Oral History of Marc Hannah

Interviewed by:
Doug Fairbairn
Marc Weber

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Weber: I'm Marc Weber of the Computer History Museum here on April 28th, 2022. Doug Fairbairn and I are interviewing Marc Hannah, who is cofounder of SGI, the company that built the building we're sitting in, and a cofounder of modern computer graphics, particularly graphics processors. So thank you so much for joining us.

Hannah: It's my pleasure.

Weber: And just want to start out at the beginning, a little bit on-- well, first, what's your full name and when and where were you born?

Hannah: Marc Regis Hannah. Was born October 13, 1956, in Chicago, Illinois.

Weber: If you could tell us a little bit about your family, their background, brothers and sisters.

Hannah: Okay. So I-- there were five kids in the family. Four boys, one girl. I'm second youngest. So youngest brother is Don, and then myself, Marc, and then my sister, Judy, brother Duane and Hubert, Jr., the oldest. We're all, you know, the four oldest are about four years apart. I mean, I'm sorry, two years apart, and then five years. I'm five years older than my youngest brother, and my parents were professionals. My mother, teacher. I think, my recollection, you know, while I was growing up, was that she was doing substitute teaching because of course, she's the primary <laughs> person in the household raising kids. My father, an accountant, and so I think education-- my mother being a teacher and both pretty well educated, so... With master's degrees, so education was always important in our family. We lived like half a block away from the elementary school down the street and so my first few years... I suppose I was fourth in line and so to some degree I had the benefit of <laughs> whatever experience was picked up in the older siblings, but so the first couple years I went to the elementary school down the block. The-- and then the-- what is it? The beginning of the third grade, I think, I was transferred to another school that was far away that was quote "better." <laughs> And so I finished out elementary school there. I was-- my birthday's in October and then I started-- so I was like four years, going on five when I started, which I suppose is a little bit early.

Weber: And what did your mother teach and what grade level?

Hannah: She-- as I said, she was substitute teaching and it was-- I don't remember specifically in the early days. You know, ultimately, I think it was permanently high school. Yeah. So <laughs> I guess as a child I was more focused on myself. <laughs> Yeah. So, you know, basically education was always an important part of what, for me, my mother's steering of my early education, so as I said, you know, third grade I went to this other school. That was in a predominately white area, predominately white school, but the school was considered better than-- it was still a public school. It was all public school but...

Weber: And how far from your house was that?

Hannah: It was a few miles, so I was, you know, early on driven there and then later I would-- I may have been driven but I remember taking specific, you know, taking the bus back home. It was like, I don't

know, whatever, four-block walk to the bus stop and then take the bus and another one block to get to my house, so...

Weber: And what were your favorite subjects as a kid or interests?

Hannah: Well, it was-- I mean, math and science was always the-- yeah. I-- yeah. I think I scored well in reading and that kind of stuff, but I suppose unfortunately I was never much of a <laughs> recreational reader.

Fairbairn: What was your experience in high school? Was there any teachers that were particularly influential? Kind of choose your own path there?

Hannah: Yeah, it was more choose my own path. I mean, <laughs> you know, the most vivid memory I have is a chemistry teacher, <laughs> because I got a B in that course. <laughs> But, you know, I, you know, I never really held a-- it was annoying at the time, but I have a lot of respect for him. It was just there was only one A that he gave out. I think there was one curve breaker.

<laughter>

Hannah: And so I think I had the second-highest score in the class, but the person who was first was so far ahead of the rest <laughs> of the class that he only gave out one. But Mr. Sherrill[1], you know, I have the utmost respect for him.

Fairbairn: But you still remember. That was...

<laughter>

Hannah: But that's most of the ticket. Actually, you know, my memory works in a weird way, and hopefully it's not a problem <laughs> with this discussion, because yeah. I remember isolated incidents, but, you know, I don't have this perfect memory of my own life. I can remember-- if I go to see a movie I can remember the dialogue in movies I've seen years ago and, you know, there's something about what's going into my brain when I'm experiencing life or something, you know, so my memory of past, like, my childhood, my high school days, it's pretty foggy. <laughs>

Fairbairn: You do any sports or any extracurriculars?

Hannah: No. Let's see. No. No organized sports. You know, couple of musical instruments at one time or another. Clarinet in elementary school, saxophone in high school. You know, independently couple years of piano, but I was never really focused on that. The elementary school, just to touch on sort of interesting things that were going on at that time, as I said, when I transferred there it was a-- basically it

[1]Walter Sherrill, Chemistry | Kenwood High School Class of 1972, https://kenwood72.wordpress.com/in-memoriam/walter-sherrill-chemistry/

was a primarily white school, white neighborhood. It's-- by the time I finished, the entire neighborhood, it switched, and it was-- I don't know about the neighborhood but definitely the school. I'm sure there was a lot of movement of people, you know, out of the neighborhood, but the school became majority black by the time I finished there in a matter of six years, so that was-- you know, at the time when I entered the school I wasn't really even that aware of race, but it was something that I became more aware of as, you know, by the end.

Fairbairn: So you were there in high school in the late '60s, early '70, was a pretty...?

Weber: But you're talking about the elementary...?

Hannah: This was the elementary school.

Fairbairn: Right.

Hannah: Yeah, and so--

Weber: So you were born in '56, so...

Hannah: '56. Yeah.

Weber: So that would've been--

Fairbairn: So...

Weber: --early '60s, really, that that started.

Fairbairn: Fifth grade in '66 and--

Hannah: And no, I actually-- I skipped a grade too, and so it's even slightly more compressed. <laughs>

Fairbairn: But by the late '60s, early '70s, you were in high school and there was a lot of chaos in the world going on in terms of Vietnam War and other protests and so forth.

Hannah: Yeah.

Fairbairn: Is that-- did any of that sort of seep into your school or life or anything?

Hannah: Not-- life, yes, from the standpoint of my brother, my oldest brother. Primarily my oldest, the-- so that was-- you know, there was the fear of being drafted and sent over there. You know, by the time I was of that age, you know, the things were over, but... I did not experience it in the context of school, but was aware of what was going on and definitely there was that question of, you know, if the war's still going on when you turn 18, is there the chance of being drafted and being sent over to Vietnam?

Weber: But the-- I think you had told the HistoryMakers interview, which I read the sort of finding aid, the-- not the full text, but yeah, you had talked about White Flight in your neighborhood.

Hannah: Yeah.

Weber: And that was the school--

Hannah: Right.

Weber: --specifically that-- so--

Hannah: Fort Dearborn.

Weber: And which?

Hannah: Fort Dearborn was the name of the school. Not--

Weber: And which neighborhood did you live in then? And what was your first school?

Hannah: Kipling was the first school, and so yeah. My older siblings basically went to the nearest neighborhood school, so they went to-- there was another school a little bit farther away before Kipling was built, I guess, Ryder. Kipling was just down the street, and then they went to high school at Harlan, which was, you know, whatever, you know, a mile or two away. But when it came time for me to go high school, Harlan was not considered good enough <laughs> by my mother and there was some, like, question. There were couple other better schools. I ended up going to the University of Chicago Laboratory School, U-High, for my first year. So that was, you know, in the University of Chicago, Hyde Park area, and then the following year-- actually, well, there's another Hyde Park public high school, Kenwood High, that was-- had opened. It turns out it was the same year that, you know, I entered the U-High, but I transferred there my sophomore year, and so finished out my high school there at Kenwood.

Weber: And you had said you weren't particularly aware of race until the elementary school that--

Hannah: Right.

Weber: --changed. So talk about that and...

