



Oral History of Robert Belleville, part 2 of 2

Interviewed by:
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Garner: I'm Robert Garner and we're interviewing Part Two of Bob Belleville's oral history here for the Computer History Museum. In part one, I think we covered a lot of ground, but we definitely wanted more time for a second part, and in part one, I think Bob-- I think we remember that, you know, we basically covered a lot of what happened at the time Steve Jobs was booted out of Apple and you left at about the same time and it was very interesting listening to all those conversations, but subsequently to that, before we get into your next jobs, it sounded like a lot was written about that event and that time and about you and about Steve, and if you wanted to comment about any of those books or stories and how you felt-- how you feel about them now?¹

Belleville: I think that's a perfectly fine place to start and Robert, I thank you again for driving all the way up here. The traffic around here has gotten to be really difficult. The way Steve worked, of course, was to manipulate the media, and he was, you know, a natural at that, and so it's always a tricky arrangement with the media because you're using them, but they're using you, and it's a complicated arrangement of what people-- the story they get in their heads and the story they want to write, the preconceptions that they brought to the thing, and the amount of time that's involved, and so we had people embedded-- to use the modern terminology, we had people embedded-- press embedded with us during the whole Macintosh development, and they came and went as Steve would find out something about them he didn't like and he'd throw them out, so I think the first one that I remember was the book by, I think it was, Michael Moritz called The Little Kingdom or something like that. He was actually inside the group, but he would be meeting with various people at various times and number of things. He started writing articles and that bothered Steve and he got booted out and we didn't see him again. And in those books, it depended on whether those people ever got to know me or not. I don't think Michael Moritz' book is very favorable to me, if I remember properly. He was taking his key from Andy Herzfeld, who thought I was a bad person, and I was described as a Nazi in that book, which is, I think, for most people, pretty hard to imagine me as a Nazi, but you see how that goes. As soon as I was out of Apple, a writer by the name of Frank Rose, a New York based writer who had written The Soul of a New Machine, which was about the Data General Nova, I think.²

Garner: Yeah.

Belleville: Now, he was an unusual person because he actually really wanted to know what was going on, and so he came to my house in Saratoga and we talked for dozens, if not hundreds of hours, about what had gone on and what I did for him was, I told him what I knew because most people wouldn't talk to him, and then he could go to other people, senior people inside of Apple, post-Apple people, and say, "I heard this. What do you say about that?" which got their side of the story as well, and he ended up

¹ For part 1 see <https://www.computerhistory.org/collections/catalog/102717192>

² Michael Moritz, *Return to the Little Kingdom: How Apple and Steve Jobs Changed the World*, 1984. Frank Rose's book is not *Soul of a New Machine*, but *Into the Heart of the Mind – An American Quest for Artificial Intelligence*, 1984.

writing the book called West of Eden, which took him almost three years to do, and that's a fairly accurate representation of that particular period. It's fair about Steve, it's certainly fair about me, and it's an interesting piece of history for that period, written fairly close to the time. Like the way we-- the Christian scholars take reference to the books of the New Testament, how many years were they from the life of Christ, and the earliest one was about 60 (50 to 100 for all give or take) years, so this was pretty close to the actual event, to find out what was going on.

Garner: Within a year or so.

Belleville: Within that year. Took a while for the book to be published, but he spent three years on that book, which is something that writers don't do.

Garner: Now, The Soul of the Machine, was reminding myself it was written-- supposedly written by Tracy Kidder, so this must've been...

Belleville: So there was a different one. He wrote a different book.

Garner: But not-- the person you're talking about, not Tracy, though?

Belleville: Not Tracy Kidder. This guy was Frank Rose and he'd written another book. You could look him up and see.

Garner: Yeah, I'll look him up.

Belleville: But it was another computer book.³

Garner: We can get it later.

Belleville: Yeah, maybe you can work on that while we're going on. What happened there was, I was using it partially as psychotherapy.

Garner: You mean the interviews or reading-- or the book?

Belleville: No, interviews.

³ See previous footnote.

Garner: Interviews, yeah.

Belleville: And a process like we're doing today, I hope to be the very end of the psychotherapy process on this. I was suffering from something that I think these days would be called PTSD, which I never thought about in those terms in those days, but was a heavy adrenaline rush. It was dangerous in the sense that your reputation was always at risk. There was very little chance you were gonna be killed, but there was a very big chance that you were gonna get disappeared from what I thought was my life's work, so for example, my plan for Apple was that I was gonna get the job of head of research and then spend the rest of my life thinking-- getting young people to think of new things that Apple could do.

Garner: Yeah, new things they could do. That would be a perfect goal for you.

Belleville: Yeah, I thought it was pretty perfect too. Steve didn't mind that as an idea, but he never thought that far into the future.

Garner: No.

Belleville: When we all came to an end there, that potential went away.

Garner: And again, we're talking about what year, just to set this up with the last...

Belleville: This would be '85. Eighty-five was the year we got tossed out. Wayne Rosing got that job, actually, for a little while and then he went on to do better things, but... (and then Larry Tesler)

Garner: Became my boss at Sun.

Belleville: Yeah, I know that.

Garner: He came to Sun and he was my second boss there. <chuckles>

Belleville: Good man. I don't know that I told those stories or not in the last one, but John Couch was the head of the Lisa division, Wayne was the engineering manager, and John Couch, I think, left in utter frustration over how difficult it was to do anything with Steve around and Wayne became the general manager of the Lisa division. And then in that meeting, which I don't think I described, I watched John Sculley's principal skill in action. John Sculley's principal skill was managing a small group of people. The Lisa division was losing about 3,000,000 dollars a month...

Garner: Wow.

Belleville: ...and Apple wasn't that big in those days. I told Steve about it. I said, "You know, Steve, the Lisa division's losing 3,000,000 dollars a month," and he says, "I just don't have time to think about that," and I said, "Well, maybe, but that's a lot of money as far as I'm concerned." You'll remember that the total cost of Macintosh was 20,000,000 dollars from the time they started to the time it started shipping, 20,000,000 dollar total investment and it was running at 300,000,000 dollars (annualized) revenue rate within the first quarter of operation...

Garner: Wow.

Belleville: ...and that was the failure, because it was supposed to be a lot bigger than that. So we hadn't spent that much money in years.

Garner: With failures like that, who needs friends, right? <chuckles>

Belleville: Yeah, right, you know. We needed to combine the two divisions. (There was no sense in having that, and there were too many people and Lisas weren't selling. Where we were selling 15, 18,000 a month, they were selling a thousand, so there was a meeting called and John Sculley and I think Floyd Kvamme and Steve and Wayne Rosing and me for some reason-- I don't know why I was there, but anyway, I was always in those meetings, and...

Garner: You were gonna be the voice of reason, perhaps?

Belleville: I'm not sure. I'm really not sure. I think John probably thought I was running a lot of it, which I really was in terms of practical matters of getting things done, so I sat and watched. Wayne Rosing had a lot of ego involvement with being the general manager, as you can imagine. You know, that's a key kind of position.

Garner: It's your baby and your family.

Belleville: And I watched John Sculley just beautifully talk him out of that job until his feelings went away. He wasn't-- as far as I know, he wasn't-- his feelings weren't hurt. He gave the Lisa division to us and went off to become in charge of the education role that he had there for a short time, and that was John Sculley just using his magic. When John Sculley first came into the company was in the very early days of Mac and we were having a vendor conference. This is in the early days, the factory is, in '83, and-- would be '83, I'm pretty sure, and we were having a deal where we're trying to get all of our vendors on

board because we were gonna do this just in time delivery and zero inventory stuff and stuff that was fairly advanced.

Garner: It was pretty new for that time, all those concepts.

Belleville: It was.

Garner: You guys were pioneering that, yeah.

Belleville: We were pioneering all the manufacturing stuff, which I was so keen on. I thought that was so cool. So was Debbie. Debbie Coleman was so interested in that as her role as a finance person, but also when she took over the factory, we had this big conference, had all the vendors in. We showed them product. We got them all wound up and got them to sign on the big pieces of paper on the wall that they were gonna do what they promised they were gonna do, because we didn't have second sources for most of this stuff either, so we were dependent upon these people and they were dependent upon us and we were all giving talks. We had a rehearsal, and it was terrible. Rehearsal just went like some rehearsals go. Steve was off, which he rarely was, but he was off in rehearsal. I wasn't on my best and I'm a fairly good speaker in that when I have a chance to prepare and so forth, so I think I can do okay, explain things to people, and everyone else, Murray for the marketing, everybody was just terrible. But John was busy and he couldn't come to rehearsal, so he didn't. He was gonna be the last speaker and we didn't know what would happen, and so the next day, the conference came and we had these talks and they went flawlessly. They were beautiful, as often happens. The rehearsal goes bad, the speeches went terrific, and so we were very high and it got to be John's turn to talk and we all looked at one another and we said, "We've never heard John talk. Wonder how this is gonna be," and he was terrible. He didn't know how to talk in front of a group, and I asked Jay Elliott, who was HR. I said, "What's the story on John?" He says, "I don't really know," so I thought about it a little bit and I said, "Well, what does it take to run PepsiCo?" and I thought, "Well, PepsiCo's probably seven people."

Garner: Yeah, automated.

Belleville: ...because they buy all their advertising. They buy all their marketing stuff out. (They franchise) a large part of their business. There's not much to it, actually, at the very top, and so he could run that by having, you know, seven or eight or ten or fifteen key people who are running all this franchised operation, Jay came back and he says, "Yeah, you're right. That's exactly how that went," and they sent him to all kinds of classes so that he could learn to speak properly, which is very common now. My wife Cathy was doing that for Net App. Over the last part of her career was helping all the executives on how to speak properly. -- We were on the track of talking about how the Frank Rose book came about and how that was a certain amount of therapy, but he could get to all those people who weren't talking very much and we could find out more about what really happened there.

