson, and then Epson just ate him.

Diamond: They become the company that's in the personal computer printer business for years.

Peddle: Yeah, but I'm just saying they did it because this guy wouldn't. And I sat down, I did the design. The guy who did the other part of it was the guy who invented the Seiko watch.

Fairbairn: This is a dot matrix printer, right?

Peddle: Yeah. It was a dot matrix printer designed for better calculators, and he expanded it. We did it together, and then I discovered how untrustworthy the Japanese were because he had made commitments to me that they just didn't keep, but it's OK. The point was that I'd just finished that, and Tramiel was deciding he wanted to replace me in the company. He had taken me out of being in charge of the computer and put my buddy in and another guy in, and he decided he wanted to replace me, and I knew that.

And so first Jobs and then Mike Scott, who was the president of Apple, came to me and said, look, we know you want to do a another generation machine. These are out of gas. We want you to come over and do that machine for Apple. They gave me the fifth or sixth biggest stock position in Apple. I mean, there made me a really good deal.

Fairbairn: What year was this, then?

Peddle: '78. I walked in and told Tramiel, I'm leaving, and he's just totally pissed, and I go over and do it. I get there and discover that Scott had been trying to get the head of engineering at HP to join at the same time, and so we both wound up there at the same time. And for a period of time, I was the guy working on the new machine. This other guy was taking over engineering, and I was working with Steve Jobs, and we were trying to define what should be in the Lisa.

And all of the guys that came over from HP wanted to make a $10,000 computer, and I kept telling everybody, you don't want to make a $10,000 computer. But Jeff Raskin, who wrote the original Apple manual-- which, by the way, you give me credit for writing a good manual on the 6502, but Raskin wrote an unbelievably good manual for the Apple. I don't know if you've ever read one of the original Apple ones, but it's really beautifully written.

Diamond: You're talking about the Apple Macintosh?

Peddle: No, the Apple 2. He was an independent guy. If you want to look at history, we can show you that Raskin said some great things about the PET when we first did before the Apple had come out, but he went to Apple and he wrote this beautiful manual for them. And he was part of that group with Park. Did you know Jeff Raskin?

Fairbairn: Yeah. I mean, I knew of him.

Peddle: He's the one that took Jobs to [Xerox] PARC, and the guys at PAEC showed him what you'd done with the mouse and the screen, and Steve came back and said, I'm going to steal it. He said, I think they encouraged me to steal it. I'm going to steal it because I want Lisa to have that interface because I think that interface is going to be important for computing.

And Jobs was exactly right, and PARC was exactly right, but they never made it happen in the business. Apple made it happen, and Gates had to follow them finally after a long, hard fought battle. He was fighting it because IBM didn't want it. IBM did not want Windows.

Fairbairn: So how long did you stay at Apple?

Peddle: A very short time at Apple. Basically, I--

Fairbairn: Months, year?

Peddle: Probably three or four months, no more.

Fairbairn: Very short.

Peddle: A very short time. It just wasn't working for me. Steve and I had kind of put together a program, and I just told him. I said, a $10,000 computer is not your market. And so they said, well, define a market you think, and I defined what they should do for an Apple 3, and then I left and went back to Commodore with the understanding I would go back to do this program. We'll calculate it with Mensch. And then the guys I had hired to do the original disk for Commodore had been misled on what a disk should do by the guy who was running engineering, so I took the engineering back over.

If you don't mind, I'd like to take half a minute and go back and tell you how we built the team for Commodore, because we wanted a path to BASIC and all that thing, but let's go back. I knew this guy in Florida that had done this machine, and I said to him, look, get in your little car-- he had a little Honda-- and drive out here and we'll do it. And my buddy, Roger Camp, I told you in the previous was in Iowa State University. I called him and said, I need a programmer.

He says, I've got the perfect guy for you. He doesn't know it. He has no idea. He's taken a job with IBM. He's going to just get lost at IBM. I think he's the right guy for you. So he sent him out and we kidnapped him, literally kidnapped him. His name is John Feagans, and he wrote all the software for all the Commodore products. It was exactly the right match. He was an introvert. Programmers often are.

Fairbairn: Was he writing operating system stuff or application stuff?

Peddle: Everything inside that I didn't write. The true operating system, he did the kernels. He did all that stuff that carried all the way through. I did the screen interfaces and then he did the rest of it. And the point was I kidnapped him.

So the next year, I need some more guys, and he takes these two kids and sends them out to do the floppy because we needed the floppy. I had gone, come back, and discovered that the floppy was like a tape. It was just [INAUDIBLE], so I redesigned it and we made the floppy. And Tramiel--

Diamond: Did you use a floppy controller chip with yours, or did you--

Peddle: No. 6502.

Diamond: You used the 6502?

Peddle: Of course. The architecture with the IEEE implies a computer on the other end. And tell me what the 6502 can't do to drive a disk. Now, floppies are pretty straightforward, right?

Fairbairn: Well, and the chips were expensive. They cost more than the $60.

Peddle: Oh, much more. But more importantly, why do I need it, right? Basically, we had to do a circuit that decoded the signals on and off, but people were actually starting to sell those-- right?-- by that time. And we signed up with Shugart with--

Fairbairn: Al Shugart?

Peddle: No, the other one. The guy who really start-- Finis.

Fairbairn: Oh yeah, Conner.

Peddle: Finis was at Xerox. Shugart Technology-- remember, they'd thrown Al out. And Al was running a bar in-- which I really didn't understand. I told him that story the other day. He was running a bar in Phoenix-- in Santa Cruz. And Finis came up with the idea for the hard drive, and went and got Al, and they made Seagate. Right?

Fairbairn: [CHUCKLES]

Peddle: And took Tom Mitchell, who was a really good production guy from Commodore who'd turned Commodore's production around. And the three of them started Seagate, and made it a very nice company. But Finis had said, I'm going to sell you computer guys all of the product that doesn't quite meet the spec for the guys doing-- remember? Word processing was high-end and the guys buying it were high-end. And all that stuff. So he had a whole bunch of fall-out parts. And he said, I'll sell them to you guys.

So Apple and we signed up almost the same time. Woz had done a really nice--

Fairbairn: Controller, right?

Peddle: No, a controller, but a special version of the controller. It's a way of making it dense, more dense.

Diamond: [INAUDIBLE].

Peddle: He what? He'd reinvented the logic that lets you encrypt the data on the drive. I can't remember-- I know the name of it. Right?

Diamond: You're talking about the IWN. Yeah, that thing-- in that thing,

Fairbairn: But within that--

Peddle: There's an architecture that was invented--

Fairbairn: Doubled the density of recording on the disk?