Hannah: Yeah. I mean, I've never had a focus on race, so when I say-- yeah. You know, beginning there there was like no distinction. People were people, right. And so I-- yeah, I don't know. It's-- you're aware of it but I don't know that it really changed the behavior much. I mean, there were-- I didn't have any issues of bullying or anything like that early in the years, but things got I think a little bit rougher in the-- <laughs> not that I was particularly bullied in general, but, you know, there were occasionally, you know, a couple of bad kids in the class and you know, you don't think would happen, but-- and then, I don't know. It just seemed like the quality of education slipped. You know, I mentioned I skipped a grade and what was it? Middle of sixth went into the seventh grade, and <laughs> maybe it was just because I

was considered behind the people in the seventh grade but I remember feeling that the expectations of the teacher were lower and, you know, in particular like whatever it was, English, is just-- I remember, you know, sitting in class reading stories aloud in class for days and things like that that seemed kind of a waste of time, and yeah. I think by the final year I, like, I went into a more normal class. <laughs> Normal. But I definitely remember in that transition feeling like the expectations were a bit lower, and I don't know how much was, you know, the particular teacher, the fact that, you know, basically instead of having a bunch of white kids there were, you know, a lot more black kids and therefore the quality of ex-- you know, in some sense kids perhaps live up to their expectations, right. So if you expect low performance, it's-- has a way of being a self-fulfilling prophecy or prediction, so... So I suppose in terms of the impact on me, that was perhaps the greatest impact in feeling that, "Okay. Maybe I'm not getting the best <laughs> of the best of instruction here." I think-- by the eighth grade I think things were, like, a little bit more back to normal, but anyway.

Weber: And, I mean, it was the teachers largely stayed the same while the--

Hannah: Yeah.

Weber: --students changed.

Hannah: Yeah.

Weber: Okay. And to get back to your family just a little bit, were there particular values, religion or politics, that were important in your family that might've shaped you or--

Hannah: I don't remember much talk--

Weber: Or you rebelled against or...?

Hannah: No, no, no. I was never a rebellious kid. <laughs> I don't remember politics in the discussion much. Let's see, the-- I'm sorry. What was the other? You said politics and--

Weber: Oh. Religion as well.

Hannah: And religion.

Weber: Or values.

Hannah: Yeah. So, you know, my parents were religious. So, you know, we went to church every Sunday. The church was, you know, fairly early on in, like, while I was in elementary school. Trinity United Church started down at the end of the block, so less than a block away, and that was, you know, it's since become this mega church. You know, Jeremiah Wright and so forth. But it was very small at the time. <laughs> But, you know, we went to church and so I was, you know, not too actively apart from Sundays involved in the church, and, you know, unfortunately I, course, have drifted away and so I'm not

an actively religious guy, but still believe, and so it didn't-- it wasn't a, you know, part of day-to-day conversation.

Weber: And values? I mean...

Hannah: Yeah, I mean, yeah. I think we had values. <laughs>

Weber: Education was one of those.

Hannah: Yeah.

Weber: Clearly. Yeah.

Hannah: I mean, the biggest thing is education, and, you know, you're sitting through sermons every Sunday and so I suppose some of us were-- <laughs> some of us were-- you know, I consider myself, you know, I'm not an overly religious person but I consider myself a very moral person, and so, you know, if I have problems with religion it's more to the ex-- yeah. Well, maybe I shouldn't get into religion, but it's just the whole concept of religion I think is a good thing. You know, I believe in morality and to the extent that, you know, religion is driving morality I feel it's a very good thing. You know, sometimes that's not necessarily all-- especially when one religion is pitted against another. Then it becomes a very messy situation. I feel like you need to always, like, be willing to flip, <laughs> you know, flip positions, right. If you're-- in your interaction with someone, you need to treat them as you would want to be treated yourself, and so-- and yeah. So in general if one is pitted against another and you're not willing to say, "Okay. Let's swap places and continue from there," you know, then you know, that's where I have issues.

Fairbairn: You have a problem.

Weber: And were you building stuff as a kid, radios or electric trains, any of the classic...?

Hannah: Oh, let's see. I-- you know, I think it was my oldest brother, you know, he-- that probably got me interested in electronics and he used to do that. You know, he had electronics magazines and he was in photography and movies and he would make movies and things, and so in terms of specifically an interest in electronics he was probably the one that sort of got me down that specific path. Did I build things? I didn't build electronics. You know, I wasn't one-- you know, it was early, so there weren't little electronic computer kits and things like that, but there was-- what was it? Heathkit. At some point <laughs> I did have a Heathkit with little electronic components and wires and little springs that you could put the wires into and make a couple little simple circuits, oscillators, crystal radio or whatever. But maybe that was about it. <laughs> Yeah, and then, like I said, in high school was primarily the math and science that interested me the most, and then it was-- was it my senior year? Probably my senior year. Took a computer programming course, and that really sort of brought things into focus, I think.

Fairbairn: What computer was that on?

Hannah: It's-- it was-- so here was our computing facility in high school. It was a room with a phone, two teletype machines so you could punch some tape. Yeah. So I'm trying to remember <laughs> if there was a card punch thing as well. I think I'm sort of mixing that with college, because college the way we did programming was cards. <laughs> Submitting a deck across a counter. But anyway, I think there were just the, you know, the two teletype machines, and so you could, you know, punch stuff in there, have paper tape and read-in programs and run very short things.

Weber: And what was the-- well--

Hannah: Oh.

Weber: Again, what was it connected to?

Hannah: Oh. Yeah, yeah, yeah. So a computer. <laughs> So...

Hannah: You know, some mainframe computer.

Fairbairn: Some.

Hannah: Located somewhere away. But, you know, you basically dial, and you didn't hear the tones of a modem and--

Fairbairn: You probably wrote a BASIC-- probably wrote a BASIC program or something like that.

Hannah: FORTRAN. Yeah.

Fairbairn: FORTRAN.

Hannah: Oh. No, first was COBOL.

Fairbairn: Oh.

Hannah: Yeah. Not the most efficient program for reading in two numbers and writing out the sum. <laughs> And then FORTRAN. Yeah. COBOL and--

Weber: And what did you want to be when you grew up if you could, if you remember, say, you know, both when you were young, like elementary, and then did it change by high school?

Hannah: Elementary I do not remember having specific, "Oh, you know, I want to be this when I grow up." By high school, yeah. First couple years I don't think I was like in a decision-making mode. <laughs> Math and science. And then sort of the last years where you really have to-- of course, you're applying to colleges and you have to decide what your major is going to be, and so I went through a phase where it was electrical engineering or physics. The, you know, having taken the computer course, and I suppose I must've found it interesting. <laughs> Because I certainly wasn't scared away from

computer programming, and then let's see. So the real thing that set me down, made a, <laughs> like a hard fork into electrical engineering, was I applied to three schools, University of Illinois Champaign-Urbana, Illinois Institute of Technology, and Northwestern, and so I didn't want to get too far from home, and let's see, the-- I guess it was the financial aid director at Illinois Institute of Technology called me up and said, "There is a scholarship that is offered by Bell Laboratories that is offered for students in logical engineering. Would you be interested in applying?" It's like, "Sure." And it was a full scholarship, and so I went in, interviewed. I remember, like, walking out of the interview still in the building <laughs> thinking-- it's like, "Oh, I didn't do so well <laughs> in that interview." I don't remember anything specific about the interview. I just remember walking out thinking, "Uh.." it's like, "Uh.. I kinda blew that probably," and so I walked back into the room. It's like, "Can I get some recommendations <laughs> from teachers or anything?" <laughs> Anyway, yeah. So I think there was a little bit of fallout, but the great thing is, you know, I later found out that I had received the Fellowship. Or I'm sorry, scholarship, at that time. So I was awarded that scholarship from Bell Labs and so that was, you know, a full, full-ride tuition, room and board, and it was specifically through IIT. Other schools, but of the ones I applied to, specifically IIT, and in electrical engineering.

Weber: Oh. Okay.

Hannah: As opposed to one of the sciences. I mean, it didn't-- there was probably some other engineering you could've been but, you know, I was kind of deciding between electrical engineering and physics, so it's like, "Okay. That determined I'm going to IIT. <laughs> I'm going to major in electrical engineering," and part of that scholarship was summer employment as well, at Bell Laboratories outside Chicago, so Indian Hill, and so it was definitely life-changing for me. You know, one, you know, set me on this specific path, but two, you know, having a full scholarship. You know, at the time I wasn't even aware of how important that kind of thing is like for the parents in terms of funding a college education.

Weber: And with five kids, yeah. <laughs>

Hannah: Yeah. And so, you know, it might've been several hours to a day before I told my parents. <laughs> "Oh, I got the scholarship." <laughs> But yeah. So yeah, it turned out to be, of course, very key, and that was the scholarship designed to get more minorities into the technical field.

Weber: Oh, okay. From--

Hannah: Yeah, so-- yeah. So...

Weber: --Bell Labs' program.