Garner: No one wanted to do a movie based on his book because it was too realistic and not these kind of mythological stories that might capture someone's...

Belleville: (0:14:25) Well, no, movies were made of the sort of the last one, so there were two movies made in the last couple of years. One was a documentary that I was in. I don't know if you saw that one or not.

Garner: Haven't seen it yet. What's it titled again?

Belleville: "Steve Jobs: the Man in the Machine."

Garner: "Man in the Machine," yeah.

Belleville: That was done by Alex Gibney of Jigsaw Productions in New York, and he did a pretty good job with that, but his thing mostly is just to examine it in power, and he was triggered by Steve's death, which might take us out of chronological sequence, but when Steve died, it was a very funny day (for me). It happened on the 5th of October, so you can see it was a-- it even looms fairly large in my memory because it was the 5th of October, was a funny day. And I heard that Steve had died and I didn't know-- I reacted pretty strongly, 'cause I hadn't talked to him for a couple years, but it was-- he was a good friend and now he was gone and that whole-- my whole future was changed in some sense. Probably not in fact, but in my mind, and so I wrote a little piece of poetry talking about how Steve was a funny figure in all these people's mind that were bringing all the flowers and candles and stuff. It was very strange, so he's sort of like James Dean and...

Garner: Greater than life for sure.

Belleville: Greater than life and maybe a little bit like Santa Claus because all of his new products which were there that people really loved. They weren't the Mac. What they really loved were those phones and I-pods and things like that. And how he-- there's a parallel between Steve and the movies in the '30s during the Depression. The movies just allowed people, for a nickel, to go away and be in the dark and be with their heroes and these mythological friends and be entertained in a time when they didn't really have very much, and all of Apple's later products don't cost that much compared to the kind of personal entertainment that they provide, and so he's, from my point of view, from parallel-- they're parallels to the great movie moguls who constructed that kind of thing. Steve and I talked about it specifically. We were working on the factory. Steve was very fond of what Sony had done with the Walkman and he wanted everybody to have a Walkman. He loved Walkman and had little Philips cassettes and he was very excited about that. He was really into that.

Garner: Now, is this-- year...

Belleville: This is maybe '83, '84 time period.

Garner: But there weren't MP3 players out then.

Belleville: No, no, no, these were all Philips cassette players from Sony, but he was fascinated by that and he wanted to allow that for the factory workers. He says, "I want them to create their own personal little space, their own music, their own, you know, their own soundtrack," and I said, "I don't want that." Maybe that's why I'm a Nazi. "I don't want that. I want them to be focusing on building the Macintoshes so that they're not making mistakes and so forth," but we had a difference of opinion about that.

Garner: But did they end up getting Walkmans?

Belleville: I don't remember. It would've been up to Debbie anyway. They probably did get their-- the ability to do that.

Garner: You're talking about the movies then, so you said there was that one, "The Man in the Machine."

Belleville: There were a bunch more low budget-- they were Hollywood movies, but I saw one in Hawaii when I was out there very early. It was a television and I just happened to be ill and I was-- watched silly movies about the mythology of basically Steve and Woz. And I know Woz is still about and can tell his own story. Steve would never have told this story. He would've used that in some other way. But Alex Gibney went to the trouble to do-- and there was this other Hollywood movie, which didn't turn out to be very popular, trying to show not quite sure what, but-- so I thought about, while we were making the Mac quite often, that it was a little bit like a movie company. You get people crammed together. There's a goal. You do the goal, you disband, and go build something else. That's very much like the movies, and so there was a lot of pieces in the Hollywood movie about Steve's relationship with Joanna Hoffman and things like that.

Garner: Now, on the-- also on the books, if the movie sort of-- were there some books that you thought that you and Steve were portrayed more fairly than others?

Belleville: Well, I think the West of Eden is by far and away the best. The others that came out later, for example Isaacson's book The Steve Jobs Documentary he never managed to get a hold of me. I don't think he tried very hard, but he talked to other people. He used some of my stories, but he never got

around to it, so whatever he said-- he said several things about me in the book.⁴**Garner:** Did you think the book was reasonable?

Belleville: I can't read that stuff. I haven't completely read West of Eden because you get in there and you-- I'm carried back to...

Garner: Triggers memories, yeah, PTSD memories. <chuckles>

Belleville: Yes. Yeah, and it's not like being in a military situation, which I don't-- can't really relate to directly because my military service was conducted in this country as an engineer, but I can imagine what that's like and I talk to a lot of those people, so the books are all just tiny fractions, only partially true, and so all of history, I came to learn, is not so much that it's written by the victors; it's just, a real human event can't be converted to history. You can tell stories and you can understand it in a mythological context. You can go back to Jungian architects-- archetypes and try to figure out what it means psychologically, but the reality of the situation, it just happened. There were a lot of people involved. They all had different motivations at different times in their lives and there was a lot of emotion that went into the original Macintosh from all the people that were involved, and they cared about it so dramatically and so personally that you get different stories. Then the relationship with the press was weird because they are conveying that information, actually much later usually. Because of the success of the consumer products, Steve really wanted to build a consumer company, so when he got back, he fooled around with the computer for a while, but Steve didn't really understand computers. He didn't know what a computer was for. He didn't have any idea that a computer could be used for something useful, I don't think.

Garner: That's a striking thing to say.

Belleville: It is a striking thing to say. It's probably why NeXT didn't-- wasn't that successful. I mean, NeXT was a serious computer that-- a serious compete...

Garner: Yeah, it was a standard Unix capable computer and he must-- you're saying that his generals, so to speak, were doing that. He wasn't as connected to that as he could've been.

Belleville: Yeah, he wasn't solving any problems that a computer can solve. NeXT was successful because, one, it was really an excellent design, but also the big screen and the Sun guys that you worked with, they knew and that was all about big screen. You get a big screen, you get enough data, an engineer can actually work on a thing that has ...

⁴ Steve Jobs October 24, 2011 by Walter Isaacson.

Garner: So you don't think that Steve perceived the computer as kinda this magical, can-do-anything piece of technology? He felt more reserved about them in some sense that he wasn't sure what their capabilities could be? He didn't, like, come into work and say, "Oh, our computers can, you know, be artificially intelligent or they can sing songs or they can write books or..." he didn't have these-- he didn't project images into computers, you're saying?

Belleville: No, he didn't project the sort of images of what, in the Mac period, computers could conceivably do, and even subsequently, as they could do more, so the Apple computers became used in-- as CAD for illustration, basically...

Garner: Yeah, desktop publishing.

Belleville: ...and photography. Yeah, that was the reason why the Macintosh was successful, was because of the PageMaker -- and of course, my training from the Doug Engelbart period was more along the lines of, "The world's gotten very complicated. Problems can't be solved by one person anymore. You have to have a lot of cooperation. People have to be able to communicate and work on things together."

Garner: Yeah, networking.

Belleville: You do networking and you have computers that can help you do that.

Garner: And like you said before, Steve didn't have a concept of networking...

Belleville: No.

Garner: ...at that time, not at all.

Belleville: He had no-- no one in Apple had any sense of networking.

Garner: So that's really a piece of the Xerox culture that you brought to Apple, you and Larry Tesler?

Belleville: I tried.

Garner: <chuckles> But with Apple talk, which we talked about last time.

Belleville: Yeah, I tried to do that. I tried to do the-- we talked about upgrading to the ISDN network and doing corporate network using switches as opposed to Ethernet, which-- that was slightly before the thin wire Ethernets and stuff like that, so-- but I knew the value of getting people to work together and working-- geographically separated people working on hard problems. I knew about simulation, about how you can use the computer to try things out before you actually have to do it in real life and see how that goes, and all that stuff is limited. You can't do everything with that, but there's a lot of stuff you can do. I suppose I'm a person that's pretty stuck with facts. I kinda like facts. When Mike Murray would tell me that perception is reality, that's a marketing phrase that I understand, but I think it's dangerous in the sense that if you can just change a lot of perception, you don't actually change the underlying facts. We've certainly spent the last year fooling around with the facts in our political life, not bothering with the facts, to be honest, for a year, and so that's a marketing thing, a perceptual thing, and yeah, if you need to sell some soap, great. Not very much harm comes from that. When you wanna modify your society, better to have a few facts.

Garner: Now, we've talked about Steve a lot. Did you have any interactions with Woz?

Belleville: I had very little -- interactions with Woz for the reason that he had the plane crash right about the time I arrived, and so he was out of commission for quite a long time. And when he came back to the company, he had no interest whatsoever that I could see in actually having an operational kind of role. And he came and did things and I specifically invited him to-- we invited him from the engineering council to join us whenever he felt like it.

Garner: Did he review the Mac design much or...

Belleville: He was vaguely involved. I mean, he would go and talk with Burl and Andy and things like that, but I'm not sure what he was doing, to be honest, in those days. He certainly wasn't visiting with me. I think he thought of me as kind of like the people he didn't want to be in the company or something like that, not quite.

Garner: Because maybe you were too regimented or something or engineer-like?

Belleville: Something. I don't know. Well, we never...

Garner: He's kind of this...

Belleville: ...even knew him.

Garner: ...free spirited, creative type guy.

Belleville: He was doing things like running-- he did a rock concert. You remember that?

Garner: Oh, I remember that now, yeah. That's right, I remember that. <laughs>

Belleville: So the timing was going in different ways and I think if he'd found some...

Garner: Something that excited him.

Belleville: He went up and formed a company called Cloud Nine or something like that, where they did a very complicated remote control for televisions of the sort of a...

Garner: That's the way the Java project started at Sun, by the way.

Belleville: Really?

Garner: Oak was meant to be a remote-- universal remote control. Then they had to create their own language, of course <laughs> and that became Java, so that was in the breeze. <chuckles>

Belleville: So he formed a company to do that and then of course, was too small of an idea, right, so, you know, he was welcome to work where he wanted to work.