Peddle: No, it wasn't doubling the density, but was a better density. And Woz was making it.

Diamond: It was non-standard. Oh no, of course not. Of course.

[LAUGHS]

I think we probably had six fellows doing it, too. I suspect, right? He's got a controller, right? And he's doing this. And he was doing a single drive, because he wanted something that would load his programs faster. I, being a computer jock, knew that you had to have two drives. So I took longer to develop my two-drive machine, and Woz beat me to market.

Jack Tramiel almost never forgave me. Right? Because we sold a lot more of our disks, and almost everybody bought the disk, because it made sense. But I'm saying our double disk made the CBM, which is the second version of the patent, which is more memory, better screen, all that stuff. It'd sell in Europe really well, because it was a dual-- you know, you could really do something with two drives that you can't do with one. Right?

But these two kids did it, and they really made it work. Right? And then we stole a couple more kids from Iowa State, and they carried on the business after we all left and went to start our own company. But the point was is I had a small group, really small group, young guys, literally all college graduates-- except Syed was a little bit older, but fundamentally.

And the reason we did that is because-- and I worked with experienced Japanese guys, because we were sourcing the product out of Japan. And the Japanese helped me a lot with flybacks and yokes and all that stuff-- is because we were doing something new. And we didn't want to have to deal with people that

knew you shouldn't do those things. Right? And these guys didn't know what they couldn't-- didn't know what they shouldn't do, so they did it the right way. And it really worked for us.

And so it was a young man's machine, designed for younger people. But it really worked. And, of course, the C64 and VIC-20 was sold to kids, but a lot of older people used them too. Right? Because they were video games machines then.

Fairbairn: So at some point, things ran out again at Commodore and you moved on.

Peddle: No, OK. So now we've got Commodore up, running. We do the CBM machines. We're doing very well. But the Europeans know that the market for Europe was not the thing. The patent was in the United States. And the C64 was coming, and the VIC-20, and that would sell into the consumer market. But they wanted a better machine, because most of the people-- were computer dealers in Europe, were guys from computer-- been XLIS guys. And almost--

Fairbairn: So you're looking for business-oriented things.

Peddle: They wanted a better machine. Right? And so all of our marketing guys said, let's do a better machine. And we said, oh, we know how to do a better machine, right? But we're gonna have to change processors. Right? And we're going to have to change everything, because the better machine is not this machine that we've been working. And this machine is actually getting a little long in the tooth, once we did C64 [INAUDIBLE].

We want a new machine. And Tramiel basically said, we've got one company. And one company's going to do the home machine, the C64 and the VIC-20. And you guys can't do it. And he literally shut my lab down and told me I had to move and do a whole bunch of other stuff. And we said, no, thank you very much. We're gonna go do our own machine. And we did the first MS-DOS machine.

We literally-- we went to Intel. And the reason we went to Intel-- and if you haven't talked to David you should talk to him. He's a really good--

Fairbairn: Right.

Peddle: Have you done him?

Fairbairn: Yeah. We got him on two or three different subjects.

Peddle: But he told you that he's the one that dreamed the 8088 idea. If he didn't, he should have.

Fairbairn: I think he did.

Peddle: Yeah, there's no question he did. And his reasoning was the same reason all of us bought it-- it's because memory was too expensive. You didn't want a 16-bit wide memory bus, because didn't want that much memory. He was right. Great product-- you know, it wasn't a great product, but it was a good enough product-- and Motorola didn't do one.

Fairbairn: Right.

Peddle: OK? Motorola didn't see it, still. [CHUCKLES] I mean, they never got to work. And so we signed up with David Allen, and he committed that we'd get it second source. IBM signed up. We went up to see Gates. And we had already signed a deal with CPM.

We went to see Gates, and he says, I've got this MS-DOS thing, and we said, OK, sure. We're happy to do that. We're gonna get your BASIC. And we knew he was doing applications, which we knew was going to be important-- the word processing, even though we were doing-- because of CPM, we were able to pick up Wordstar and all that stuff.

But what Gates was working on was important. And I don't know if you know it, but Gates set out to do-- he didn't set out to do MS-DOS. He set out to do applications. That's why he opened the group up there. And he gave Marquardt a job-- let Marquardt [Dave Marquardt] invest, because he got the word guy out of Xerox. You knew Mr.--

Fairbairn: Yeah, Charles Simonyi.

Peddle: Word guy, right?

Fairbairn: Charles Simonyi, yeah.

Peddle: Who made Word happen.

Fairbairn: Yeah, he had written-- it was called Bravo at Xerox. And he basically reimplemented-- I mean, you look at Word, you look at Bravo, you think, oh, same purpose.

Peddle: No, Gates wanted him desperately. And so he told Marquardt that if you can get him to come to work for me, I'll let you invest. And so Marquardt is the only venture capitalist that ever got to invest in Microsoft.

Fairbairn: Marquardt, Dave Marquardt.

Peddle: Dave Marquardt, yeah. Did you ever talk to Marquardt? He's been--

Fairbairn: He's on our list. We haven't actually done--

Peddle: Yeah, you should, because-- OK, now we're getting ready to start Victor. And we talk to Marquardt and a couple other guys. And Marquardt says, I'll sponsor you. But we were looking for a US distribution. We knew how to sell in Europe, because we'd been selling there. But Commodore hadn't done very well in the United States. And we didn't have any pick up there.

And I had been approached by Victor Calculator Company to do a machine for them. So they did the investment instead of Marquardt, which is the stupidest thing I ever did, because it ultimately cost me the company. Guys like Marquardt don't let happen to them what these guys did to me.

But that's why in the United States, it was called Victor. And in Europe, it was called a Sirius. And then we lost the name Sirius to a local company here who had the name. So we just bought Victor by then, and so we just changed it to Victor 1000. So we sold Victor worldwide.

But the purpose-- I put together a team from the guys I had-- plus, I'd had a development team down in Phoenix, and I brought them all in. And we were working on hard disk at that time for the Commodore. But it was too early. Remember, you said about don't be too early. Hard disks-- see, Gates had started, but they really weren't there. Nobody was there.

So what we did is I brought these guys in. And we set out to do as good a machine as we could. So we made a really good screen. We put a Codec in, so that you could do voice and sound stuff. We put in these-- our floppies were-- I got a deal with Jugi Tandon, that he would make this double-sided, special floppy for me. And then we'd put our own electronics on it.

So the IBM was 300K, and mine was one megabyte. And so we had two megabytes in, and that was a really serious machine. And we got it packaged nicely-- actually, the kid that packaged it for me walked in our door right after we started the company. And he says, I am not going to drive the hill again. Can you please get me a job doing drafting?