Hannah: So I was definitely the beneficiary of that, because-- yeah, it's just-- ultimately, you know, Bell Labs has played a huge role. Very grateful for what, because jumping ahead briefly, I ended up going from the Bell Labs undergraduate program onto a Bell Labs PhD Fellowship program as well, and we can get into that in a-- later.

Weber: And so when-- your first summer though was after your freshman year in the Bell Labs.

Hannah: Right.

Weber: Okay.

Hannah: Oh.

Weber: Or before?

Hannah: Interesting question. I think it might've been before. I don't... Yeah, I thought there were four years there, and it wouldn't have been after. Yeah.

Fairbairn: So you went there each summer.

Hannah: Each summer. Yeah.

Weber: And got pai-- or not paid but it--

Hannah: And got--

Fairbairn: --part of the scholarship.

Hannah: Yeah. I remember my first salary, I think. What was it? Think it was $110 a week. Was good money. <laughs>

Weber: For the time. That was-- yeah.

Hannah: Really good money. <laughs>

Weber: That was really good money. Well, for a student at the time.

Hannah: Yeah. Yeah, yeah. No. I mean, I-- yeah, so...

Weber: And did you know or did you meet the other people who got in the sa-- was there--

Hannah: Yeah, there were--

Weber: --a group of you or...?

Hannah: Let's see. That year? I may have been the only one that year, because I don't-- you know, the people I remember are people who are a year later than I was.

Weber: So maybe it was just starting then or was it national, was it just Chicago?

Hannah: So it may have been--

Weber: Do you know?

Hannah: It was national. There were other schools.

Weber: But you were the first--

Hannah: I think I was--

Weber: First one at IIT?

Hannah: I might've been the first one at IIT, and I think-- actually, I met someone who's a couple years behind me at IIT, or few years, and this was just a few weeks ago he was in town, and he told me this story that I hadn't heard from him before. He said that, you know, I think maybe at the time I was there there were 10 people per year that they-- 10 scholarships per year that they gave out, you know, spread around the country, and, you know, he'd applied and he didn't make the cut of 10 initially, I think, but I think maybe he was 11th or something and then he later got a call that said, "Oh," you know. It's like they've increased it to 15 because, you know, Marc Hannah, like, has been so successful that they... <laughs> Not to take credit. I just, like-- I don't-- it's <laughs> just a story. <laughs> And I'm sure there were lots of successful people. But anyway, they-- but it--

Weber: But you were the one for IIT.

Hannah: For IIT. Yeah.

Weber: So you became the example.

Hannah: Yeah. Yeah, I just created the... Yeah.

Fairbairn: So what was your experience at IIT outside of the Bell Lab jobs, which, you know, you go through a normal EE program? Was there anything you were focused on?

Hannah: Yeah, it was a normal EE program. You know, the first two years are just sort of generic engineering stuff. You take chemistry and math and physics and so on and so forth, and then by the last two years you're getting more into your specifics of electrical engineering. Yeah.

Fairbairn: And were there any particularly influential professors that you worked with there?

Hannah: Yeah, let's see. In courses... do-do-do-do-doo. This is where it gets into that, the whole question of how my memory works, <laughs> and... You know, so the name that pops into mind was Andre Vacroux, and I actually never took a course from him. I believe he might've-- he was ultimately I think chair of the EE Department, but I worked with him on an independent project.

Weber: On what?

Hannah: The project was-- what was the project? It was a graphics thing, actually. It was a little microcomputer. Let's see, use-- and a one-bit-per-pixel graphics display and displaying it up on a screen. Interesting. I never made that connection, but <laughs> yeah. So it was just, you know, had this little mic-- it's, you know, you breadboard it on this little thing, you know, the breadboarding thing, and it got to be a fairly big breadboarded thing but it was basically a microprocessor, you know, some memory to run the program, and a, you know, one-bit-per-pixel frame buffer and then you drive that out onto a screen and you have to generate, you know, the CRT timing and read stuff out. It was, you know, 4-kilobit DRAMs I think were used and you have to run refresh cycles and yada, yada, yada. So that was the little project, and yeah.

Fairbairn: Did you develop a bias towards software or hardware during your years there or--

Hannah: No, no.

Fairbairn: --you found both interesting?

Hannah: Yeah. I took a bunch of-- yeah, a bunch of both. Definitely within electrical engineering it was computer focused, and so, you know, you take circuits and information theory and all this kind of stuff, but I think my interest was always more specifically the computer aspect of things and-- yeah. And like I said, you know, the project was basically building a little microprocessor thing, and the--

Fairbairn: What--

Hannah: Yeah, so--

Fairbairn: What about your four years? You worked at Bell Labs for four different summers?

Hannah: So there-- yes.

Fairbairn: So what are your notable memories or experiences or influences from that?

Hannah: Yeah. So that was software. <laughs> But working on-- what was I? Number four ESS. That was my department. Electronic switches for phone. Number four was a toll switch, long distance, and so I was doing-- you know, I don't remember what I did all the summers. Again, this, like, specific memory of one project was, you know, writing diagnostics for this number four ESS switch. I think that was probably one of the later summers. <laughs> One of the earlier. So I think I did come right out of high school <laughs> into it and so the level of tasks that you can do in a summer at a place like that is somewhat limited, and I remember, like, looking for something in a bunch of information and printing out like a card deck and sorting it all kinds of which ways. <laughs> That was like one specific project. Yeah, so you have big, you know, boxes of cards and the card sorter machine you put in the stack and tell it what to sort on and "bldl-bldl-bldl-bldl-bl," you get the little bins and... But yeah, that was, you know, a software focused thing. You know, the whole hardware/software choices. You know, software's great because you can quickly whip something together and can see the results. Hardware's great because I don't know. I like building stuff, and so that's why I tend to lean toward the hardware side of things and, you

know, software is critical, of course, to getting the hardware to work. Especially these days, right. Everything's got a, you know, a program microprocessor in it. But even in my day it was, you know, hardware is part of an overall system and things were microcoded and so...

Weber: Did you work at the same-- so, I mean, it was the same part of Bell Labs, but were you working with the same people each summer, same--

Hannah: I believe so. Yeah.

Weber: --physical location?

Hannah: John Kulzer I think was my supervisor there, and ultimately-- you know, so I was on this path studying electrical engineering. There's another interesting sort of transition in my-- so my freshman-- in high school, you know, I was good at school but I was not-- my parents weren't so like, "You have to do--" you know, straight A's. So A's and B's, I was fine with that. So... And I was never focused on, unfortunately, <laughs> all right, I'll admit it, <laughs> doing the best I could, right. <laughs> It's like if I could skate through a class and get an A or B I would skate through the class and get an A or B, and it wasn't until my freshman year in college that that changed. And it was a particular little fluke, I suppose, in that my first semester, I got-- it was close, in some cases, but I got all As in the important courses. I got a B in a drafting course. And I don't know, something like-- it just kind of flipped a switch. It was like, okay, well, why don't I keep this up? And so, the goal switched from being, you know, do the work, you know, A or B is fine to the target is to get an A. And if you have to work harder to get an A, then you just have to work harder. So, you know, for the rest of my educational career, it was that. I mean, it was you have to-- I suppose there are levels of A, and so, I suppose that was-- I won't necessarily say that it was always absolutely maximize your potential <laughs>, but it was definitely you need to do well enough to get an A in the course. So, and often that meant working-- some courses were easier. Some were hard, but you just had to work harder in the courses that were harder. And so, that was a particular transition. I think I finished-- I did get one more B in my undergraduate education here in-- but that was so boring <laughs>. I just couldn't stay awake in that course. And yeah, so it's focus on trying to, I don't know, I could say do the best you can, but it was really, I really specifically had that specific thing, I need to get an A in all my coursework. And then toward my senior year, Bell Labs played an important role because I was on this path of working summers at Bell Labs, get a degree in electrical engineering. My parents had master's degrees. I was always planning to get a master's, and then to be a member of technical staff at Bell Labs, I think you needed a master's, as well. They had this program OYOC, one year on campus, where they would hire you with a bachelor's degree, and then you'd go off for a year and get your master's degree, and they would pay for it, then you'd come back and work at Bell Labs. And so, that was my set path, my set plan. And my last summer there, John Kulzer, my supervisor, told me about they've got-- Bell Labs has a fellowship program for women-- just minorities. They had another program for women, I think, specifically, but-- it was called CRFP, cooperative research fellowship program, where they would provide a fellowship for a PhD. And he encouraged me to apply for that. And my first reaction was I don't know. I probably just ignored it. I don't know. I did not apply, actively apply, for it, initially, because I wanted to build stuff, and my perception of PhDs was they're doing research on theoretical stuff, and I just wanted to build stuff, or they're professors and taught-- teaching, and that wasn't what I wanted to do. So, I wanted to build stuff. I like working here. So, I'll just get my master's and do here-- come here. And so, he ended