Garner: Is there anyone else on the Mac-- before we leave Apple, is there anyone else on the Mac project that you wanna talk about, that struck you as one of those key contributors or made a difference in a way that wasn't really recognized maybe in all the-- by other people?

Belleville: Well, I will say specific ones, yes. That's good to do and I always try to do that. You don't do a product like the Mac-- just like you know very well, you don't-- that's not a one person deal. You got a lot of people involved in that and their very, very strong contributions. We had very strong contributions from George Crow on the analog stuff and while there were things that George Crow and I didn't get along with about, he did a pretty good job on that thing. We've talked about Burl and Andy and their contributions were quite significant, but we had a lot of other people like Peter Ashkin, who kind of helped me hold things together and take care of things, not all on the Mac, but some on the other projects. Debbie, I always wanted to credit for really pulling the manufacturing out of the depths of despair. She did a terrific job with that. The person that helped me an awful lot was Bill Bull. He was an old Apple guy.

He'd been in charge of manufacturing in the very early days of Apple and had come over to work for me, was there when I got there, but he did all kinds of things. Like, he's the one that got to go and actually put thermal couples in the box and found out it was gonna burn up.

Garner: <laughs>

Belleville: So many things that you have to do like that. Jerry Manoch and Terry Oyama did spectacular work on that ...

Garner: So they didn't-- the openings weren't sufficiently large or the fan wasn't-- was there a fan in that?

Belleville: No, there's no fan.

Garner: Yeah, there's no fan as I recall, so...

Belleville: No fan.

Garner: Yeah, there wasn't sufficient openings then.

Belleville: Right, there weren't sufficient openings, so I got them to cut some holes in the top and Jerry hated that.

Garner: That was the good old days. You could have something without a fan. <laughs>

Belleville: Well, I really liked it being as quiet as it was, even though the disc was kinda noisy. I'm sure I left people out. People that people don't think about is, we had a layer of purchasing people who did a spectacular job of working with those vendors, getting the specifications intact.

Garner: Getting sample parts and all that kind of stuff.

Belleville: Well, no, that's pretty easy, but the work is, can you really make that stuff?

Garner: In volume.

Belleville: So there's that part of the manufacturing. Somewhere between engineering and manufacturing where those guys were working. I would remember those names if I had...

Garner: Did you have a so-called product engineer and try to have a product test plan for the Mac?

Belleville: What I did-- I invented a thing. Because I was doing the Mac and the laser printer and Apple Talk network and the file server at the same time, and so I invented a system where I had-- I got one person from Manufacturing, one person from Engineering, and one person from Marketing, and they weren't assigned a leader, but they were responsible for that product, so I had a three person team on each product and they solved all the problems associated with that product.

Garner: Did they have a test plan for testing? I mean, that's...

Belleville: Depending on the product and how they did it. They were so different from one another that we had to do all those things quite differently, so there was the testing that you know about well. There's all the FCC and compliance stuff and stuff like that. Things like the laser printer was completely different animal because the bulk of it was coming from Canon. Only the logic board was done by Burl. The skins were done by somebody else. It was quite a complicated deal. The Apple Talk network was basically just a transformer and some connectors, so there wasn't really much to it. The file server never came to a product, so it was a problem. Gursharan Sidhu did all the software for the Apple Talk network and that was why it was able to be shipped: because he just grabbed that and did it. It wasn't all that complicated, but-- none of these things are, but somebody just has to do it. So at least, I could-- with some notes and with some time, I could name 20 or 25 people who-- for whom the product would not be the Macintosh.⁵

Garner: Yeah, we could always add that to the transcript later. That might be the fun thing to do. Okay, so back to where we left off, I think we've covered a lot of the Mac story, so, you know, we left off with Steve being ejected and you being ejected and then that became an issue for you. What did you do next? How did you decide to keep your sanity and look for a new job, and what was it like to look for a new job after such a, you know tumultuous period?

Belleville: The first thing I did was, I tried to get Sony to build a phone.

Garner: On your own?

Belleville: On my own. I had...

⁵ Adding all the people here is out of scope for this transcript. They know who they are and I so much appreciate what they did.

Garner: A mobile phone?

Belleville: No, it wouldn't have been a mobile phone 'cause that wasn't ready yet.

Garner: Yeah, I was wondering how advanced you were going there.

Belleville: No, this was-- would be a phone hooked to an ordinary (2 wire telephone) pair. Sony liked the idea of this phone and I had so many good contacts with Sony that I had built a mockup of the thing. I built a software mockup of the thing and I was showing it to them and my contact at Sony, who's...

Garner: Let me understand this. You mean like a Minitel type thing or what? I mean, it had a screen or something or what...

Belleville: Yes, it had the screen. I don't remember Minitel.⁶

Garner: That was the European thing, yeah.

Belleville: What would I have known about? I don't know what I would've known about.

Garner: It wasn't well known in America.

Belleville: No, but I wanted to build-- 'cause I'd had a lot of experience working-- on the Apple Talk network, we were going to use switches, private switches, as the backbone of the network after Apple Talk. In other words, to get more area, we were going to use ISDN.

Garner: Whose idea was that? Was that yours?

Belleville: Mine.

Garner: Was yours, okay.

Belleville: And so-- who else would it have been? And so we...

⁶ I did know about Minitel although I never saw one.

Garner: Just as a comment, though, we didn't envision switches at Xerox, remember. We just had these cables. We never thought that ...

Belleville: I understand.

Garner: ...central switching, so somehow you came upon that by reading or thinking, or how did you come upon the idea of using ISDN switches?

Belleville: In the course of doing the Apple Talk network and for some reason because of the Mac (I can't remember what the connection was) we got involved with AT&T, Steve and I, and I went out to Boulder, Colorado to where AT&T was building their private switches, and talked with them there, and I said, "You guys are, like, you know, only a few milliseconds away from having a network with this box that you already make," so when a phone goes off hook...

Garner: You say a network. You mean an Ethernet-like network or you mean...

Belleville: I mean a star connection network.

Garner: Star connection network.

Belleville: Because remember, when the Ethernet came out, because you were right there when that happened, IBM immediately went into this fear, uncertainty, and doubt thing and said, "Well, you know, the cable will burn up in the plenums and it won't work" and so forth, but I looked at it and I said, "People are gonna climb up in that thing. They're (installers) are going take a cable television boring tool, put it around the thing (coax cable), screw this thing in (Gerold cctv tap), get a hold of a little probe that goes up and hits the (center connector) -- that isn't gonna happen. That is not gonna happen," and it wouldn't have happened. Had that been Ethernet, that would've failed.

Garner: Killed it, yeah.

Belleville: (You and I) know Ron Crane solved that problem and I'm not sure what other help he had, but that problem got solved later.

Garner: Yeah, you mean with the twisted pair.

Belleville: With the twisted pair, 'cause people were doing that already. They were putting, you know, five taps in one place and running the cables. How long can you run the cable from the tap? Remember that? So I knew that that wasn't gonna work and Apple was early enough that the network hadn't really established. In fact, the Apple Talk network was much more popular than Ethernet for a very short period of time, before the Ethernet cards became good and the...

Garner: For the PC, yeah.

Belleville: ...before the six wire...

Garner: Four wire.

Belleville: Four wire?

Garner: Uh-huh.

Belleville: But it's in a six wire connector.

Garner: Yeah.

Belleville: RJ-45 connector. It is six wires, isn't it? It's twisted send/receive and power, isn't it? I don't remember.

Garner: Oh, you count power, yeah.

Belleville: But RJ-45. Before the RJ-45, people had to take coax (thin coax and BNC connectors) and run it up from computer to computer, which is sort of okay, but it's pretty geeky, and then you had to put terminators on things and you had to make sure the terminators were in the right places. It wasn't gonna work, and so the Apple Talk network had -- I wrote this specification for it and its only specification, really was, if the user can get it plugged into a Mac and something else, they'll communicate, so I figured as-- you know, we didn't have wireless and that was impossible, but that was my rule, so Apple Talk was going and Apple Talk was only 256 kilobits, and that's fine for documents, but that's not fast enough...

(The original Mac had only 128K bytes of memory. It would only take about 4 seconds to copy all of memory to the network. In the same way the floppy disk was only 500Kbytes – 16 seconds.)

Garner: I used it in my house <chuckles>.

Belleville: It's not fast enough for even voice, nothing with video or pictures, and so I knew that would have to go, but I knew people would have to get used to using a network and having a shared printer as a relatively expensive resource that you could share was gonna be the way forward in that. Also, the file server would be a way of not having to have every machine have a huge amount of disc on it, so I was continually working with where that was gonna go and one part of that was working with AT&T to see about how to use switches. We walked-- worked with the company that was a spinoff from Rolm. Is it Rolm? Yeah.

<https://en.wikipedia.org/wiki/ROLM>

Garner: Yeah.

Belleville: 'Cause it's four guys' names. We know most of them, I think, but they were building a little private switch and they-- or big private switch perhaps, and they-- somebody spun out of there or something spun from there. It was called David Systems, as in David and Goliath...

Garner: I've heard of it.

Belleville: ...and they were gonna build a cheaper, better switch.

(In 2023 RLB was unable to find any web information about David Systems.)

Garner: ISDN again.

Belleville: Probably ISDN and so we thought about buying them. (0:40:16) We were working with them, but I was also working with a guy called Tommy Thompson, who was an executive vice president of AT&T, who wanted to be-- to buy the Mac's kind of OEM number and sell them out as stations on their network. We went out to Bell Labs, to the hallowed halls, and-- 'cause AT&T had a really interesting backplane kind of switch. It was star connected kind of thing, but there was a backplane and a bunch of wires. All the things came into the backplane and time division multiplexed into the backplane. It was very clever and I thought it was a possible solution to the problem, but the one I knew would work was-- when you pick up a telephone, there's a dial delay that happens, several milliseconds long, while the switch goes around, but the switches were all digital even then and I said, "If you can lower the pickup time on that line to below a millisecond, it's a switch-- I mean, it's a network." (If they understood) -- you don't need anything different. You can transmit very high speed on these wires, which you do with ISDN,

and you can-- all you have to do is make sure you can service these lines in a timely fashion. So the idea was to go that way from Apple Talk. Meanwhile, Ethernet made an end run, as Bob Metcalfe likes to explain.