It turns out he's got a great design company. He's designed all kinds of stuff for the Japanese. He was just a really good industrial designer. And so we had this really nice-looking package with the screens built, because we were really good at that at that time. And we won computer of the year over the PC.

And we outsold the PC, according to Gates during that time, because we had a better product. It was demonstrably better and user-better. And then they redesigned it for the XT. That's right, that's what they did, is they redesigned the PC to the XT. And the XT was a hard drive machine.

Diamond: Horsepower and--

Peddle: Right, hard drive machine.

Fairbairn: Yeah, had the 80286 in it, I think?

Peddle: No, no. Not yet. It was 8086, then. May have been an 8086, though--

Diamond: 8088.

Peddle: Maybe, I think it was still 8088. Yeah, the reason for the 88 was because memory prices--remember, memory prices have done some wonderful things since the Japanese really got control of it. But in 1980, 1981, memory prices were still high. ROM prices had come down. Right?

Fairbairn: Yeah, ROMs were cheap.

Peddle: We'd bid on ROMs, right? But RAMs were not down, cheap. And it wasn't until a lot later. Basically, it wasn't until everybody got over capacity the price became more reasonable, right?

Diamond: They also wanted to make the bus.

Peddle: Because of that. The memory bus, right?

Diamond: The IO bus.

Peddle: Oh, well, yeah. I was using memory. I was using memory in I/O. I don't use the I/O instructions ever, right? Because they're in the way. You can do everything with your I/O devices in the device itself. So our 8088 never used the I/O instructions.

Fairbairn: So this was an IBM compatible machine? Or not?

Peddle: No, the definition-- no, MS-DOS compatible.

Fairbairn: MS-DOS.

Peddle: We were ahead of them. We had-- everything was better. The Codecs, everything was better than the IBM. And that's why we were out-selling them. We got picked by Ford Motor Company as the right company, and everything else.

No, Ben Rosen created the concept, when he came up with the idea for compact, to be a full compatible. And he got some consultants that said, if it's not 100% IBM compatible, it's not worth buying. And he sold-- that's Ben Rosen. It was Ben Rosen, a couple of consultants, this woman in Texas and everything. But it was really them.

And Compaq came out with a machine that was 100% compatible, and we were trying to sell the Victor into that market, and people stopped buying it. The guy at General Motors said, I'll buy your machine. It's a better machine. Make it 100% IBM compatible, and I'll buy it in a heartbeat. But I'm not going to take a risk and not buy an IBM compatible. Because he'd established that Compaq was doing IBM compatible. A couple other guys were doing IBM compatibles. Yeah, and we lost that company as a result of that.

Fairbairn: And did you not want to do the IBM compatible, or--?

Peddle: I wanted to do the IBM compatible. I can tell this story, because it's true. I had actually commissioned my development team-- I had set up a small development team down in San Louis Obispo. And I'd commissioned them to get me a DOS-- a BIOS-- that I could use.

And my engineering manager thought I was wrong. And so he overrode my instructions, and neither one of them ever told me. So I went to go get the-- but if I'd done something smart, I'd have just taken Jugi Tandon, who had licensed the BIOS, because he had a trade with IBM. IBM wanted his disk drive technology. He had a right to the BIOS, and he wrote a BIOS. And we could have done it-- which, by the way, is what we did with our second company. We actually used Jugi's company to--

Fairbairn: Which was Tandon.

Peddle: Tandon, we went, and we created Tandon-- went into that market.

Fairbairn: So Victor eventually died, because of--

Peddle: Victor-- we did about seven things wrong, wound up with a bankruptcy lawyer who decided that even though we had a deal to satisfy all our creditors, that they didn't make enough money unless they put us in bankruptcy. So the day we were voting on the deal for the creditors, he put us in bankruptcy. And I discovered that bankruptcy lawyers-- if you have a bankruptcy lawyer and form a committee, you're guaranteed to be in bankruptcy, and you're guaranteed to lose control of the company.

Fairbairn: Because that's what they do.

Peddle: That's how they make money!

Fairbairn: Right.

Peddle: Because remember, what his job is-- he's the focal point for every creditor. Every creditor has to have a lawyer. So the minute he gets him into bankruptcy, he's created jobs for 200 law firms. And they all do this. They all trade it back and forth. They're absolutely sharks, right? They don't care. It doesn't matter how good an idea it is, anything else. They want you in bankruptcy.

Tandon got into financial trouble, big financial trouble, because of the IBMs they brought in. And I was called in, and I told them-- I said two things. The board of directors has to take a year off. Go away. OK? Because I don't want you voting on anything that could get us in trouble. And I said if a bankruptcy lawyer shows up, I'm going to kill him and bury him so that the other guys don't know he showed up. OK? [LAUGHS]

And what I did is I went around to every creditor, and said, if you'll sign a document you won't bug me, I'll give you 10% of what we owe you. And they all took it, because none of them ever made 10% off the Victor bankruptcy.

You know, 10% up front and a chance to keep doing business was dramatically better. And it worked. Because our sales were taking off in Europe, we paid them off in six months. But during that period, we could have gone bankrupt if we'd let somebody around us.

Fairbairn: And Tandon's business was pure IBM compatible machines. Is that right?

Peddle: Oh, yeah, totally. But remember, Tandon was the original. I think this is a funny little story, but we need to get it on tape. Al Shugart and Finis Conner sold the concept of the floppy to Commodore. So Tom Mitchell went over and told Shugart, I'll buy all of them. And Steve Jobs went over to Shugart and said, I'll buy them all. So they gave him 50-50 allocation.

And RadioShack said, well, I gotta have floppy. And they said, but we don't have any. Right? And so he went to Jugi Tandon, who had invented the double sided floppy, and had worked-- he actually did the first floppy disk when he was working at IBM for Al Shugart. He actually put the first coating on and got that part working, and then he invented the double-sided floppy.

And his brother had made it in India, and so he was making heads. Right? But he wasn't making a ton of money at it. And the guy from RadioShack said, I'll pay for you to go in the floppy disk business, if you'll sell me the floppy disk exclusively at the beginning. And he did. [INAUDIBLE] until it was up in production.

And so when IBM was looking for a floppy disk supplier, they couldn't buy from Shugart, because that was a Xerox company. And if you recall, that was a real war then, right? So they went down to Jugi, and Jugi said, of course I can supply to you. Right? And he started another factory up in-- because his brother had a big IBM factory in India.