up, I think, got the director of the fellowship program to call me. And again, he said you should apply for this program. And so, I think basically just to get them off my back I said, "Okay, I'll apply." So, I applied. Part of that process was to actually fly out to research, Murray Hill, maybe both Murray Hill and Holmdel were both research in New Jersey, and talk to different groups to interview. And so, I did that. And I can't remember whether that was one day or two days, but basically interview with probably four different groups and-- four or five different groups, and I think a few of them were too theoretical for my taste, but there were two, I thought, that were really interesting. One was doing space synthesis, I believe, and the other was digital switching, but it was-- there were people in that group doing all kinds of things. There was-- Brian Kernighan came up, and there was some UNIX people doing MERT, I guess it was called, multi-environment real-time, like a real-time version of UNIX. There was the guy that ultimately ended up working for Hal Alles, who was-- created this digital music synthesizer. And anyway, just lots of interesting stuff, interesting people doing what seemed like really exciting stuff. And so, I came away from that interview saying, it's like, basically my eyes were opened, right? My perceptions were wrong. I need to-- I'd like to work at Bell Labs Research, get a PhD and work at Bell Labs Research. So, I guess I need to get a PhD. So, <laughs> so, ended up. I later was awarded that fellowship, and that sort of set me on that path of getting a PhD.

Weber: And did you have the flexibility to choose where you went, or what was the--?

Hannah: Yeah, I was already-- I had already applied to Stanford. I basically applied to Stanford and Berkeley because I wanted to go somewhere where the weather was nice. And my preference was Stanford because, at the time I applied, I was-- alright, fine, I thought Stanford would be easier <laughs> for the master's degree, for the master's degree because the master's degree at Stanford was just, you know, you take the courses, and you get your master's degree. Berkeley might have required a thesis of some sort. And so, I wasn't into writing. And so, it was a pretty bad way to make a judgement about which, but they were both great schools. And so, it's hard to make a wrong choice between Stanford and Berkeley. Bell Labs also, for the OYOC [One Year On Campus] program, Bell Labs sent a bunch of people out to Stanford. And so, you know, all these things added up to I ended up going to Stanford. And yeah, so.

Weber: Had you ever been on campus before you arrived to go to the first class?

Hannah: On campus-- I had a-- sort of my father's first cousin, so I think of him like an uncle, who lived in Menlo Park, worked at-- I think he worked at SLAC and had visited once before. I don't remember visiting the Stanford campus, though.

Weber: You'd been out to--

Hannah: I'd been out in the area.

Weber: So, what year did you graduate from IIT?

Hannah: '77.

Weber: '77?

Hannah: Yeah.

Weber: So, you came to Stanford in the fall of '77.

Hannah: Yeah. Yeah.

Weber: And before I'm finishing with Chicago, just very, very briefly say what was your university life like. You were living on campus?

Hannah: Living on campus, yeah.

Weber: Activities you enjoyed.

Hannah: Yeah, that's-- I was in a fraternity. The first year, I joined a fraternity. Again, I think it was critical for me. I'm an introvert. And so, having like an instant group of friends, and there were 13 people in my pledge class, and six or seven of them were electrical engineers. So, there was an instant study group. That was very helpful.

Weber: What fraternity was it?

Hannah: Pi Kappa Phi. And so, lived there on campus in the fraternity. IIT being a technical school and, you know, the male to female ratio is heavily skewed toward male. I was not a party animal anyway. And I didn't participate in sports. And so, yeah, it was primarily just to focus on the studies. And, to the extent that there are parties in the fraternity, you go to a party in the fraternity, but yeah, I was just more focused on the studies.

Weber: And in the summers for Bell Labs, you lived at home, or you would live on campus?

Hannah: I lived on campus, I'm pretty sure, yeah, commuted with a couple of the other students who were at IIT and working there.

Weber: So, back to Stanford if you're--

Hannah: So--

Fairbairn: So, you arrived at Stanford. Was that a big change, or--?

Hannah: It was-- maybe I mentioned before, at IIT, the computing facility, I didn't go into the details. So, yeah. So, at IIT, like the basement of one of the buildings, there was a big room, what was it, UNIVAC 1108 I think was the machine that was back there behind a counter, rows of card punch machines. And so, the way you did programming was you brought your program on a piece of paper. There was a coding form, right, which <laughs> goes in the card punch machine--

Weber: Key punch, yeah.

Hannah: So, you fill it out on this sheet of paper that was gridded and had column numbers at the top, and you punch up the deck of cards. You submit your deck to-- over the counter, and then you get back a printout of this is the program that ran, and these are the results. And yeah, so if it didn't work, you-- yeah, the whole debugging mechanism was you try to go through the launch in your head to see what might have happened, and then you resort to putting in print statements at various places to try to look at intermediate variables, whatever. You submit it again. So, that was the debugging process, but no interactive terminals or anything like that. You get to Stanford-- well, the first thing, of course, you're hit with is it's a gorgeous campus <laughs>. It's very much-- I hadn't been to country clubs, actually, so I can't call it a country club <laughs>, but that's I guess the reputation is is it's like a country club environment, right? And so, you have all-- you know, it's huge. It's great looking buildings and all the greenery and trees and so forth and the facilities. And with some of the computing facilities, there were rooms filled with interactive terminals. I came out to graduate school, although I was focused on coursework initially, sort of once I got into the like after second or third year, probably the third year, when I started working on whatever research I was working on, you figure out how much equipment there is behind the scenes, like insane amount of-- it's not really insane, I suppose, but compared to what I came from at IIT, just huge-- there was equipment all over the place. There were machines sitting idle because they'd been donated and hadn't been put in. When I started work on the smart image memory stuff for my dissertation and the Geometry Engine, I basically had a VAX 780 to myself, which was, I don't know, probably a million dollar computer or something, ultimately became used by more people, but yeah, I was just-- so, just the physical campus, in terms of sort of the beauty of it. Of course, the weather was what I expected, great. And then there was all kinds of equipment to do whatever you wanted to do. So, there was that. The other thing about Stanford was, so I was afraid that this like okay because of Stanford's reputation, which is of course a great school, it's like a whole other level of difficulty. And so, I thought I'd have to work really hard. Not that I didn't work hard, but I thought I'd have to work especially hard, more than I was used to, because of just it's a school on another level. But I was pleasantly surprised that actually IIT really prepared me well. So, it was basically it was an easy transition for me going from the academic environment at IIT to the academic environment at Stanford.

Weber: So, you just entered the PhD program immediately, or you were going to do a master's and then--

Hannah: Yeah, it's master's. I mean I was on this PhD fellowship, but the first, yeah, the first two years, I was just taking courses. So, you know, you get the master's after a year of courses and continue taking courses because you basically need two years of courses as part of the PhD. And I hadn't really figured out exactly what I wanted to do. So, I was just focused on finishing the course requirement. I did take the qualifying exam, the PhD qualifying exam, my first year and was able to pass that. And so, I was in the PhD program.

Fairbairn: Even for the master's degree, you have to have an advisor or something, right? Is there a particular area that you--?

Hannah: I don't recall working with an advisor. I was there definitely-- I took a bunch of software courses. As I said, I hadn't come down hard on one area or the other. So, I took compilers and operating systems

and data structures and all the software stuff as well was more hardware, more information theory or whatever, double E oriented stuff. And then-- but one of the courses I took was introduction to VLSI design or VLSI systems, the Mead-Conway methodology of doing integrated circuit design. And so, again, is this a repeating theme in my life like a misconception about certain aspects that would drive you away from things when maybe you should be driven toward them? Yeah, my perception of people who did layout or integrated circuits was all this device physics and all this.

Fairbairn: That was a proper conception at the time.