Garner: Oh, yeah, they totally replaced ISDN and...

<overlapping conversation>

Garner: ...become Ethernet switches. <laughs>

Belleville: It's all gone now. Good question.

Garner: Yeah, 'cause the original ones were all circuit bay switching and it probably took them a while to find available circuit, right, and then that was the problem.

Belleville: Yeah, exactly right, but it wasn't-- they weren't that far away, but the problem was, they were so incredibly entrenched. They just couldn't get it, and I talked to people who-- very few who could get it, and they could make no headway with inside AT&T at all, so they lost that whole opportunity. But the buildings were already wired. The infrastructure, all those little punch boards and the cabling systems and everything was all worked out and we didn't have to do that over again, which is what Ethernet had to do. They had to do that whole thing over again, which essentially wasn't necessary, but that's what we ended...

Garner: So did they tell you why they couldn't get that initial ... ?

Belleville: It wasn't a technical problem. They couldn't...

Garner: It wasn't technical?

Belleville: They couldn't think that would be useful. It was as simple as that.

Garner: They must not have thought it was-- it wasn't a real requirement or something.

Belleville: Yeah, they thought it was a real requirement.

Garner: Was not a real requirement, I mean. They must've...

Belleville: But it was a real requirement, of course, for it to be a network. But we're only off, like, 20 milliseconds and it wasn't as if it was a Strowger switch with relays. It was a physical computer and it was switching those things at the speed of light, so I don't know. Anyway, we did-- I didn't succeed getting a cooperative deal with any switch maker. We didn't buy David Systems.

Garner: Well, it was partly because they didn't believe in packet switching, I assume. Maybe this was-- that was the reason ...

Belleville: I think maybe they felt threatened by packet switching.

Garner: Yeah, so they just...

Belleville: But they, you know, inside Bell Labs, they had-- they knew all about that stuff. There's lots of ways to do it. It's the same. Ethernet's not the only way, and the AT&T way, the Bell Labs way-- I can't remember the name of that system, but it was a good design. Whether it would have scaled to the size..⁷

Garner: Okay, so we're back to, you left Apple and you went to do a phone, so that's how we pop the stack.

Belleville: Good, thank you.

Garner: <chuckles>

Belleville: I was working with Sony and they made phones, and I thought we could do a home phone or, you know, a consumer product phone. It'd have a little screen on it. We'd do-- we just take advantage of the fact that we could do slow network work order phones. They can pick up the phone and transmit data over. It could have a dialer. It could have a way of doing messaging. It could do all kinds of things. I had it pretty well worked out and I could do it on a very small display. So the LCD displays at the time were pretty primitive. They had very poor viewing angles, but they were getting bigger and bigger pretty quickly, and so I worked hard with Sony and my contact there, Jimbo-san, last name Jimbo, he called me up. I was living in Los Gatos. He called me up and said, "We're not gonna do it. We can't the general managers." Sony's run by about 50 general managers that actually run Sony and they couldn't come to consensus that they should make this investment and do the phone. That was a very sad day for me and so I called Peter Ashkin and I said, "Let's start a company and do the phone." -- Peter came and we

⁷ Of course once almost everything was wireless, the ALOHAnet idea was just renamed Ethernet and there we are.

worked together for a long time and we tried to round up venture capital, which was-- I didn't wanna do and he needed to do. He needed to do that because he needed a salary, and I was willing to live extremely cheaply to get away from dealing with venture capital. So I rounded up half of the venture capital and I said, "Peter, it's your turn now. You round up the other half and we'll be in business." He couldn't manage the other half, so that failed, it failed. Peter had already designed a telephone-based voice compression system that you could use the telephone to compress voice and send it over the line digitally and also to do things like-- a thing which none of us like is-- we had no idea it was gonna get out of control with this, but to do robot controlled order entry over the phone. So what we now do on the web, I anticipated being able to do on this little computer with a link and you could go in and it would speak to you and you could poke the buttons on the phone and order things and here are the-- it was cool. We demonstrated it. We showed it to Floyd Kvamme. People couldn't quite figure out-- you know how it is with venture capital. People couldn't quite figure out what to do, and so finally, Peter really needed to get work and I needed to leave the country, and so I went to Germany.

Garner: How did you know-- where'd you know Peter from?

Belleville: He worked for me at Apple. Peter's a...

Garner: So you went to Germany.

Belleville: ...electrical engineer and good man. I, through some friends, I got in contact with Siemens in Munich and they were in the private switch division, and they wanted to build-- they had already built a telephone and they knew my interest in this and they said, "Come to Germany and..."

Garner: Maybe that was one of the Minitels or something. That was a French thing, so ...

Belleville: No, it wasn't a good thing; it was a terrible thing. It was a big box about the size of a small minicomputer in those days. It was a horrible thing that they dreamed up and...

Garner: Over-engineered, perhaps.

Belleville: Well, yeah, it was way over-engineered, but you've been here as long as I have and products are hard to do and sometimes the specification gets in the way of the product. Can't quite figure out-- nobody knows quite what it is, so you write some godawful specification and if you build that, you're really sorry.

Garner: <Inaudible> try again.

Belleville: So through these friends, I went to Munich, 'cause I'd always wanted to live in Europe, so I moved to Munich and lived there for a year. I worked as hard as I could to get the Germans to build this phone and I eventually failed. Siemens was making a little PC, little tiny thing, and so I got them to get me one and I got a C compiler and wrote the model and I got it to run on this machine and to demonstrate how you could have a calling list and do messaging and things like that, and they thought, "Wow!" Some people, my boss and his boss, said, "This is really exciting. We could do this. This will be (in)expensive." The box they had was, like, 10,000 dollars. Ten thousand dollars is too much to pay for a telephone. They sold five of them. It wasn't gonna work, and so-- and they had ISDN. It was already running, so they brought in their user interface group and user interface group looked at it and they looked at it -- they said, "How'd you do this?" It'd only taken me a few weeks, and I said, "I just got the C compiler, wrote this stuff. This isn't hard," and they said, "We have 400,000 dollars worth of rapid product development. We couldn't do this in six months." He says, "We'll get back to you."

Garner: You're embarrassed, them, now.

Belleville: Honest to God, it took them six months. They came back to me. They had built slightly less...

Garner: <laughs>

Belleville: ...and it was hopeless. It was just absolutely hopeless, and I-- it was the first time I'd actually gotten the inner guts of the ISDN spec in my head and I realized ISDN was gonna fail because it was just designed very badly.

Garner: It's all based on time synchronization between two distant points.

Belleville: Technically, it's probably okay, but the way they had layered controls like-- the one I use as an example is, they had a field to control the language that would be used by the operator who might answer the phone. Well, that's a real problem. I'm not saying that's not a real problem, but putting a field in a data format in that particular way is not gonna solve that problem, 'cause the problem will get too complicated too quickly beyond that. You need something much more powerful, like an XML kind of a thing or something way more flexible.

Garner: Extensible, yeah.

Belleville: And they were just gonna die. Spec was, like...

Garner: I remember, yeah.

Belleville: ...thousand pages or something like that, so I did-- I finished out my year in Germany and came home and it was a lot of kissing the ground for a long time. I really didn't wanna live in Europe <inaudible>.

Garner: Did you enjoy the German culture at all?

Belleville: The German culture's difficult to live in. It's more fun to visit than it is to live in.

Garner: It can be very-- well, the engineering culture can be very set and rigid.

Belleville: Very set and very-- the business environment was very regimented. So they got nothing done, but-- and other things just didn't (work out) -- I was also not well, as we talked about last time. It was cold. It was really cold. It was a record setting winter and the summer rained all summer and forth, so beer gardens were closed and the rain was terrible.

Garner: Miserable.

Belleville: I came back and started looking around for something to do, and I'm not quite sure—oh, I was...

Garner: Nineteen eighty-eight, you came back?

Belleville: Yeah, I came back in '88 ('87 fall) and I went-- I was working in my house and I'm not quite sure what I was doing, but I was in contact with Jeff Huskamp. Not Jeff Huskamp, Jeff Harbors of-- Jeff Harbors had been my alter ego at Microsoft, so when we did the Mac-- while we worked with Bill a lot and were in meetings with Bill all the time...Jeff Harbors died in a plane crash in 2006.

Garner: Bill Gates, you mean?

Belleville: Bill Gates, yeah, 'cause Microsoft was really little then. It was just in that one little building.

Garner: Simonyi was there, but...

https://en.wikipedia.org/wiki/Charles_Simonyi

Belleville: Simoni was there, but he was beavering away on Word during that time. I don't remember seeing Charles during that time. It was Charles and I who thought about starting a company. We were talking about, sitting around in at PARC, you know, out on the patio talking about starting a company. As with many people, when-- you've had this conversation times, I'm sure. People say, "We'll start a company" and you say, "What will we do?" and they will tell you this list of technology that they wanna do and you will say, "Well, which part of this is this and which part will do that and where does that-- where are we gonna sell this thing and how will we structure this?" and then it all gets very complicated and they realize their idea's awful complicated, and so Charles was spirited away overnight and ended up up there where he got fabulously wealthy and did a pretty good job on Word. But I didn't talk to Charles again for many years until later, when they tried to hire me to be the manager for NT and I spent a day up there with them.⁸

Garner: And you said no to that. <laughs>

Belleville: I wasn't first in line for that job. That was one. They'd already been through people who could've done a good job on that. They finally got to me and I said, "I can't do this job, probably and secondly, I can't live in Seattle, so that's just not gonna happen." But that was enough of that story, really. I was working trying to get-- something worked out with Microsoft that I could do and Jeff called me one day and he said, "Well, Bill thinks we're really gonna go with object-oriented programming. We want you to come and help us do object-oriented programming." That would've been a disaster too and I had recently, because of my contacts in Germany, had met up with the 3Com people. Yes, no, not 3Com.