And he could make the floppies for-- so he wanted to be an exclusive floppy supplier to IBM. And so he was an exclusive floppy disk supplier, and he was also my exclusive floppy-- so he was selling all the disks of the two top-selling MS-DOS machines. Took his company public, made a lot of money.

Diamond: What year was this?

Peddle: So '82, '83? Yeah, '82, '83. I think Jugi went public in about '83. And that was when they started getting hot, right? The computer started getting hot right about then. Right? And--

Diamond: And you were using their BIOS?

Peddle: No, no, no, no. I was using their disk. Jugi was making a special disk for me at Victor.

Diamond: OK.

Peddle: And IBM-- he wasn't using IBM's BIOS either, right? He was just making the disk for IBM. He, then, did a BIOS and sold a BIOS to RadioShack to do an IBM-compatible machine for RadioShack later.

Diamond: So they licensed the BIOS [INAUDIBLE]?

Peddle: Well, IBM decided that Tandon's quality sucked. So what they did is they told Tandon, we'll only keep doing business with you if you cross-license us on the floppy so we can make it ourselves. And they ultimately took all business away. Tandon, ultimately, had to write off $150 million worth of inventory, because they couldn't meet the quality standards for IBM.

Fairbairn: And Tandon had the license to the--

Peddle: It was their disk.

Fairbairn: No, to the BIOS. You said they--

Peddle: No, they had done their own BIOS, and IBM gave them a cross on their BIOS, which is one of the few cross licenses. Ultimately, the people in Taiwan-- Taiwan government paid the BIOS that you see nowadays, today. They did an independent development of their BIOS, and IBM let them get away with it. But no, no. Tandon had a right to it, because of this thing he'd done with the cross licensing IBM, who insisted that they get cross licensed if they were gonna keep selling disks.

So he was cross-licensed with-- so I could have bought the BIOS from him. He and I could've done a deal. I just was stupid and didn't get it done in time, before I got aced out. One of the first things these bankruptcy lawyers do is get you fired if you're a CEO, because they don't want you around, because you might save the company.

Fairbairn: [CHUCKLES]

Peddle: Anyhow, Victor won computer of the year, was outselling IBM. But the most important thing we did at Victor-- if you don't mind. Am I taking too long?

Fairbairn: No, you're fine. You've got another hour.

Peddle: OK. I started the company-- the MS-DOS company-- with the dual floppy. Right? Better floppy, everything else. But I had already been developing the hard drive in Phoenix. And we brought it up, and

we were playing with the hard drives. And when I got Jugi to agree to do my double sided floppy, he says I've got a simple deal for you. I'll do the floppy if you'll agree you'll buy your hard disk from me.

And the reason he did it was totally political. We were right next door to Seagate, and he wanted-- he and Shugart had never really liked one another. So he was doing it in the face-- you know, we were the most important-- selling more product, and everything else. And we bought from him.

But Jugi was a good partner at that time his life, because what he and I did-- we sat down. We had the computer ready. We had the drive ready, and we had the controller ready. We sat down, and he and I agreed on a price that was well below market. Right? And the reason for doing that is that both of us believed that if you get the price down low enough, you'll sell a lot more. And he was a strong believer in that, and still is a big believer in that. We follow that.

Diamond: Fool with pricing.

Peddle: What? Eh, it's not just fooling with pricing. Create the market by having a price that people think is a price they can afford. Right? And I think it was $2,500 at that point. But it was still, comparatively-- at the time, it was a great price. And so now, I go to Gates. I'm the MS-DOS customer for Gates. I sign a contract with Gates before we introduce a product for Victor. You know, we're buying the product, paying him money. He's happy with me.

And I met with him at this show in Southern California, because we wanted to introduce the product at COMDEX, which is just coming on stream at that time. And I said-- he and I actually had a meeting outside Disneyland-- on the island outside Disneyland, because I'm telling him I've got to have this DOS.

And he's saying, I don't have the resources to do it. And I say, well, I've got the resources to do it. If I do it, will you put it on for me. He said, yeah. So we did. And so we were able to launch at the COMDEX show-- we're able to put five of these computers with hard drives on them.

Fairbairn: Oh, he didn't have the software to do that--

Peddle: He didn't have the software to the hard drive. It's a different software than the floppy. Right? And he just didn't have the resources to do it. And he didn't see that it was that important right then. He later on found how important it was, but-- [CHUCKLES]. Nobody believed it was important. Right? Seriously.

Fairbairn: Did you then give your software back to him?

Peddle: Of course, that was the deal. He would just put it on for us, and then it was his. That was a fair deal, as far as I was concerned. I had to have it, and we had a deal with him, and we were doing fine. I mean, both of us were doing fine. It was a friendly deal.

But the same guys I had gotten from were still the same guys doing that. Right? So I had one team that really knew how to do it. And so we went to that show-- the CS show--

Fairbairn: COMDEX.

Peddle: COMDEX, I'm sorry. And we announced that we had a machine-- well, I think it was five megabytes. It may have been 10 megabytes, but I think it may have been five.

Diamond: It started about five.

Peddle: Yeah, probably, I think it was five. It was really small. Both of them were small.

Diamond: [INAUDIBLE].

Peddle: And so the guys -- the editors said to me, well, you've already got two megabytes. Right? Why do you need five megabytes? Who needs five megabytes? [LAUGHS]

You guys laugh now, but you recall that was the kind of conversation that was going back in those days, right? And my comment to them was, I set five machines up there for only press people. 10 minutes, 20 minutes with the machine-- you go use it, come back, and ask me again. And every one of them walked back and said, I have to have our disk machine.

And to the point that-- nobody today would even think about having a floppy machine. You had to have that, because it felt better. Right? Everything about it was better. And so we just got to be heroes. We got to go public, the whole thing about it. Right? Then IBM came back with the XT, and we screwed up. But the point was that it was no question that we got the press, for the first time, to believe that you need to have a hard disk. Because the first time, they played with it. Right?

I mean, the Cromemcos and those guys-- the people that were the guys doing CPM-- they had big, hard disks, and they were doing all that sort of stuff. But it wasn't part of the operating system. It wasn't integrated, if you recall. Right? CPM wasn't that integrated anyhow, for the IO. Right? It wasn't designed around that, whereas our system was really designed around making the disk system fast.

Fairbairn: So Victor, and then you went on to Tandon.

Peddle: So Victor had vanished. But Tandon had now done it. Just for the record, IBM used a company other than Tandon, because they told Tandon we can't buy from you, because we're buying floppies from you. And they can't buy from whoever else was doing-- Seagate, for some reason. They didn't buy from Seagate at the time.

And they bought from a company that went out of business, and they almost took the XT down. You remember that period? There was a period of time for about three months that the hard disks were all failing in XTs.