Hannah: <laughs> Yeah, probably.

Fairbairn: The whole thing about Mead-Conway was to change that.

Hannah: That was the introduction of it's like just make these simplifying assumptions. These are the rules you follow, and then you can have system designers like doing integrated circuit design. And the great thing about that is it's a blank sheet of paper, right, so if there's some more efficient way of doing things, you can do it. You're not restricted to the pieces that you can build up. Of course, integrating a bunch of stuff onto a silicon chip makes it much cheaper and yadda, yadda, yadda, the whole microchip revolution, right? And so, I suppose that was my second year at Stanford that I took that course. And that was, of course, a critical thing in terms of what I ultimately did in working with Jim Clark on the Geometry Engine, my dissertation being this custom architecture for graphics.

Weber: And so, where were you living on campus, or were you living on--?

Hannah: Yeah, I was living on campus, first two years anyway. It was a dorm. First year, my roommate was a history PhD student, and then second year, it was-- so, that was first year, dorm, and then second year, physics.

Weber: That man who was your roommate? Physics?

Hannah: Oh, he was a physics student, a physics PhD, yeah.

Weber: And--

Hannah: David Gelphman was it, yeah.

Weber: And were you still doing-- did Bell Labs have any requirement for summer? I mean not at that point for the PhD program.

Hannah: Yeah, so I worked summers in Bell Labs out in Murray Hill.

Weber: Oh, from Stanford, you--?

Hannah: From Stanford, yeah.

Weber: Okay.

Hannah: So, again, so that was where I learned C programming and started doing a little bit of-- like one summer I did a graphics related thing. It was like programming, I don't know, it's kind of hard to call it graphics in the sense of graphics today, but I had a bitmap terminal and just coming up with algorithms to draw and fill in the interior of-- given an outline. So, I think that was probably my first summer there. And so, you do this little project. It involves some programming and played around with hardware, and at the end of the summer, you'd give a little presentation on what you did. And so, those were really great experiences going back and working there on the summer, getting a better feel on kind of what kind of stuff is interesting or not or what people are doing.

Weber: Let's get on tape how-- you were working on some projects at Stanford. Who were you working with, and then how did you actually get to be introduced to Jim Clark and get on the graphics path?

Hannah: So, first years, mostly just focused on coursework. There was a project I did shortly after I think I passed the qualifying exams where I remember like building some circuit board. I started working with someone who was doing robotics. I should remember his name, but I can't. If I thought about it, maybe I would, but that was one little project. But ultimately, that summer, I started working with Forest Baskett on, like I said, I don't have-- I remember-- I don't remember specifically what I was doing <laughs>, or, like I said, it was multi-microprocessor-related, but my biggest memories from that summer were playing a lot of tennis, for some reason. I don't know <laughs>, but I went to Forest at the end of the summer. And yeah, so that's-- and I have to reconcile that in my mind, right, because I should have been at Bell Labs, and I probably was at Bell Labs for some part of the summer. So, maybe it was a more condensed period that I was initially remembering it where I was like working on this project and kind of got bored with it, was learning how to play tennis and stuff, and after a, whatever it was, a month or two, came to Forest and was like, "I'm kind of bored with this, and I want to work on something else, and I don't even know whether I'm more interested in hardware or software. Help me." And then I mentioned that I was kind of interested in doing graphics, but nobody is doing graphics. And part of the motivation, my interest in graphics, was I was, at that time, I was interested in like flying and maybe learning how to fly. I was like fascinated with flight simulators and being able to play around with those. And so, it's like it would be cool to be able to have my own personal flight simulator in the basement. And so, that was part of my motivation for saying ooh, graphics is a cool thing. And it'd be cool to build something that would be cheap enough to like you could have your own personal flight simulator. But anyway, this me with Forest, I mentioned that I was interested in graphics, nobody was doing graphics, and that's when Forest mentioned that well, there's a professor that just started at the beginning of the summer. It is Jim Clark. He's doing some stuff in graphics. And we basically just, my recollection is we just basically got up and walked across the hall, and he introduced me to Jim Clark. And so, I sat down with Jim, and he talked about the kind of stuff that he was working on, mentioned the Geometry Engine and the other part of the problem is the rasterization into a frame buffer. And that was an area he thought I could work on. And so, that was the introduction to Jim Clark and sort of my sort of hard fork into graphics. And so, yeah, so basically from that day on, I was working with Jim Clark.

Weber: Could you talk about your first impressions of Jim? What was he like?

Hannah: Well, perhaps the interesting thing about that first meeting was he mentioned that, ultimately, like he wanted to start a company based on this stuff. And at the time, I was on this path of get your PhD, work at Bell Labs, but I guess there have been enough situations where somebody said something, and my initial reaction was not very positive or not interested, but I think I knew enough to keep an open mind and to shut up <laughs>. And so, my internal reaction was that's not my path. I'm going back to Bell Labs. But, as I said, the area of study and work was definitely interesting to me. And so, that's-- so, I was working with him. And what other impressions from the first meeting-- I don't know, nothing real specific.

Fairbairn: Did he ever talk about Evans and Sutherland because they had flight simulators, and Jim had worked there in Utah? Did that ever come up?

Hannah: I don't know if I even like talked about flight simulators with Jim, but certainly was aware of Evans and Sutherland's, you know, they were the big name in high performance graphics at the time. And I think I was aware that he had worked with Sutherland, I think, at Utah. And so, yeah, I don't know. It's like I think he was busy doing his stuff. I went off. I mean there was some interaction with him, but I was focused on my aspect of the architecture, would work with him where appropriate to help him with what he was doing on the Geometry Engine, occasionally check in and tell him what I was doing and so forth, but that's kind of the memory I have. I'm sure I'm forgetting things, but--

Weber: Were you the first student to work with him on it?

Hannah: Yeah.

Weber: And it became your thesis. At what point did he become your advisor, then?

Hannah: No, I mean basically from that point on, from that first meeting.

Fairbairn: This was the summer of '79, correct?

Hannah: The summer of '79, or end of summer.

Fairbairn: End of summer, right.

Hannah: Yeah, beginning of fall. And yeah, basically, handed off from Forest to Jim, and he was my thesis advisor from that point.

Fairbairn: So, you had a-- then you went ahead and designed this chip to do this, or the architecture? What was your actual project, subsequently?

Hannah: Yeah, design the chip, it's to define the chip, and then do the layout and try to get a working prototype together. Yeah, I remember Jim was very much I think sort of the regularity of the architecture was very big in Jim's mind. Of course, the Geometry Engine is a very make one thing and replicate it, right? So, the Geometry Engine pipeline, you assign this Geometry Engine chip that has several different functions, but it all can be done with the same data path, microcode, and then you sort of replicate it to

get the performance that you need in this pipeline within the chip. There was data path, and then you replicate that to get the four component vector, the exponent part of the floating point data path was basically the same as the mantissa part of the data path, slight differences, but-- because you don't have to shift the exponent, but yeah, but basically-- and that was also important just from the amount of work you had to do, right, because you have to layout all this stuff by hand, putting rectangles of diffusion and poly and metal and contact, and there were much fewer layers in those days <laughs>. I'd gotten away from the like the details of integrated circuit fabrication until very recently, and it's-- things are much, much more complicated <laughs> now than they were in those days. It's pretty amazing. And just, the original Geometry Engine-- so, I'm bouncing around, but the original Geometry Engine had 40 thousand transistors or so, and then today's chips have 40 billion to 80 billion. It's just a million times more gates. The technology of today is incredible, both on the integrated circuit technology and then what you can do with that technology. The graphics, I had sort of gotten away from like the nitty gritty details of graphics for a long time, and then more recently got back into see what's going on at a deeper level. And it's just, yeah, it's just the realism and the amount of computation that you can do in real-time, and the realism that you get from that is just amazing. But I'm sorry. I bounced around. Where was--?

Fairbairn: Oh, so you had this chip to do as part of your PhD, for your PhD thesis. Were there any major roadblocks, this will never work kind of--?