Garner: Well, Siemens is where you were.

Belleville: I was with Siemens. (longish pause) Convergent.

Garner: Oh, those guys.

Belleville: Yeah.

Garner: Our competitors at Sun.

Belleville: So Convergent-- the marketing-- the guy who became marketing head of Convergent (Bruce Morgan) was my contact for communication with Convergent in Germany and I got to know him very well,

⁸ Actually, in the later days of Mac before or soon after launch, Charles brought a copy of MS Word down to us in Cupertino. We spent a day sort of alpha testing on our Macs. This is late 1984 or early 1985.

and he hired me straightaway to be in the marketing, which was not a great match, but I did some interesting things there. Learned how to write blogs. Made me one of the first bloggers on the planet, 'cause I published a little newsletter explaining technologies and things we could do. During that period, I had had very similar ideas to the ideas that Bill Atkinson put into Hypercard. I don't know whether you remember much about Hypercard, but you have a small computer with a relatively small screen, and you basically think of it as just like index cards and if you flip between them fairly quickly, and put anything you want on them, they form kind of an interesting database, and so I'd worked out on just a plain PC 80 column wide by 20 row high thing that I called Business Cards, where you could pretty much type anything you wanted anywhere on this thing and you could do-- what I learned there in that work was, name value pairs will solve almost all data problems. It took a really long time for that idea to stick.

Garner: It was in the database industry at that time, key value stores ...

Belleville: Yeah, but it didn't...

Garner: It wasn't very popular, but it was in the...

Belleville: People, yeah, everybody...

Garner: ..academic literature. It was in academic literature.

Belleville: Yeah, but I just saw that that was exactly what you needed. It solved all known problems, basically, and this idea of doing tables and so forth meant you had to have tables (database tables and SQL), but this solved the problem of-- you don't know the same things about every person you have to have in your contact list, and to put-- to invent a field for every possible thing that every possible person could possibly have is a losing game, so I had that idea, so if you put something on your card and you put a tag on it, you could run a search on it and find all the tags. You could also do computational things, so it was part card, part spreadsheet, part database manager. It was very cool.

Garner: You'd done this on your own?

Belleville: I did this on my own. I wrote all the code.

Garner: You didn't give it a name. You called it Business Cards?

Belleville: I called it Business Cards.

Garner: Business Cards. Of course, that sounds like it's all it is, but <laughs>.

Belleville: Wasn't a great name.

Garner: Right. <laughs>

Belleville: I needed another person.

Garner: Hyper business cards <chuckles>.

Belleville: I needed that. I tried-- I almost got it to the guy who started the software company down in Scotts Valley. (Philippe Kahn)

Garner: Oh, yeah, Borland.

Belleville: Yeah, whatever his name is. Almost sold it to him. I almost sold it to-- I almost had a chance to sell it to Oracle, but-- 'cause Smoky Wallace, who I knew from SRI-- you know Smoky, right? Probably?

Garner: Uh-huh.

Belleville: Passed away 10 years ago, I guess. He was working for...

Garner: He was what?

Belleville: He was working for Oracle. He was working for-- what's Oracle's...

Garner: Larry Ellison.

Belleville: Larry Ellison. He was working for Larry Ellison and he said, "We'll show this to Larry. He might like it." So Larry decided he wasn't interested, didn't wanna see it, so I needed a job <chuckles> and what happened was, Bob Metcalfe was kind of looking out for me. Steve was kind of looking out for me, basically, and Steve and Bob Metcalfe happened to talk unbeknownst to me, and Steve-- Bob Metcalfe probably said, you know, "What happened to Bob Belleville? Did he kill himself or what?" and...

https://en.wikipedia.org/wiki/Robert_Metcalf

<overlapping conversation>

Belleville: "I think he's looking for a job, you know," so Bob Metcalfe called me and I went to work for Bob, and I worked very briefly at 3Com and I had my...

Garner: Ron was still there, right, Ron Crane?

Belleville: Ron was definitely there. Ron and I worked together there. Ron and I tried to work together, although we couldn't quite get a grip on things. I wanted to build-- I was still trying to build this phone, to be honest, and we can do it there.

Garner: He was doing transceivers and <inaudible>.

Belleville: He was doing whatever he wanted to do because he was alone. And Bob wanted to sort of exploit my local fame in the sense that, you know, here's the guy that did a lot with Macintosh and so we could do something, and so he was trying to do promotions and things, and so he gave me a little lab (very near Ron Crane's lab) and I started building another phone, and by that time, you know, year by year, the technology is improving, so I built a pretty neat phone and I did-- had video on it, especially things like-- I had a wonderful boss there, is what I had. It was a great thing. Having a wonderful boss is the best thing in the world, and so my boss said, "You can't use a video camera to do text 'cause the resolution's not high enough," and I said, "Oh, you can," and he said, "Well, you have to prove it," so I got a camera. I bought a camera on my credit card and I-- a Sony videocamera cost 2,000 dollars in those days. I bought it, hooked it up to this thing, had a video card somehow. I don't know how, something commercial. I stuck it in some sort of PC and I put camera picture on a high resolution camera and you could read the text, of course, because it's grey level, just like the NeXT did. Right, so he says, "Yeah, this could work," and so we had video. Multimedia was a big thing, so the network was coming up. It was a little bit before the web, but multimedia was coming up. We actually-- I think...

Garner: Yeah, this is 1998 (no 1988). Yeah, SGI was certainly pushing video stuff. Everyone was soon going to do the video server game in a few years.

Belleville: I was doing that and-- oh, I don't remember how it happened, but I had my next to the last-- my penultimate mental breakdown and-- oh, I think-- oh, I know what happened. My boss had promised himself a sailing trip to the Sea of Cortez. He was a sailor. He was gonna leave from San Francisco Bay, sail down the coast and into the Sea of Cortez. He (was going to) repeat the Steinbeck experience and he has boat and he has radio operator's license and he has plans and he has-- he was so happy.

Garner: Sounds good.

Belleville: Got his boat, sailed down to the Sea of Cortez, and got a phone call his children had burned his house down.

Garner: Oh, my God.

Belleville: He had to come back, but when he left, they said, "Bob, you have to take his job," and I didn't want his job. I didn't want his-- he had a bunch of employees that weren't very happy with me. They thought I was a dilettante, which I probably was.

Garner: Well, that was what you were kinda doing, I mean.

Belleville: That's what I was supposed to do, so it just-- I did the job for about five minutes and I just, "I can't do it. I want my old job back. Go away." And so I left-- what I got from Convergent was my wife. That was the most valuable thing I got at Convergent, (from) 3Com. I moved over to Silicon Graphics, though I think there was a break there.

Garner: Yeah, looks like a year or two.

Belleville: Yeah, I did some work with a company called C Cubed.

Garner: Steve Purcell.

Belleville: Yeah.

Garner: My close friend <chuckles>.

Belleville: And Alain Rossmann and the guy who's in charge of it was Ed Sun, I think his name was.

Garner: Yeah, right.

Belleville: And they wanted me to do something. I don't know quite what. They wanted to build a camera. And it was too early to build a camera. They were doing MP3, MP4...

Garner: Yeah, four...

Belleville: ...encoding.

Garner: ...decoders and that.

Belleville: They had a chip for doing MP4.

Garner: Encoders and decoders.

Belleville: And they thought that you could just build it into a camera and I kinda felt like, well, y yeah, you have an MP4 encoder, but there's a whole lot more to a camera than an MP4 encoder and, you know, most of the technology just wasn't there (it was in Japan), so I helped them out the best I could, but wasn't much I could do. I built them an assembler so they didn't have to hand code the macro code for the MP4 chip, which they were very pleased with, but that didn't last very long. It was a horrible job, basically.

(What they were building was a JPEG encoder not mp3 or mp4.)

Garner: Was a tiny startup that time.

Belleville: Tiny.

Garner: Yeah. Small.

Belleville: Then there may have been other things in that period, but I started interviewing with SGI and went to work with-- for Carol Peters, and they had built a workstation and they wanted to build a little lightweight one, and so since I knew about Mac, they thought I could just sprinkle fairy dust and it'd have his thing, so I went to SGI.

Garner: Big mistake to compete against Sun <laughs> try to. <laughs> Andy (Bechtolsheim) <laughs>...

Belleville: SGI. Well, you know a lot about them, so I had my final mental breakdown there when somebody called me on the phone and said, "You have to come to this meeting immediately and do this and this and this." And I went to Yosemite for a week.

Garner: Alright.

Belleville: And I thought they'd fire me, but they didn't, so-- they transferred me over to Forest Baskett, which was very kind on their part, and bad things will not be said about SGI. However, I went to work for Forest (Baskett) and I went to Forest and I said, "What shall I do?" He had a little tiny 12 person quote unquote "research thing," where he said, "We don't do research." I didn't know how to do anything except think about what products would be interesting and how to get far enough ahead of the curve to be...

Garner: Pushing the envelope forward, yeah.

Belleville: e said, "Do whatever you wanna do." Well, that, I'll point out to anyone who thinks getting to do whatever they wanna do is a good deal...

Garner: ...is easy...

Belleville: ...it's not a good deal. That is a very hard deal, and so-- I suppose it's a good deal if you don't have much ambition, but I had a lot of ambition and still had a lot of things I wanted to. And I set myself the research topic of, why is it so difficult to get your computer to do what you want it to do ...

Garner: Do what I mean, not what I say, that old phrase?