Fairbairn: Hm, I don't remember that.

Peddle: If you go back in history, you'll see it was there. And they went to Seagate, and Seagate saved them. And Tandon did fine. And we lost our company.

Fairbairn: So when the Victor die?

Peddle: Probably '84.

Fairbairn: OK, and then Tandon lasted for how long?

Peddle: Tandon Computer-- Tandon's floppy disk business died in about '85, '86. But my partner and I had come up with this idea for the fact that the hard disk should be portable. You should put the whole operating system, everything, on our disk. And instead of carrying a big, clunky thing home, you take this disk home, plug it in your home, and you just move the entire environment. Right? It was called the data pack.

And I convinced Xerox to invest in it. They did a-- Bob Adams, who was an ex-computer guy, was in charge Xerox at the time. And they did several focus group studies. And it turns out the big companies weren't so impressed, but the human beings we showed it to were totally impressed. Right? So they signed up for it. So now, we're going to go do that product. But we've got Xerox development contract for two years.

And so I come to Jugi, and I said, look. I'll give you this OEM contract, but what I want to do is I want to own the rights to sell Tandon computers in Europe. And I want your 286 first. And I want to be able to control it. Any he actually took me to my factory, and we fixed his factory, and we did a whole bunch of

things so that we could announce the 286. And as I was talking you at lunch, we-- the guys at Tandon-- had started a chipset. [INAUDIBLE], but a chipset.

So they reduced the cost of electronics. They couldn't make it work, but my team-- I brought a team of engineers in, and we made it work, and got the OK to do it. And so we launched in Europe with a 286 at half the price of everybody else's 286, and did very well for a long time. And then we put a 386 machine in, and then Intel and Microsoft stuffed us on this 386 SX.

Do you remember the cost-reduced 386? They gave it only to Compaq for almost a year. Compaq was big player at that point. They gave it to only Compaq, and Microsoft did all the software for it, and that sort of thing. And it was at that same session where they told us this, that I had to go in and tell Gates not to do the IBM software, which IBM was pushing him to do, and instead do Windows. The Windows guys were already done.

Xerox had said, we want Windows-- for obvious reasons. So we made a commitment for Windows machine. Right? And we did an extra chip, so that we could run with a 286 and run Windows. And Gates was being pressured by IBM, who had made his fortune up until that time, to go with-- I can't remember. They had a system they were proposing during that time.

Fairbairn: OS2?

Peddle: Something. Whatever it was, they were pressing him. And he decided to Windows, and of course, the rest is history. Right? That was the right decision, and it made Microsoft the company it is today. And it's too bad, because IBM got him there, but he had to basically tell them no, I'm going to go my own way. Which was the right way, the Xerox way. We got our fourth computer of the year for the data pack machine when we introduced it.

We made the data pack so that you could throw the data pack on the floor. Juggy went in and redesigned the head so it mounted in a casting, and you could throw the data pack on the floor.

It was the first time. It was back when data-- when disk drives were dropped. And it was a great idea.

The problem with it was that it wasn't a MR head. If you recall, we went from 20 megabytes and 25 megabytes to 400 megabytes in less than a year because you had changed the head technology. And a big fight with Seagate, a big fight with IBM, but ultimately MR head-- which started at IBM-- became Seagate's primary tool.

We had the disk drive business at that point. We won this award, computer of the year for our removable disk. And I took a look at what was going on MR heads and said, we can't afford-- I was the COO at the time-- I said we can't afford to invest in the next generation machines-- which were 386 going to 486 and so forth-- and invest in a hard drive.

I don't think we can afford the hard drive investment anyhow. So we sold it to Western Digital. And that was the last time I was in the disk drive business.

I've been in and out. But we had made the business happen, didn't we? And we showed people things you could do with a hard drive.

And then Juggy got upset because he didn't have his disk drive company anymore and decided he wanted to run a computer business. And so we parted ways and he ultimately went into bankruptcy. I went off to do new low cost memory systems.

Fairbairn: When was that? When did Tandem go away, or when did you leave Tandem?

Peddle: Towards the end. Right about '90-- '89, '90, '91.

Fairbairn: OK. So we've got 25 years ago.

[LAUGHTER]

Peddle: It's really simple.

Fairbairn: What happened after that?

Peddle: I had a patent on how to use partial DRAM. And we turned that patent into a very large business making DRAM in Sri Lanka, in India, using reject die from Micron.

Fairbairn: So you took reject die, packaged them-- you mapped out the bad bits or something?

Peddle: No, we actually--

Fairbairn: We're entering phase four of our discussion with Chuck Peddle. And that, is post the time when he was doing IBM compatible work with Tandem, '91, 92 time frame. So walk us through the major steps in your career to bring us up to date over the last 20 years.

Peddle: What we did, is we had this patent-- which I've discussed-- and I'll just summarize it. I had a patent that says, if I take a disk, a DRAM-- DRAMs are organized by outputs. I don't know if most people know that, but the structures are internal. Internal structures are organized by output.

And so when you test it, you know which outputs are working and which don't. When you repair, you figure out which columns are failing and which things are failing, and then you can make that bit work sometimes. By repairing two or three of the things.

Fairbairn: Using fuses on the die?

Peddle: Using fuses on the die, right.

Fairbairn: And this is standard DRAM technology?

Peddle: No, no, it's Micron technology.

Fairbairn: Micron technology? OK.

Peddle: Only Micron. Everybody else does the cuts and stuff at the wafer level. And they don't have it. It's one of the reasons Micron's always been a leader in having dense devices.

As soon as they get a certain level, they go back, put 15%, 20% failures in, 30% failures in, sell them through a company called SpecTech, and sell the partials to people that beg for the partials. And then we were buying partials past that.

We also could use partials that nobody else could use. Because people sometimes will take four working bits and four working bits, and put them together. But my patent said that if you put three and five, it's mine. Anything that net use a variable number of patches. We call them patches.

And the technology had to be done in a third world country. That's where we used the SMT. We put all the dots on the front making them all fire, run a quick test, discover which ones have to go to the back, and then we put them on the back. Test the thing again, and it's now a good DIM. And so having tested

the ones in the front, now we can go and decide which ones-- and we have our room full of ones, twos, and threes with various pin combinations-- and the little girls put them in a tray, and we SMT them on the back.

Fairbairn: So you basically-- it takes two die to get the capacity of one?

Peddle: Right, to get the capacity of one. Question

Fairbairn: And you're able to-- because these are essentially rejects from the initial manufacturing run-- you're able to acquire them at a very low cost and--

Peddle: We buy the good ones in the front, probably about half price because they sell them about half price. Although we buy them less than half price because a lot of them don't make the 50% numbers that other people are looking for. And then the ones in the back, we basically almost get free because we can use them up.