Hannah: Yeah, I guess that's why I was talking about Jim's emphasis on regularity because basically I defined the architecture and the chip I was going to lay out, and originally-- and it was a fairly small simple chip. And so, it was a very specific data path. You know, these are the operations I need it to perform, and so I have one piece that does this, another piece that does that, another piece that does this. And you put it all together. And when I talked to Jim about that, it's like no, it's like it's too irregular, and you have to like just take the Geometry Engine data path and microcode it to do what you need it to do. And so, it's like it's going to be big. And this is like it's not that much work. Of course, I always underestimate the amount of work it would take. So, he had a point, but my objective was to get my PhD and get out of there. So, and then getting into that kind of argument with your thesis advisor is not a good idea. Plus, he's got more experience than I do. So, anyway, so I said okay, fine. I'll do it that way. So, I laid out the chip that way, and it was huge. It was actually too big to get fabricated <laughs>. So, then I just went back and did it my way. I don't know that I ever got the whole thing working, but there's-- he definitely had a point. On the other hand, ultimately, there are practical implications when you do any system design, right? So, it's a trade off between a bunch of stuff. That's the whole thing of computers and architecture is like it's one game of trade offs and efficiency and how much work does it take to get something done.

Weber: And you were doing this on-- I mean were you visiting PARC in this period?

Hannah: We had Altos there at Stanford. So, I was not-- I may have made one or two visits to PARC, but no, the work was done there at Stanford. There was a room with several Altos, and I was running, on this VAX 780, the software, simulation software, circuit extraction and all that stuff. And so, it was all done there at Stanford.

Fairbairn: So, did you actually prototype this chip using the MPC program, or did you--?

Hannah: Yeah, MOSIS.

Weber: MOSIS, yeah.

Fairbairn: Oh, and it was already-- I thought MOSIS was early '80s.

Weber: Well, we are--

Hannah: Maybe MOSIS was a year later, the official like formation of MOSIS, but yeah, I think the first chip was just working with PARC probably as part of a multi-project wafer thing. Yeah, right.

Fairbairn: They were kind of debugging the process before they could hand it over to MOSIS.

Hannah: Right, right, right. I remember-- so, I was going back to Bell Labs to work for the summer, and yeah, the summer, one of the later summers, maybe it was the last one, I'd done the layout on this chip, or mostly done it, but it wasn't quite ready to tape out, and I was trying to do it before I left there, but I didn't get it finished. I like went back there, and I was trying to like do the rest of it while I was there, and it wasn't working out. And so, anyway, I flew back, and what was supposed to be a week, like I said, I always underestimate how much <laughs> time it takes to do anything, and yeah. So I was like busting my butt for a couple weeks out here...

Fairbairn: To finish it up so it could be taped out before--

Hannah: Taped-- yeah, yeah, yeah, so-- yeah.

Fairbairn: So that must've been like the summer of '81? Two years after...?

Hannah: It was prob--

Fairbairn: You started with him in the summer of--

Hannah: Yeah, sum-- it was probably '80, would be my guess.

Fairbairn: All right.

Weber: So a year after.

Hannah: But it might've been '81. I could go calculate it probably, but-- yeah, '80, '81.

Fairbairn: That's all right. So when did the critical juncture come when, "I'm not going to work at Bell Labs, <laughs> I'm going to go start this company with Jim Clark"? How did that--

Hannah: Yeah, I mean, it-- yeah, I think that summer of '81. So over the-- you know, from '79, '80, '81 he collected the team of folks, you know, students and hired some staff to work on this DARPA-sponsored

Geometry Engine project. You know, fabricate the Geometry Engine chip, put together a demonstration system, and so there was, yeah, a collection of us there. You know, Kurt Akeley and Tom Davis, Rocky Rhodes, Herb Kuta. Sorry if I'm forgetting somebody. Dave Brown. That were working on that project, and... But at some point, you know, basically we-- things got more serious associated with, you know, specific things toward starting a company, and got an office off campus so, you know, when we talked about things that were not school related, you know, we'd meet over there. And, you know, it just-- I don't know that there was one big event, but at some point things became more real and I, you know, had to make a decision, and so I, I think, you know, probably called up the folks at Bell Labs and said, you know, <crying voice> I wouldn't be coming back.

<laughter>

Fairbairn: Did they try to talk you out of it or they...?

Hannah: No, I don't think-- I mean, there were no strings attached. I mean, that's the great thing about the Fellowship. There were no strings attach. You know, the expectation, the hope maybe, was that-- and several people did come through that program and go back to work at the labs. Others, you know, went into academia, and then, yeah, I-- yeah, I guess my attitude was-- again, coming back to this thing, I mean, you really don't, when you're making these life choices you only choose from the stuff you know about, right, and so that whole idea of starting a company and... Was foreign to me before, you know, before working with Jim, and so my initial reaction was not very positive but as it became more real it's like, "Okay. You go off. We get to bring this great technology to the marketplace." You know, there's a potential to make a bunch of money and if it doesn't work out, you know, I can always go and get a real job.

<laughter>

Hannah: Hoping I could still-- they would still have me back at Bell Labs. <laughs> And so, yeah, I said, "Let's..."

Fairbairn: So can you describe, without going into sort of the gory details but sort of a high-level, what architectural insight or implementation at the IC level or whatever that made this chip important or that changed the paradigm of how graphics were done? You know, what was the sort of fundamental insight or change of that versus the way things had been done previously? Or was it just the integration of the way things had been done previously?

Hannah: In terms of sort of generalized graphics, I-- you know, I don't know that I was aware of the way. <laughs> I mean, I have some knowledge of the way things were done previously. I think-- so a big part of it-- the way things were done previously though was sort of constrain-- to some degree it's constrained by the hardware resources you have, you know, the performance of the things that you're working with, and so, you know, and Jim was always focused on providing more and more realistic 3D graphics and interactive performance, and so at that time in order to get that kind of thing you were either on these multi-million-dollar flight simulators or you were doing vector graphics. And so part of it was just bringing the price points down. This was sort of the combination of integrating this functionality into a chip. Mean,

you could just replicate 12 of these chips and you'd have a nice system that could do bunch of stuff. As far as the whole-- the computational part of the problem, taking the geometric, you know, 3D representation of stuff and then getting that into a projected and, you know, mapping onto a 2D screen, and then my part, the-- what I was working on was the rest of that. You know, taking that 2D screen space representation and rasterizing that to the image on the screen, and so it's not necessarily that the math was different. Some sense it was just implementing the algorithms that people had been playing with for I don't want to say, you know, for a while, because a lot of this stuff was relatively new. But, you know, people had developed these algorithms on CPUs and writing to a frame buffer, right, and so you didn't have the performance but you could look at the still image and say, "Okay. That looks good," or bad, or better, and so was I trying to develop an architecture that could do that kind of stuff, those calculations, in real-time. So that was a big part of it. Another part of it, which actually, yeah, I wasn't intimately involved with, was in terms of getting these kinds of systems deployed and used by people is-- and a critical part-- so part is the hardware but another major part is the software, right, and so a graphics library that could provide the-- a way, you know, programming interface, right, so that you could write programs and take advantage of this hardware in a very nice and clean and easy-to-understand and structured way was a critical part of what Silicon Graphics did. I was focused on the hardware. Jim. At Stanford, was probably a combination. I was most familiar with the hardware aspect, the geometry engine, but I'm sure he was always thinking about the software side, the algorithmic side as well, and then when SGI started, you know, basically he handed off the Geometry Engine and that si-- the hardware side of things, that architecture to me, and he was more focused on the graphics library, which is a, you know, really critical part. You know, you can have the fastest hardware in the world but if nobody can program it then, you know, it just-- it gets used by a few people and that's the end of it. So a big part of the sort of what was done at Silicon Graphics was to find this software standard that let people program the hardware.

Weber: So, I mean, back at Stanford, you were using ICARUS on the Altos for the design then.

Hannah: Right. So the layout aspect of the design was done on an Alto using ICARUS. I hadn't thought of that name, except in the Greek context, for 40 years now actually, but...

<laughter>

Hannah: But yeah.

Weber: And Doug, do you want to just say-- to make the connection on the tape, so you--

Fairbairn: Yeah. So Jim Rowson and I had developed ICARUS in 1976 and '77. He was actually a summer student working, a PhD student for-- with Carver Mead and came to Xerox PARC for the summers of '76 and '77, and the two of us wrote ICARUS for use within PARC to do chip design, and then it got transferred to various other places like Stanford or whatever where they could-- where they had Altos, so that was the-- and I noticed in the article that Jim also was consulting with-- Jim Rowson was consulting with Jim Clark about some of the architectural tradeoffs of doing the Geometry Engine.