Belleville: Well, just anything. I mean it is still not a solved problem – so I had my little office and the problem was, I was really far down the curve on my thyroid failure and I was freezing cold all the time, and they thought I was just mentally ill. In fact, they sent me to a psychologist, which was a lot of fun. I had a lot of fun with the psychologist, learned a lot, but it didn't solve the thyroid problem, so I was just literally by myself. You'd think a 12-person group would be no problem, but it was a bunch of people were really on specific kinds of things. And the first thing I realized was people would have to program in order to get the computer to do what you wanted to do. So I spent a lot of time thinking about programming languages. That was a period that was in the full thrush of everybody and his brother thinking up a programming language. (for example Python started then) But I went back and understood how LISP works and really understood more fully how--

Garner: Smalltalk?

Belleville: Smalltalk worked and what really is involved in--

Garner: Did you talk to Alan at all during that time or--

Belleville: Alan--

Garner: Kay.

Belleville: --Kay?

Garner: Kay.

Belleville: No. I don't know how well you know Alan Kay. Do you know Alan Kay?

Garner: I know him pretty well, yeah.

Belleville: Yeah. I think--

Garner: He's--

Belleville: I don't think Alan Kay thinks at the level that I think. I think Alan Kay thinks at a higher level, not really worrying about the lower things. I think at a higher level, but I'm always completely worried about the low level. And maybe you can verify that in from your own experience.

Garner: Alan's gone through phases, I think, in his life.

Belleville: Yeah. In the very old days he might've had different view. But I always credit Smalltalk more to Adele Goldberg than Alan. And probably a few like Ted Kaehler, was it?

https://en.wikipedia.org/wiki/Ted_Kaehler

Garner: Yeah.

Belleville: Over there. I think they probably did all the hard work.

Garner: Yeah.

Belleville: And I'm not sure those are the issues of human programmability. But we don't want to get into things that still haven't been figured out. The second thing I realized was everything in your computer is lost. The only way to find it is to search for it. And this was slightly before the web took off. This was slightly before Alta Vista, the DEC search engine, was--

Garner: The whole concept of indexing instead of searching.

Belleville: Yeah.

Garner: Yeah.

Belleville: And so I set myself to learn how to do B-trees and so on. (Conversations like this you blank on names because I have so many names.)

Garner: We can fill them in later. Yeah.

Belleville: In my head.

Garner: <laughs>

Belleville: But the two brothers, Martin Haeberli and his brother (Paul in the 'research' group at SGI)

Garner: I know Martin. I didn't know he had a brother.

Belleville: And his brother. And his brother (please ignore this mental lapse)

Garner: Because Martin worked on the optical mouse, which I worked on at PARC, yeah.

Belleville: Yes. And Martin worked for me at Apple.

Garner: Ah, okay. I didn't know that.

Belleville: And then his brother was in the research group. And they're both super smart. And super innovative kind of guys, and very much iconoclasts. And Martin's brother (Paul) said, "There's only two

ways to search, Bob. Hashes and B-trees.” <laughs> I never thought about hashes. I immediately went to try to discover how hashes work, how that whole system works.

Garner: Well, you’re on the right track then, you know. Yeah.

Belleville: And so I built the hash engine. And I immediately built an actually magnificent search engine that would do documents, so I was running on a, one of the SGI workstation machines. I think it was about a hundred megahertz machine, something like that. So not modern standard machine, but a pretty fast machine. And I could take a hundred megabytes of textual data, run an index on it, and find any page in 30 microseconds.

Garner: Hm, that’s good.

Belleville: In 19—(’91 or ’92 about)

Garner: You probably had a lot of memory in it.

Belleville: Used a lot of memory.

Garner: Yeah.

Belleville: It turns out it was (the code was) really small.

Garner: Right. Oh.

Belleville: Everything about it was small.

Garner: Oh.

Belleville: It was a very clever hierarchy of hashing procedures.

Garner: Hm, I see.

Belleville: Very simple little data structures that were built. Problems associated with that are you have to parse the input text, you have to decide what words really are, which is lot of the harder problems.

Garner: To rate the data, as they say.

Belleville: I think the Google thing solved the problem by just assuming everything was a word. I had to-- I couldn't assume that everything was a word, because 56 is not a word. You know, a phone number's not a word. Lots of things are not words, of which there's a huge number of them. Product names are, only certain parts of product names are words. It's a very hard problem, that part of parsing.

Garner: Why did you care what a word was?

Belleville: Well, because I had to put them in a hash table.

Garner: But you could've put everything into the hashtag.

Belleville: Well, I couldn't put-- in those days I couldn't.

Garner: Because of the memory constraints.

Belleville: Because of memory--

Garner: Okay.

Belleville: --restrictions on it, so... And I didn't necessarily want everything in the memory.

Garner: Because that's what everyone does today.

Belleville: Yeah, absolutely. Yeah.

Garner: Yeah. <laughs>

Belleville: No problem. But in those days I'm a little constrained. And so I built this thing, and it had-- I built a system and I was grabbing data from-- I had, like, a serial line that I was using bulletin board

systems, because (the web) wasn't there yet. I gathered all kinds of big, ugly databases, then I parsed it and stuck in this thing. One thing I found was a dictionary out of a spelling machine. It was online. I brought that in. And it had all sorts of weird things in it, like the birth dates of baseball players and words and like that. And I have very poor spelling. And my spelling, my brain works in a very odd way, and sometimes I can spell a word and sometimes I cannot. It's been that way since I was a child. It caused me all sorts of trauma as a child. <laughs> And I was writing a document for somebody and I needed the word Columbus for some reason. And I was sitting there on (my) this search engine, before the search engine existed, and I said, "Discovered America." And I got two hits. And I thought, "Whoa."

Garner: <laughs>

Belleville: "I have discovered something here." So we got Christopher, of course. But we also got Leif Erikson. And I said, "This solves all known problems." "With name/value pairs, and this kind of searching, this solves all known problems." And I think now been proven that it does solve all known problems. I didn't get to do the actual--

Garner: Including spelling challenge. <laughs>

Belleville: Including spelling challenges. One problem, of course, is technical documentation. And there are two aspects of that. One, somebody might have to write it, but two, users need to improve it as time goes on. This solved all that problems. When you are engaging in a new technical problem, you don't know all the vocabulary. Use other words and you'll find the words that people use. You'll be drawn into that thing. This was in the very early '90s. And the Web was just coming up. And I had my first experience with the Web. I was scared to death that this thing was going to die, because there was no way to find anything. You had to, you know, go to lunch with your buddies and get the new URLs and find out what you're going to do. Then a friend of mine came in and said, "Well, have you heard about Alta Vista?" I got the Alta Vista website. I learned that. I thought, "Oh, this is going the right direction." This was still before Google. We had an annual R&D event for the senior staff of SGI, where all of our activities were exposed. I went to this event with my search engine and my stuff, and Tom Jermoluk was in charge of SGI (CEO or COO). You might remember him.

Garner: Tom what?

Belleville: Jermoluk.

Garner: I remember the name. I don't think I ever met him.

Belleville: Jim Clark, founder.

Garner: Yeah.

Belleville: Had kind of gotten mad at him, I think. I mean, he was still the chairman maybe, but he was not operational. They had a very good president (Ed McCracken) who I liked a lot. And he, I think, they made enough money he wanted to do something else or... And Tom Jermoluk became in charge of SGI. He and his senior staff were sitting at this thing and they were just bored to tears. And I was trying to catch their attention, but they were talking among themselves and so I did my little speech and sat down. And absolutely nobody got it. And I would go take my dog-and-pony show and go show them everything. And one of the things I'd say was, "What would happen if you put all your e-mail in this thing and just threw it in there?" Just everything you'd ever seen. Every web page you'd ever visited, every e-mail you ever got, just throw it in this thing and then just ask the questions. Because you'll always remember something. And they said, "What?" <laughs> They just couldn't understand--

Garner: Huh. Couldn't understand.

Belleville: --that you don't need hierarchical structures to store data. And I knew that all hierarchical structures would fail.

Garner: Yeah. You were ahead of your time on that.

Belleville: Yahoo was doing this curated web thing and I thought, "There's not enough people in the world."

Garner: <laughs>

Belleville: Not to mention the fact that when you put information in a hierarchically--

Garner: No one else knows what the hierarchy is.

Belleville: It loses value.

Garner: Right. No one else knows what the hierarchy is.

Belleville: That's right.

Garner: Well, yeah.

Belleville: And so you cannot discover these hierarchies, because you have to look at every branch of the tree to find out what's in it.

Garner: Yeah.

Belleville: Now, everybody knows this, everybody accepts this. But then, they wouldn't do it. They wouldn't even think of--

Garner: Well, I think again, the magic missing ingredient, Bob, is the--

Belleville: Steve Jobs. <laughs>

Garner: Well, perhaps. But actually, yeah. The sense that even when Google was started they didn't know how they were going to make money. And all your execs at SGI are probably thinking, "How is this going to make money?"

Belleville: Yeah.

Garner: And there is no inherent way to make money when you look at it as a technical thing, right?

Belleville: Right.

Garner: It was only when the marketing people at Google realized or that company they bought that you need advertising, which is we don't think that way in the workstation and compute business, right. We don't wake up in the morning and go, "Oh. The way we're going to make our products successful is to open--"

Belleville: Give it away and sell advertising.

Garner: "--up advertising." Yeah. We didn't think that, right. I mean, the network was anti-advertising, so none of us had that in our genes.

Belleville: No, we didn't.

Garner: So any idea like this, how would you make money, you know? I mean, software's free, so...

Belleville: Yes. Well, I thought--

Garner: You should've written a book at that point. <laughs>

Belleville: I was very sick in those days and so couldn't have done anything. I could barely work.

Garner: Ah, I see.

Belleville: I think I told the story last time. I reached a point with that thyroid. I'm like one of those people, you know. If you're cold all the time and you haven't had a thyroid check, you should, because eventually--

Garner: Yeah. I have a friend who's had the issue, yeah.