Fairbairn: So basically you are able to do so these--

Peddle: DIMs

Fairbairn: DIMs at a very competitive or lower price then.

Peddle: Yeah. We're just selling them in the broker market as a normal DIM.

Fairbairn: And how long have you been in this business?

Peddle: We were in that business from '91 to-- no, no. '89 we moved into the business in the final version of it. We actually did some stuff in England with the old SIMs. Remember a SIM was easier to build than a DIM.

DIMs didn't really happen until about the end of the '90s. And when DIMs happened, we had to use the new patent. In order to do this, we had to have a low labor content.

I thought we were going to go to India. We didn't, we went to Sri Lanka took over a factory. They had been making removable heads for SciQuest, and ultimately put 3,000 people in there doing this function. Of little girls dotting on the line, and then putting them on a PC tester.

Fairbairn: Now is this your own company or are you doing this--

Peddle: Oh, it's a company with Tandem.

Fairbairn: With Tandem?

Peddle: We set up a separate company in Asia with Tandem to do this. Because Tandem had the big factory in Mumbai, India. And I thought that's where we were going. But they had this factory set up in Sri Lanka.

And then all of a sudden, SciQuest went away. And the other guys went away. Concept removal disk kind of died in one week.

So they had this factory for that. And it was nice factory, but they had all these people. And you're in a socialist, communist country, and so you have to keep the people-- you know there's a whole bunch of rules.

So I just took the factory over. Slowly built it back up, got up to 3,000 people with a heavily automated repair. And then we had another 1,500 people in Mumbai doing the same thing.

We did a lot of our development work in Mumbai because I had good programmers. This repair thing was not trivial. We had to write a lot code and I used about eight programmers from India. Really smart guys. We did it, and then we brought it up in India, and then we would bring it back to Sri Lanka. We lost 4,500 jobs in a weekend when they stop selling partials.

Fairbairn: So at some point you're doing business with Micron, and Micron stops selling partials. In what year?

Peddle: Um, 2000 plus.

Fairbairn: Early 2000s sometime?

Peddle: No, even later. Later I think it was. It may have been 2006, 2007. 2006 I think-- maybe 2007-- because I came to the United States to design the Flash device that uses page mode. Did we cover Flash drive? I came in December-- ah November-- 2007. And we developed it--

Fairbairn: When you say came to the United States, where were you?

Peddle: I was running the factory in Sri Lanka.

Fairbairn: Oh you'd been living in Sri Lanka?

Peddle: I was living in-- yeah most of the time.

Fairbairn: I see.

Peddle: It was a shock. It's a beautiful place. And in a big factory you tend to keep busy. And I had most of my engineers over there.

I came here because I was able to use Minch's group to do the chip. For the USB controller. Using the 6502.

Fairbairn: You then were looking for other opportunities--

Peddle: I figured out this thing with Flash. I figured the thing out with Flash before that though.

Fairbairn: Similar concept, that is be able to-- different technology--

Peddle: To use the bad one. Use the bad devices. I told everybody when I first looked at Flash, I said we can't make any money at it. The big guys-- the guys buying the biggest volume-- get the best price. You're going to get your butts kicked.

And then I came up with this idea. I took a look at it, and I said, shit. I can use all these parts nobody else can because they made this oversight. And my so-called page mode really lets me use all the bad parts as good parts. So now I'm buying a part for $0.25 that's worth $4.

So we set up to do the USB. Now by the way, when I tell you that that's easy, it's not. We spent some time developing the controller and the software to do that.

Fairbairn: But these are basically storage drives-- storage technology-- that you can use in a variety--

Peddle: USB 2.0.

Fairbairn: USB, so thumb drive kind of things.

Peddle: Yeah. USB 2.0s and 3.0s.

Fairbairn: But the same technology could be used for other Flash product right?

Peddle: Then what we're doing, is because USB uses four disk, four die-- and I showed you some of the tricks we use for stacking die, right? So we're good at that. But now, what we'd like to do is to make the SSD work that way because it uses 32 die. So we came up with--

Fairbairn: This is solid state disk?

Peddle: Solid state disk, right. You use 32 Flash devices to get 256, and that's about what people want to buy. We were just playing around with it, and we discovered that everybody was wearing out the Flash. Everybody was wearing out Flash. So myself and these guys from Canada, we were looking at it, and we came up with the idea for how we would use DRAM as this SSD device. And we don't have any wear. We went at full size speed. We're not doing this block cleanup. We're not doing any of those things. Just like that.

Fairbairn: So you just use the RAM as the storage until power goes away? And then you--

Peddle: The RAM is the SSD.

Fairbairn: Then you have the SS--

Peddle: The SSD then does archives it's data onto the Flash, and then can read it back off the Flash. So if you want to re-put all your programs out on a Flash, and then you bring them in and fast load them. And so we're infinitely fast. if you're doing updates and everything else, they happen right now because they never leave the Flash-- or never leave the DRAM. And DRAM-- Flash wears out. Every time you write it, it has to wear. It's logically true because of the way it's constructed. DRAM loves to be beaten up. it's called refresh.

[LAUGHTER]

Fairbairn: It has to be refreshed.

Peddle: So by definition, you can't-- SATA runs 600 megahertz. DRAMs run a minimum of 800 megahertz now You can mostly get 1600, but I'm always as fast as SATA And if you're want a double SATA Good. USB 3.0 is a little slower? All of those devices I'm just faster than. Yeah, that's the product we're working on now.

Fairbairn: And that will be going into production shortly?

Peddle: No, no. We've got to get the controller for the SSD. That'll take us most of the rest of the year to do if we get funded. It takes a lot of money to do those.

Because you have to buy-- it costs like $2 million just for the IP to do SATA. You'd be crazy-- you can't develop that stuff. So you go to Synopsys, and you pay them $2 million. And now all of a sudden you can use DDR3. And you can use-- then you've got a development activity which is cheaper than that $4 million, but you have to raise enough money to do that. And we're in the process of doing that.

Fairbairn: Does that cover what's happened over the last 20 years?

Peddle: Afraid so.

Fairbairn: OK.

Peddle: Haven't had much.

[LAUGHTER]

Fairbairn: Just make a lot of money from clever--

Peddle: No, no, no. We made money clever, and then we gave it all back because of the fact that we tried to save the companies. And we'd use the-- the money had kind of vanished along the way because we were trying to do too many things at once.

I was, over at Tandem. We were trying to do too many things at once and they took the cash. And this product, we've been self-funding up until now.