Hannah: Yeah.

Fairbairn: So... Yeah. So ICARUS goes back to summers of ’76 and ’77, and was used in quite a number of different contexts and to launch several different companies in terms of the chips that came out of it.

Hannah: Yeah. Yeah. So it’s... Yeah, that technology that Stanford had access to and stuff that came out of Xerox PARC was just-- it was amazing stuff for the time and definitely facilitated the stuff that we were doing, so--

Weber: And that into, I mean, ICARUS became part of MOSIS as the standard?

Fairbairn: No, ICARUS was just--

Weber: No.

Fairbairn: It only ran on Altos, and that was a Xerox tool, so no, it never-- there was a whole different set of software that was originally developed at PARC to sort of prove out the multi-project--

Hannah: Wafer.

Fairbairn: --wafer concept and I think that was probably rewritten, transferred, whatever, to, you know, the ideas were integrated into the MOSIS program but I don’t believe the software was transferred, so think that-- I think they were created to serve a function rather than moving the software directly.

Weber: But then what you were using at the end at Stanford before going off to SGI was what became MOSIS. Or were you?

Fairbairn: Or you ran-- you said you ran an MPC, the--

Hannah: Right.

Fairbairn: Yeah, that was--

Hannah: Certainly the Geometry Engine, original Geometry Engine chips I don’t think were done through MOSIS. It could’ve been like the last fabrication I did might have been through MOSIS. MOSIS was talked about, I think, in that time frame, but it’s also possible that, you know...

Fairbairn: Well, let’s talk about--

Hannah: We just hopped onto a Xerox wafer or something.

Fairbairn: Yeah. Let’s talk about the transition from Stanford. You have this team that’s-- Jim Clark has accumulated together. There are a couple of chips that have been prototyped, the Geometry Engine-- and what do you call your chip, the rasterization chip?

Hannah: Smart Image Memory, I guess, the--

Fairbairn: Smart Image Memory, whatever.

Fairbairn: So those are sort of the core demonstrations of this capability that was to be the seed for Silicon Graphics, correct?

Hannah: Yeah, yeah.

Fairbairn: And so when Silicon Graphics was formed and you went off to do that, and we'll talk more about that, but just from a technology point of view, did you use those actual chips? Did you start from scratch to redesign them for the real world or whatever? How was-- those were the prototypes, if you will, but not the--

Hannah: Right, yeah.

Fairbairn: --not the final products.

Hannah: And the prototype, I guess, like I said, I don't know if I ultimately-- I think I got pieces of my chips to work but never enough to like put together a full system, and so the demonstration system that was on there at Stanford was done using like normal discrete components of the time, of the frame buffer and rasterization hardware, and-- but the Geometry Engine was the key computational part...

Fairbairn: And that was fully functional or...?

Hannah: And that was fully functional, and then-- and then when we did the transition to SGI to commercialize the product the Geometry Engine-- architecturally it was, you know, basically the same. I think the chip that was done at Stanford was a 4-micron process. Yeah. I think we went to a 3-micron process for the commercial chip, and, you know, the clock rate wasn't the fastest in the world for the commerc-- so we-- so the two things were informing the company to do a commercial version of the chip. The Geometry Engine was try to make it smaller and faster. <laughs> But the functionality basically and the architecture, basically remained the same, and so, you know, so I know spent a lot of time just basically doing a relay out customizing the bit-slice of the data path a bit more to try and make it smaller. The PLA in the original design, program logic array, was like one big giant thing which had the same number of terms across the entire array, and so I did things like just sort the terms <laughs> so all the wide terms are down at the bottom and the narrow terms are at the top and so you can cut out that part of the-- it gets into the details, but basically optimizing the layout so you could, like, make the chip smaller, make the data path smaller, make the control parts of the chip smaller. But there was some microcode work that was done, I think, to sort of optimize that as well, and then a later revision-- the original Geometry Engine chip was, pipeline, was the 4-chip, so matrix multiplier, so it's-- we're operating 4-by-4 matrices, right, and there was a 4-bit vector in each one. A 4-component vector in each one. So four chips to do the matrix multiplication. One chip for each clipping plane, you know, top, bottom, left, right, near, far. So six chips there, and then the last two were scalers to do the divide by Z to-- the perspective division, and like map it into screen space. The-- and then I think the second revision I did a change

where you could actually-- because the pipeline's not perfectly balanced, right. So whatever-- the throughput would be determined by the slowest function, and so there were some underutilized parts, and so the matrix multiplication I think was taking the longest and so did a thing just to interleave-- put two sets of matrix multipliers and each one would take every other thing to do the multiplication. So that was like a minor tweak on the architecture in addition to, like, doing a relay out for the 3-micron process and sort of optimizing the architecture to make it smaller.

Fairbairn: So what-- by this time you were out of Stanford and doing this as part of SGI, right?

Hannah: Right.

Fairbairn: So what tools were you using and were you doing this work--

Hannah: So--

Fairbairn: --yourself or was there a team or how do--

Hannah: No. There was a team. I remember working with Tom Davis on some of the tools. Let's see. I think they were-- yeah, I think Tom Davis is the layout editor, and some of the tools were just taking those same MIT tools and using them.

Fairbairn: What computers were you using at SGI? What did you buy first?

Hannah: Oh, let's see. We did not-- I suspect-- I'm trying-- we didn't have an SGI workstation <laughs> to work on. I think Sun terminals.

Fairbairn: You did have Sun?

Hannah: Yeah. Yeah. Sun terminals, and then a, you know, a VAX and a terminal. So yeah. Yeah. The layout, of course, had to be done on a graphical terminal. The rest of the stuff could be done on a, you know, a minicomputer with a, you know, standard text terminal.

Fairbairn: So the tools were just ones you cobbled together from university work and that kind of thing?

Hannah: Yeah. Yeah.

Fairbairn: So tell me about the actual creation of SGI. You got these guys sitting around a table at Stanford and there was a time in which you say, "Okay, we've got a building. We've got a-- and we are now a company and this is what we're doing." How did-- did you have a big party? Did you-- was there a particular day this happened or did this migrate over time? And how did this begin?

Hannah: Think we had a funding party. <laughs> Let's see. So it was-- so I can remember like sort of these isolated incidents that I suppose strung together maybe they tell a story. But maybe not. I remember November of '81 going to-- what? I think it was Wilson Sonsini.

Fairbairn: Mm-hm. I'm sure.

Hannah: And-- to incorporate. Like you have to--

Fairbairn: Yeah. Probably for the funding, right, or...?

Hannah: No, this was--

Fairbairn: Oh, this--

Hannah: This was just-- no. This event I remember is just sitting, like, going to file the paperwork to make it a company. So November of '81, and the whole, you know, any company you have to figure out what the name is. I'm sure, you know, Jim probably came up with the name Silicon Graphics, but there was like a moment of like, "Silicon Graphics Systems or Silicon Graphics?" <laughs> We ended up with Silicon Graphics, Inc. But I remember little bit of discussion around that and I just-- yeah, I just remember like sitting in a lobby in this law office and maybe there was a little bit of discussion about the whole naming thing in that, but, you know, coming out and saying, "Okay. It's official now."

Weber: What was your position within the corporation?

Fairbairn: Did you have a title?

Hannah: Member of the technical staff. You know, I don't know, like, in November if we have titles but, you know, eventually, yeah. Once you start working with VCs and things have to be formalized, yeah, there is a title. But we were all-- we were all academics basically, right, and so there was, you know, Jim was-- Jim was a big motivating factor, right. You know, his Geometry Engine architecture. Like he was the one who said, you know, "Let's go off and do a company around this stuff," and, you know, we were students and some staff, but I don't think any of us had any experience before that of dealing with startups or even like thinking about going off and do that kind of thing, so... So he drove the business side of things and talking to the VCs and so forth, and when SGI started, for the most part, you know, that entire time, we were members of the technical staff. Tom Davis, he had more experience among us. He was a software manager, and then the rest was more experience, executives hired from-- to be a part of the company, and I don't know. You know, some of that was probably driven by the VCs but I wasn't involved in that. I was pretty much heads down, you know, focused on redoing the Geometry Engine.