Belleville: I got to the point where I could no longer read. My metabolism was so low that my brain stopped functioning.

Garner: Mm-hm. Wow.

Belleville: So I'd look at a piece of paper-- it's still partly true. By the later part of the day, there's a lot of documents I can't read. I can read fine in the morning and I taught myself to read again afterwards, but at the depth of that, before it was, I got the treatment, I could not read. I'd look at a page and I'd just say, "What nice words. I know there's some nice words there. I wonder what that means?" you know.

Garner: <laughs>

Belleville: It was really scary. I couldn't remember when I'd had a bath. I couldn't-- it was nothing. Nothing good about that. So I was quite ill in that period. And I've had more energy, more thyroid, more... Somebody helped. Somebody stood up and said, "This is fun. Let's just go work on that for a while." It would've been different. But it wasn't. And they lost that whole thing.

Garner: Mm-hm. You mean SGI now?

Belleville: SGI.

Garner: You're talking about. Yeah, well, we're sitting in their building. Thank you, SGI.

<laughter>

Belleville: Yeah. I was just down the street.

Garner: Uh-huh. Were you ever in this building at that time, when it was here?

Belleville: I was in this building few times. This was International Sales.

Garner: It was International Sales.

Belleville: So I rarely had a reason to come here.

Garner: Yeah. But they had a computer center from down there, which we've now occupied. But they had-- so they had computers in this building.

Belleville: Mm, I don't know. They did run-- they're constantly having to sell the stuff, so they had all kind of stuff going on. I wasn't operationally connected to that company. And I kept, the last year I was there, I told one of my friends, I said, "You know, I'm giving myself one more year. If I don't become relevant in this company somehow, I'm leaving." Things got rough in 1998 for SGI.

Garner: Mm-hm. Yes, indeed.

Belleville: And we had a stupid meeting with Forest and the rest of the staff and Forest says, "Well, this is just a 10 percent hit to cash flow and we'll recover this."

Garner: They weren't concerning themselves with reality, that they're--

Belleville: And I looked at Forest and I said, "Forest, you got three businesses."

Garner: Yeah.

Belleville: "You got supercomputers, you got servers, and you got workstations. You're going to lose your workstation business to the PC. You're going to screw up your supercomputer business because you're not paying a bit of attention to it. You just bought Cray," or whatever they were when they bought them. "And you have no idea what to do with this business, and so you're not going to do anything with that. And you are ignoring the fileserver business and you're letting everyone else in the industry, including SUN, eat your lunch on file servers. You don't have a 10 percent revenue shortfall that you're going to recover. You're going out of business."

Garner: Going down the tubes. <laughs>

Belleville: And <laughs> it was a, "You just don't understand, Bob--"

Garner: <laughs>

Belleville: --moment, and I did. I told Forest I was going to retire, so... So I retired. And the reason I retired mostly was I had to go to a doctor and have enough time to get fixed. I just hated the way the industry had evolved so much. You must've felt a lot of that same thing. I mean, it became all about money. And not in a sensible way. I mean, I'm not opposed to money. Money's great. But most computer things, when you start them, don't really have that clear of a course for how they're going to make money. That was the thing with Cub. You know, "Bob, will it make 500 million dollars?" Said, "I have no idea."

Garner: <laughs>

Belleville: And said, "Well, we can't do anything with less than 500 million dollars." I said, "How would you do-- how would you get started if you had to start at 500 million dollars?" You have to make too much up-front investment to fool with something that's going to feel like 500 million dollars when you don't need to make those investments. You can't productively use that money.

Garner: Yeah. This is the one with all large companies.

Belleville: Yeah. And even understand the problem, but there's lots of ways. And now, now we don't really have the problem. The problem is you start a small company and you run it up to some level and you fuse it in with someone else. So that, most of that problem has more or less gone away. But, you know. And that was the transition point between hardware limitations and software limitations. I mean, we've always had software limitations, but we went through this part where hardware's no longer an issue.

Garner: Yeah. With performance doubling every 18 months, it eventually became less. There's a human scale thing that <inaudible> most of the problem.

Belleville: It's just the things that I would sit for hours and hours and hours and hours and struggle with at every level of my career. "How do you get this to actually work fast enough to be useful?" One of the things on the search work was it has to be really fast. I mean, really fast. Because you don't want to commit your-- your brain is a very powerful gadget, but it has lots of limitations, bandwidth being one. And it isn't good at formulating complicated questions and then waiting a long time for an answer. It's much better at just throwing things out. And I knew that straightaway. I knew that way before we proved it conclusively with Google. The search engine-- I told you that number, which was true-- it could get any, you know, it's small by current numbers, but out of a hundred million byte database it could get any page in 30 microseconds. On a hundred megahertz machine.

Garner: That's good.

Belleville: So very quick.

Garner: Wow.

Belleville: And so you could just, "Boom, boom, boom, boom, boom." And I just thought, my way up was, at that time SGI was spending a bulk of its cost, revenue, developing its version of UNIX. Like you guys were. And I thought that was a losing proposition, but I thought, "You know, if you're going to build a new operating system, why don't we build a new operating system and make search the core of it?" Me go back to--

Garner: Yeah, that would've been a good idea.

Belleville: If you think back to the Star days, Bob Metcalfe was really upset with people because they wanted to just have files be numbered. And I thought-- he thought that was never going to work. But, in fact, it'd be perfectly fine, I think, in the current environment. You've had numbered files and you could actually do content search, or you had a branch of that file that had a bunch of tags that you'd stuck on it.

Garner: Yeah. The filename becomes irrelevant, so--

Belleville: The filename's irrelevant.

Garner: Yeah.

Belleville: And you don't have to have them in hierarchies, because that doesn't really work that well, and that's what we're stuck with even today. So, you know, I was ready to go as far as technology was concerned. I wasn't ready to go physically.

Garner: <laughs> All right. So then you retired and now you're into this amazing hobbies. Do you want to talk about that--

Belleville: I have two.

Garner: Yeah. <laughs>

Belleville: I have one hobby that's relevant really to the computer side. One hobby that's also somewhat related to the computer side. I have been, since I was a child, interested in photography, and I've done that since I was a child. And the digital photography has allowed me to work in a much more interesting way. And that has evolved a life that I didn't, I never expected, to live. When I was a kid in high school, I thought I'd be a writer. There weren't any computers in those days. I had just barely seen one. I was interested in that, and I still am interested in that. But photography's a different artistic pursuit. And with the training that I've had over my whole lifetime, you know, I had a chance to work with Ansel Adams in the '70s and most of the West Coast people.

Garner: Was that a class you took?

Belleville: Yeah. I took a-- I got to go to the Yosemite workshop. He was also very active in the Friends of Photography down in Carmel. We'd go down there for workshops and weekend events, and talk to the photographers. So I met many of the West Coast School photographers that are, they're still alive, or were alive in the '70s. And it's been a real... You and I both have things we really love to just do. And photography is one of those things I just love to do. When I'm doing that, I just don't care about anything else. It's very relaxing and very challenging at the same time, but it's good. So I do more and more of that. And then--

Garner: I always appreciate the photographs you took back in the Xerox era. <laughs>

Belleville: Well, I wished I'd made more.

Garner: Yeah, uh-huh.

Belleville: Because they didn't have the... Didn't think to do it. They were probably--

Garner: Well, back then we weren't supposed to take pictures.

Belleville: Weren't supposed to.

Garner: Yeah.

Belleville: For one.

Garner: So right. So... <laughs> Right.

Belleville: People did. Bill Atkinson took a lot of pictures.

Garner: Ah.

Belleville: I don't know what he did with them, but he is one of the first ones to get one of those little, tiny, 35 millimeter Fuji (actually Olympus not Fuji) cameras. So I've done that. And I've been doing more and more work now with the software we have and the machines we have. You know, you can do anything you want. And now that you can do anything you want... I have a good friend who's, John Sexton, who's one of the last remaining black and white print photographers. Works with large format cameras, teaches darkroom photography. Lives down in Carmel Valley.

Garner: Hm. I recognize the name, yeah.

Belleville: Yeah. You've seen his pictures, I suspect.

Garner: Yeah, I've seen them. Yeah.

Belleville: He was Ansel Adams' darkroom assistant for a while, but he's worked on his own since then. Does absolutely magnificent work, so no question about that. But that's really hard. And when you're done... I find that the creative expression that you can make, for me, in that, is too, too limited. It's too hard to do and it's too hard to explore. So I work much more like a painter now. And all my photographs are almost entirely abstract photographs. So that's a great interest of mine, so in watching the-- watching the evolution of the programs, Photoshop, Lightroom, all the other ones that are absolutely fascinating. And the technology, unbelievable. I have a new camera, a little bit tiny, not particularly expensive camera, that is so much fun to use because it just--

Garner: Usable. <laughs>

Belleville: It's just very, very usable.

Garner: Yeah.

Belleville: You can really-- it's like you can think about what you want to do and set it very quickly and go on. When I was in college-- changing to the, my other fascinating hobby-- <laughs> a squirrely hobby. Somebody showed me $2\pi\sqrt{L/g}$, and said that was the period of a pendulum. And I said, "That sounds great. I like that. I can put a magnet on it. I could make a pendulum go," and so forth. So spent-- built my first one in 1965. And I still, I'm on--

Garner: Your house is full of them now. <laughs>

Belleville: My house is full-- well--

Garner: Exaggerating a little bit. <laughs>

Belleville: There are ones at my house.

Garner: Yeah.

Belleville: And the current one that I started, the evolution for it about two years ago, will go into operation in a few more weeks, I hope. But I'm able to build a, I use a Parallax propeller chip as the main controller. And it's very much like the Star.

Garner: Yeah, I've noticed that. I read a spec, I thought, "Whoo." <laughs> "Sounds familiar in a weird way."

Belleville: I thought, "I recognize this. I know--"

Garner: Yeah, yeah, yeah.