Diamond: Are you using a 6502?

Peddle: I got 11 6502s on the controller. One 6502 on the USB controller. And the reason there's 11, is because I put each USB controller-- I put eight USB controllers-- on the SSD controller.

So I've got all the Flash problems solved. I've got them solved. Proven them in production, so I don't have to deal with Flash problems. I'm only dealing with SATA problems.

Because this is what distributed intelligence is about. If I get the problem solved, move it over here, it's done. I put eight of them on-- they're eight-- they run in parallel, they're very fast because they're running in parallel, so I can run at full sized speeds to write and read if I need to. Then I got a couple processors-- one processor managing DRAM, one processor managing the system. And maybe a third one managing the data bus.

But probably 10. It's probably going to be 10 processors. And the processors is so small-- back to my good old 6502-- the processor is so small that nobody notices that we're putting 10 of them in. The RAM and ROM take more space than that.

If you were going to build a 16 wide arm, you'd have all that extra RAM and ROM too. The 6502 is most efficient on memory and most efficient on ROM of any of the architectures on the market today. So I get small ROMs and small RAMS and do a job. And that job is unique.

It's only that job. And each of these processors are not multitasking. They're doing their job, and they talk to somebody else who tells them something else.

It's I/O communication. So it's all DMA-- which just to remind you-- we've got several patents filed on DMAs. And the handshake, we've got some handshaking to do, but SATA has got a set of rules. So you basically let the master processor--

Fairbairn: What has a set of rules? SATA the sending commands, SATA.

Diamond: SATA, [INAUDIBLE].

Peddle: I'm sorry?

Diamond: SATA.

Fairbairn: What is SATA?

Peddle: S-A-T-A.

Fairbairn: Oh, oh. SATA.

Diamond: The disk interface.

Fairbairn: The disk interface.

Peddle: Right. It's basically rewrite. Think about it. There's not much else. There's a couple error detections and everything else. So it's not like you've got this enormous stuff to decode. The master controller gets a command. And it tells the DRAM, hook that DRAM up, and here's how much is coming. And then the DMA loads it and we're done. And then if we want to send it back, get a command that says, write all this. We hook it up to DMA and let the DMA write it back.

Diamond: And you've got a super capacitor in there for your [INAUDIBLE]?

Peddle: Yeah. USB. Yeah. super capacitors are one of those technologies that's happened, and it really works, and it's not expensive.

Fairbairn: Just as back-up power, that's what it is.

Peddle: No, it's the power that it takes to write. When you lose the power you have to write everything to disk. When you just do it severely. Dump. Right? Eight gigabytes, which is not that much to dump.

And then when you start back up, you bring all the eight gigabytes back in. And the snapshot logic that you're using to be able to recover if there's a power down, everything else is all built into the software. In combination in the PC and in your drive. With all that processor power, I can do a lot myself.

Fairbairn: OK, maybe to wrap up, you've been active in the computer-- in the personal computer-- business from its beginning. You've helped launch it.

Peddle: I wanted to make a comment that the only-- one of the major reasons-- I'm doing this DRAM SSD-- in addition to just making a lot of money-- is because I think with all the features we can build in-- if Microsoft will work with us-- I think we can do a new, very low cost combination tablet by somebody like

Lenovo or HP. That will sell for $300, $400 and it will kick the crap out of a Mac Air in terms of performance and price. And I think there's 1.6 million-- billion-- PC users that have not upgraded for the last three or four years. I don't know if you've been following that statistic.

Fairbairn: No I didn't true.

Peddle: It's true. They just haven't been upgrading. Why upgrade? Windows 8 was a disaster. I got stuck with having a Windows 8 notebook to replace my previous notebook because my notebook died. And they wouldn't sell me one without Windows 8. They've slowly cleaned it up a little bit, but Microsoft has done terrible things with the operating system. And they haven't done anything about the performance. The dis-performance just--

Diamond: It's worse.

Peddle: And the recovery gets worse. They just totally ignored the things that made the PC happen in the first place. Remember I told you the first time we put the hard disk on, people said, oh geez, look at how it works?

Nowadays they look at the Mac and its works faster than the PC. Why? Because they're not doing the right software. And because they don't have the right controller. This new controller is-- if we're going to do a project working with a couple large OEMs to see if we can get those 1.6 billion people buying new computers.

Fairbairn: And you'll give them something with much higher performance at a very low cost?

Peddle: Right. Yeah, if you look at the tablet combinations they're $300, $400. My SSD doesn't cost much more than a normal-- it costs less than a normal SSD-- and it costs not much more than a hard drive. We're giving them all this performance at roughly the same price.

And something that really feels-- and by the way-- how we're doing the disk operating system, it's going to feel just like it did before. Right? You're going to ch-ch-ch ch-ch-ch, right?

Fairbairn: Feel responsive.

Peddle: Disk is never going to be in your way. It's always going to be there faster than you. Which isn't true today.

[LAUGHTER]

Fairbairn: No, it's not.

Peddle: With the architecture we've got, that's simple to do. So that's what we're trying to do. I can sell a lot of this product. I can all the product I can build with partials and make money.

And we'll make good money, but I want to see the industry start again, to answer your question. So what I'm doing, is I'm doing a licensing thing trying to get the semiconductor companies, and guys like Seagate and others-- that are currently supplying the market-- to supply the high volume. I'll supply the lower volume. But using their architecture.

Because I really want to see the PC business come back. I watched Charlie Rose beat up on Bill Gates when Jobs was still alive. And he was telling Gates, what are you doing about the fact that Jobs is kicking you?

[LAUGHTER]

Peddle: And Bill didn't have a great answer. He's a very polite guy, but he didn't have a great answer. Because at that point, it looked like Steve-- that Apple-- was just beating the crap out of Microsoft.

And then of course Microsoft screwed around to match a tablet, which they didn't do. And tried to match a phone, which I guess they haven't done yet. Instead of going back and saying hey, the fundamental thing we built was this wonderful PC. Let's go back and make it a wonderful PC again. And oh by the way, we can make a good tablet then as a derivative.

Because there's some things that you want to do on a tablet. So if you've got the two, I can plug it in, it runs Excel, or I can write a presentation, bring the presentation in and show it to everybody using the tablet, that's the right combination. And it's already there. I actually proposed that idea to Microsoft two, three years ago, and they just ignored me. We hope that now with new management they might get more interest.

Fairbairn: So is there anything-- any other questions you had Steve? Chuck we've sort of worn you out talking for the last four or five hours.

Peddle: No, I like talking about this story.

[LAUGHTER]

Fairbairn: Are there any other major things that I missed? That you--

Peddle: Did I get rid of the fact-- I want to really emphasize-- and I'm going to try to get Wikipedia to listen-- we did the first hard disk drive. I think you've got documentation here for the MS DOS machines. I think you've got stuff that I've given you that is write ups.

And if you look at the literature from that time, it was done right after COM-DEX in '70-- in '82 and '83. The idea that Apple invented the personal computer? They literally were following us around. They followed [? Sooting ?] around on the other one, and they followed the rest of us around on the other. And that's OK. The Mac--

Fairbairn: Just want to get the story straight.

Peddle: No, the Mac was a rip off from [Xerox] PARC.

Fairbairn: Everybody admits that.

Peddle: What?

Fairbairn: Everybody acknowledges that one.

Peddle: Yeah. But it was a great idea. And he forced Microsoft to do the same thing, so our PCs were better. And so that was a very important step.

And I'll give Steve the credit for having forced it. Because PARC couldn't make it happen. People at PARC say they couldn't make it happen. Xerox just wasn't going there at that time.

So Steve made it happen. But so did Gates. Windows is-- I think can be-- superior to Apple's product. But they're both good because they're using the PARC interface.

With all due respect, you were at PARC. I don't know what major new things they've done. Can you tell me what's really that much better than what they did at PARC? I mean I saw STAR.

Fairbairn: Fundamentally it's all the same. All the things that we associate with the modern PC including bitmap display, Windows, mouse, laser printing, file storage, Ethernet, all existed and were demonstrable in 1973, 1974.

Peddle: Yeah. I mean STAR was a great product. And you had all that stuff in it. And Xerox deserves the credit. They never got it, but they deserve the credit.

Fairbairn: Just my observation, is that people say Apple made a success of it. But even in 1984-- 10 years after PARC had it-- the Apple-- the Mac-- was not a huge success. It was too expensive and so forth. And it really wasn't until early '90s that that technology really took off in the form of Windows. That was 20 years after it was demonstrated.

Peddle: By the way, the world believes that Mac was great and sold a lot. They didn't sell a lot. They didn't sell until Adobe.

Fairbairn: Well the printer, and that's also Xerox technology.

Peddle: Adobe made the Mac work. And by the way, every artist, landscaper today-- the people who own Macs today are mostly artists. My girlfriend is a landscape designer. I gave her four free PCs and she still has a Mac. Because they really love what Apple does. That made the Mac. Apple too, by the way, was getting its butt kicked by Radio Shack in Europe and US and us in Europe, until VisiCalc was on it.

Fairbairn: Yeah, VisiCalc really was a home run for them.

Peddle: VisiCalc is what pulled the Apple in. And by the way, that's great. Because what they--

Diamond: That became business.

Peddle: What?

Diamond: That became a business tool.

Peddle: Yeah, and that's what reason the MS DOS machines took off as well as they did. Because people had started using them as VisiCalc. They'd used them as BASIC for their tools, but VisiCalc--

Fairbairn: Needed a killer app.

Peddle: Well more importantly, VisiCalc was the first piece of software that was unique to the PC. I'll be happy to prove that if you want.

Fairbairn: Didn't exist before, right?

Peddle: I'll be happy to prove that if you want. It's really true. Those guys at VisiCalc deserve the credit. Because Excel and Lotus were just takeoffs on what they do.

Diamond: They were ahead with the Windows scenario they couldn't make a practical version. They had that full model ahead of Windows but they--

Peddle: But my only point was that VisiCalc itself-- dreamed up by these two kids at Harvard that didn't do Facebook-- these two guys came up with a unique capability. That today we wouldn't do without. I mean how would you try to do something like a spreadsheet without that? I mean, they changed the way you use computers. And it was only personal computers.

Diamond: That was the first application many people in business ever used on a personal computer.

Peddle: Yeah, because it was unique to the personal computer.

Diamond: And it was also something they understand, because it was a computer analog of something they used to do on a piece of paper.

Peddle: Yeah but on a piece of paper you never had-- I was in the computer business forever.

Fairbairn: Right. Never existed on a mainframe or anything like that.

Peddle: We never had anything like that on the mainframe, period. Even on a Tandon machine. Never happened. Visicalc was unique. OK.

Fairbairn: So any other last stories? Any other last points you want to make?

Peddle: I just wanted to make sure that we-- and I think I've given credit to Davidow, I hope? If I haven't given credit to [Bill] Davidow. He's the one that made the 8088, the real basis for MS DOS. Gates of course did a whole bunch of different things that were important. Siler of course, Fagans, I've talked

about. Glenn Stark, Scott Patterson were the guys who were doing the disk stuff that made this all happen.

I want to make sure I've given proper credit. Bill Mensch of course has already been getting credit because he did 6502, and has made a fortune off of it. Rod who is now dead. He was one of the guys who did it. [INAUDIBLE] were the guys that helped me do the 6502. and Terry Holt who is still in the PC business. John Paivinen, I can't say enough about John Paivinen.

Fairbairn: Sounds like he was a major character.

Peddle: Yeah. Well John Paivinen is a character and a major character in his own right.

Fairbairn: A major player, a major contributor.

[LAUGHTER]

Peddle: A major character.

Fairbairn: We don't mean to be slighting him in any way.

Peddle: No, no, no. He is a special guy and I hope you get a chance to talk to him.

Fairbairn: Yeah, we'll definitely look him up.

Peddle: He's not-- he's older-- but I think he's probably pretty fit. So he's probably still around. Who else, did I miss anybody? I don't think so.

I think-- the two Japanese guys, Uterakura who made the Commodore 64 and VIC 20 happen. Fujiyama and Augi who were the two Japanese guys we used. They made the original PET thing work with us.

And the Japanese were a very important part of all that. Yaz Uterakura gets no credit at all by the way, for the C64. Anymore than [? Siler ?] who invented the [INAUDIBLE], gets any credit. So if you sometime or another want to talk to [? Sile, ?] fine.

[? Yaz ?] is in Honolulu but he comes around here occasionally if you want to talk to him. He's got an interesting perspective because he saw it all from the Japanese side. So it might give you an interesting view.

Because he was actually in Japan most of that time. And he got to see Epson do bad things to us. He might have an interesting-- if you get a chance to get him here. He comes to the United States probably once a quarter. So you might be able to get him to do it.

Fairbairn: All right. Well Chuck, thank you very much for spending the day with us. We very much appreciate it. It's a very valuable contribution to our archives and history of computers. So thanks again.

Peddle: Thank you. I appreciate the chance.

Diamond: Thank you it was a pleasure.

END OF INTERVIEW