Belleville: "I know how to do this."

Garner: <laughs> I had the same feeling. <laughs>

Belleville: So you get, you know, eight 80 megahertz operating system-free--

Garner: Yeah.

Belleville: --cores.

Garner: Cords, yeah, yeah.

Belleville: That you can toggle bits. And so you could make all the peripherals and you can do... I mean, in the assembly language you can work all the way down to 12 1/2 nanoseconds, so you can just iterate whatever bit patterns you want. So I can watch the clock move. I can watch the GPS to give a second, the GPS second signal, so I can do a calibration from the great world of atomic clocks out in the sky. And I can, I got a part, it's a thrill for me. I just want to make sure everybody doesn't think I take this stuff for granted.

Garner: <laughs>

Belleville: It's a thrill for me. I got a chip, it's 2 1/2 millimeters square. It's on a board, fortunately, because I can't deal with 2 1/2 millimeters.

Garner: No.

Belleville: But it has a barometer, a hygrometer and a temperature meter in it that's 10 times more accurate than what I'd been using before. Took me a week and a half to learn how to program it, but I learned how. I have infrared temperature sensors that can actually look at the pendulum without touching it. Reply to a hundredth of a degree C in less than a half a second. So I can measure the temperature of this thing. And then in the last phase I worked out how to do, use, IR photo transistor interrupters, to watch slits go by so I can actually do like you would on a digital caliper or a--

Garner: Mm-hm. You don't mean interference patterns?

Belleville: No, not interference patterns.

Garner: Okay.

Belleville: It's not that accurate.

Garner: Just--

Belleville: But just watched slits go by and measured the loss of the pendulum and measure its period very accurately. So I can watch actually the energy in the pendulum. And so I have a good pendulum that's fused quartz, and I can, once I've put this in operation, I'm using a Raspberry Pi as the logging computer, and all this stuff occupies about a third of the space of the original electronics which didn't do as well and so forth. And so that clock...

Garner: But you could almost make a portable one and you'd carry it on trips to Yosemite or something. <laughs> It wouldn't need such an environmental--

Belleville: It's a pendulum.

Garner: Well, yeah.

Belleville: That's all we could ...

Garner: Remember they used to take thermometers up there and stuff. They had barometers and...

Belleville: Yeah. One of my friends in that--

Garner: <laughs> And ships, they had pendulums, right, so... (actually not they used balance wheels.)

Belleville: One of my friends in that region is a guy named Tom Van Baak and he holds the world's largest collection of atomic clocks. Personal collection of atomic clocks. He was recently on a television program where he takes half of his atomic clocks and he takes them up to, like, an observatory at several thousand feet. They actually did it out in New Mexico (no Arizona), so you'd know where that was. What's the big observatory that's in—

Garner: In New Mexico?

Belleville: In New Mexico. So they did this—

Garner: Los Alamos was the lab, but I can't remember the observatory.

Belleville: That was an observatory.

Garner: Yeah.

Belleville: It's a ...

Garner: Yeah, ...

Belleville: Eight or ten thousand feet, something like that. And so he leaves half of his atomic clocks down at (the bottom of the mountain) -- and he takes the other three to the observatory on the top of the mountain, on the television program, they showed it very clearly of how it was, there was this difference between the two. But I asked him about it after I saw the program and recognized that it was him. And he told me about how he actually did it. He showed me the pictures that he made and he'd actually taken three clocks up and three clocks down. And he averages them out.⁹

Garner: Hm, yeah.

Belleville: And he's done it many times before, because he knows he has to do this for about 24 hours. Because there's enough, there's a couple of <snaps> nanosecond error in those clocks that you have to allow to accumulate enough data to get rid of that. So this clock will never be that, but my goal is to be able to, from an engineering standpoint, predict the period based on the environmental (conditions) and be very clear about that. But that means I have to program in C for the Raspberry Pi and even--

Garner: <laughs>

Belleville: --just program in Spin for the propeller. And I have to do assembly language on the propeller, which is a, it's a micro coded horizontal machine like you know very well. Not particularly difficult, but different than anything else that's ever been built. And then if I want to do like a web interface, I can put that on the Raspberry Pi. <laughs> You know, it's amazing what you can do now.

Garner: Yeah, yeah. Yeah. Yeah, definitely. It might be fun, Bob, to-- we could take this off camera-- but hook you up with some of the opportunities at the museum to teach kids some of this stuff.

Belleville: Yeah. I see when you do the--

Garner: As they expand the program here, yeah. Yeah. Okay. Well, we might be getting near the end.

⁹ This comment I made is incorrect. For a correct recollection of this story please see <http://leapsecond.com/great2016a/index.htm>. This is feature of relativity that clock further out in a gravitational field run faster than ones lower. Thus time runs faster at higher altitude. Pendulum clock run slower because the value of g (gravity) is lower higher up. But we digress.

Belleville: I think we should be pretty close to the end.

Garner: Yeah. We have so much to talk about. What's ThirdAndLark.com?

Belleville: ThirdAndLark is my website.

Garner: Ah, okay. Okay.

Belleville: On there you will find pictures and you will find all of my clock publications and...

Garner: Okay. Have you published any books of your photography? You can always self-publish these days, right?

Belleville: Well, we--

Garner: <laughs>

Belleville: Yeah. My wife is the big publisher.

Garner: Yeah. <laughs>

Belleville: I'm much slower. She has done two books since I told her that Blurb was a good idea. But yeah, I'm going to do a book, I think.

Garner: That's good. All right. Is there anything else for the people reading this that they might want to, any words of wisdom for, what, 40 years, 45 years of working in Silicon Valley? <laughs>

Belleville: Fifty. Fifty years.

Garner: Fifty years. Yeah.

Belleville: Fifty years.

Garner: Yeah. Follow your instincts, right.

Belleville: Well--

Garner: You haven't let other people get in the way of your instincts. I mean, that's one thing that's true, right.

Belleville: That's true.

Garner: <Inaudible>.

Belleville: And I've hopefully done that in not too rude of a way. You know, so many people do that in such a rude way. Because I've been willing to work with people. If it is something that needs doing. But almost always when you see-- you have, you have, the direct experience of when I started the 8010.

Garner: Mm-hm.

Belleville: And I don't take a lot of credit for the 8010, but had I not done that thing, I'm not sure what would've happened. We can speculate all day about what might've happened and what might not have happened, but that was, that needed, to be done. And it involved a certain amount of saying, "No, we're not going to do that. We need to do this thing." I have been lucky, very lucky, to have been with people who wanted to go somewhere, and I always tell people that the best thing, and I hope you can correlate this for me, best thing is to have a small team of people, all of which have some idea of how to do thing but have some idea that there's something hard there. But that someone else who doesn't think that, thinks hard. And to work in a team of two or three or four or five or six--

Garner: Because they complement each other in that way.

Belleville: Where you complement each other.

Garner: As opposed to competing with each other. Constantly. Yeah.

Belleville: And--

Garner: They might compete a little bit, but not to the point of killing each other. Yeah.

Belleville: Where you're not-- I think when we did the 8010 there wasn't any competition at all.

Garner: Right.

Belleville: Do you think there was any?

Garner: Mm-mm.

Belleville: I don't remember any.

Garner: No, mm-mm.

Belleville: We were all more or less fighting against one, the technology on one side, and the fact that we just had to get this all the way through Xerox.

Garner: No. We each had a sufficient amount of our challenges where we actually needed each other's help to accomplish them.

Belleville: Yeah.

Garner: Yeah.

Belleville: That is the, I mean, to have done that a couple of times in my life is the best possible thing. When you work by yourself it's hard. Have to do that on a clock mostly, and I had to do that those last eight years at SGI. Those are hard. That's no fun. But I've, before that, I always found a willing group, somehow willing group. And when you can find that and put your oar into that boat, that is the best, is-- that's the very best. The other thing that I've had the experience of that is fairly rare is being at the edge of scientific discovery, finding something that nobody's ever seen before. I did this very recently when I did a paper for the clock on tides.

Garner: On what?

Belleville: Tides.

Garner: Tides.

Belleville: So there's <inaudible> around.

Garner: Defective tides on your clock, for instance.

Belleville: They changed the amount of gravity.

Garner: Yeah.

Belleville: You can't, I can't, measure it.

Garner: Oh.

Belleville: People claim they can measure it but...

Garner: <laughs> You haven't measured it yet, yeah.

Belleville: I have seen reports from people who have data that would indicate that probably there's, like, one clock that's accurate enough, it's stable enough, to run the Fourier transform and find the signature of the tides. But I was doing the tides, and I discovered by just doing the research and doing it, that there's a point on the planet at roughly 32 degrees North, 32 degrees South. It's San Luis Obispo in California, where the, one of the tidal effects goes to zero. And as far as I know, nobody's ever seen it. Nobody's ever explained that. I couldn't find it anywhere in the literature. I couldn't find it, nothing.

Garner: Yeah. Because it's inside the surface somewhere, probably, right?

Belleville: No. It's a very odd effect having to do with how the sun effect and the moon effect--

Garner: But where is it relative to the...

Belleville: It has to do with where the sun goes up and down and the moon goes-- the moon and the sun.

Garner: But, I mean, it's the point on the surface of the earth or is it inside the earth?

Belleville: Yeah, no. It's on the surface of the earth.

Garner: On the earth. Okay.

Belleville: Where one of the tidal effects that affects clocks goes to zero. The long-term effect of the clock. So if you hear people from Scotland reporting long-term effects, I can tell you there are some long-term effects, tidal-- long-term, like, 19-year-old effects, with clocks that are in the millisecond range that you can discover. Theoretically you can. I don't think you could measure them. But when I found that, I thought, "This is so cool."

Garner: <laughs>

Belleville: Yeah.

Garner: Interesting. Yeah.

Belleville: Yeah.

Garner: That's cool.

END OF THE INTERVIEW