Fairbairn: So you mentioned funding party. Do you remember when you actually secured that first round of venture funding?

Hannah: Yeah, so that was May of '82.

Fairbairn: Okay.

Hannah: What was it? Eight hundred? Was it $800,000?

Weber: Eight hundred thousand. I think so.

Hannah: I mean, it was a relatively small amount of money by today's standards and gave up a relatively <laughs> big piece of the company.

Fairbairn: Yeah. Jim described, I think, giving away 40 percent for 800 or something.

Hannah: Forty. Forty percent for eight-- those are the numbers I remember. Forty percent of the company for eight hundred thousand, and in terms of the-- yeah, I think the, you know, percentage of the company that the founding team from Stanford got, it was not, I don't think, what is more customary by today's standards.

Weber: Do you remember-- are you willing to say?

Hannah: Oh, I won't get into <laughs> the specifics of that.

Weber: Okay.

Hannah: But I think a lot of that was driven by the VCs. I do remember-- I don't think Jim was happy with-- I don't know specifically about if he was happy with his piece. Probably not totally happy with it, but I know he was not happy with the amount of stock the rest of the team got, and so I think that was one of the things in terms of Tom Davis becoming our manager. It's like, "Well, you know, if we're going to give you more stock you need to, like, be a little higher up in the hierarchy," kind of deal, and he actually gave me a little bit of his stock, Jim did, to sort of boost me up a little bit. But anyway, you know, we all did okay, so <laughs> I'm not-- yeah.

Weber: And who were the-- so the other Stanfor-- I mean, there's Kurt, who-- the other Stanford students, if you could say who they are.

Hannah: The other, the people on the team that came on at Stanford?

Fairbairn: Tom.

Hannah Tom Davis, Rocky Rhodes, Kurt Akeley, Herb Kuta. David Brown. Me. Am I forgetting anyone? Hopefully that's all of it.

Weber: And you were the first and then sort of roughly what order did you--

Hannah: Of the subsequent--

Weber: --guys come in?

Hannah: Yeah.

Weber: Or was it all in a group?

Hannah: No, no, no. I mean, so some came in as, like, I think-- so ’79 I started working with Jim and then, you know, there was another group that came in in ’80. If it was a student, then yeah, he came in the subsequent year, and then I think, you know, by ’81 we were, you know, that fall we were sort of off. I don’t think anyone joined past the fall of ’81 out of-- in the-- terms of the Stanford team. I think Tom Davis was-- I think for the most part it was ’80 that probably the next wave came in, and then I think Tom Davis and David Brown were hired as staff, I think. Kurt definitely a student. Rocky definitely a student, Herb student.

Fairbairn: And who was working on what, very briefly? So you were on the Geometry Engine.

Hannah: So I was on the Geometry Engine. I mean, Kurt... The vacuum rasterization was, I think, a big part of what Kurt Akeley was doing, and again, that was done using standard available parts -- ultimately it wasn’t the custom integrated circuits, that was done for the back end.

Weber: Because that had been your thesis.

Hannah: Right.

Weber: But so why did you-- why did SGI ultimately--

Hannah: The same--

Weber: --not do that at Silicon?

Hannah: It was just--

Weber: Or in that--

Hannah: The practicalities of, like, doing a custom chip and--

Weber: Time and money and... <laughs>

Hannah: Yeah, yeah. It’s just another risk that wasn’t necessary.

Fairbairn: So what was the original goal, that is to you were building these chips but the goal was to build a stand-alone computer to build a...?

Hannah: So yeah, it’s-- a stand-alone computer was very early on the goal, but it was not the first thing we developed, and I don’t know if, you know, when we were in first meetings talking about our product, when we were first incorporated if Jim’s mind was, “We have to do a workstation.” I mean, it probably was in there somewhere, right, but any-- in any startup organization you have to get a product out, right, and we didn’t want to bite off more than we could chew. Standalone workstations were not the way

people were doing things. Generally they had, you know, minicomputers or mainframes in the terminal, so... So the first product was a graphics terminal that hooked in, you know, hooked into-- presumably over Ethernet. I don't know. To another computer somewhere, bigger computer somewhere. But even before that was finished I think we knew that that was not the way of the future, and like I said, it was probably in Jim's mind from the beginning but the wave of the future was stand-alone workstations, right, full integrated computers where you do everything there locally, the, you know, CPU and the graphics are closely coupled, and so that's what we set out to do, and the workstation was just basically taking the hardware that was for the terminal and, you know, slapping in another CPU card in the box. Not quite that simple, but... <laughs> But yeah, basically that's-- you bring the CPU inside the box and then you have a stand-alone workstation. The, you know, of course, a big part of that is once you're building the entire computer you need operating system people, you need compiler people and all this other stuff, right. So part of that decision was hiring the team of people who could deliver a complete workstation solution, so they were people-- I think several of them came out of Bell Laboratories where, of course, there was a lot of UNIX development and C development work being done. I remember Bart Locanthi and Sally Browning and Steve Bourne. Some of the names associated with that. Greg Chesson. I remember-- yeah, so... So yeah. So at that point-- so very early on, if it wasn't the original concept, the, you know, the terminal was just a step along the way to getting to workstations, and then you come out with a single product and then over time you expanded that. There was another decision point about essentially becoming a supercomputer company as opposed to just a, you know, high-performance graphic company, and I think that was not a part of the business that I was focused on. <laughs> But I think Forest Baskett played an important role in some of those decisions as well.

Fairbairn: You want to back up? Is there something you wanted to cover?

Weber: Well, the-- to go back to the who did what in the group. So you went through you, Kurt, and then the others, briefly what were they working on?

Hannah: Yeah. So ah, let's see. Again, I'm not-- I don't guarantee the accuracy <laughs> in terms of what other people were doing, but I think, you know, Kurt and I were primarily hardware folks, and my recollection is that the other folks were primarily focused on the software side of things. And to be more specific, I don't know. I know I, you know, as I said, I worked with Tom Davis some on tools, but there was that sort of two critical parts of the project. One is developing this new hardware and the other is developing the graphics library and the software associated with being able to program it to the higher-level functions.

Weber: And Jim was working on the graphics library with other people once you started the company?

Hannah: Yeah. Yeah. And I certainly-- Kurt Akeley was much-- also a lot involved in the graphics library activities certainly at some point. You know, I mentioned before that one of my motivations was driving down the cost of high-performance graphics and so I was always focused on the low end of things, and as we did more than one product <laughs> there was a split between high end and low end, and my focus was on the low end, and Kurt's focus was on the high end. And the high end was where new features were introduced and I would sort of try to take-- each generation take that feature set and see what could be brought down into the lower price points, and so a lot of the GL work was done in

association with the high-end product work and Kurt Akeley was heavily involved in that. And plus, I think Rocky and Tom as well.

Weber: And the terminal-- sorry.

Hannah: Yeah.

Weber: Before the terminal. I mean, when you were doing the demonstration to VCs and stuff, what did you actually have working back at the beginning?

Hannah: It was in a lab. Set of cards in a chassis. <laughs> The frame buffer was the, you know, discrete hardware design. There was a, you know, a board that had the pipeline of Geometry Engines.

Weber: And what could you show on it?

Hannah: And a screen where you could show stuff, and I-- the original-- Snoopy was one of the original <laughs> demos. <laughs> I guess Snoopy on a biplane kind of flying around. I think that was one. There was-- I know a very early demo. I don't know if that was at Stanford or like an early demo in the terminal, but a Rubik's Cube. Like manipulation of a Rubik's Cube, and then it was definitely not at Stanford but Gary Tarolli was another name that was involved very on-- very early on. Not at Stanford, I don't think, but very early on, and he wrote, I believe, the flight simulator, if I recall, and that was an early demo that was done for the terminal.

Weber: So you finally did get a flight simulator. <laughs>

Hannah: Yeah. So I spent a fair amount of time flying the flight simulator. I had just maneuvered, you know, in the fighter jet. You take off and you go, like, vertically, cut power, and then the trick would be to, like, turn around, come back and land at the airport with no power, <laughs> but-- and we had dog fights and things and so... So I had a-- knew a little bit about how to fly and then one time I-- Jim was into flying and so I remember at one point like going out with him and, you know, he let me have the controls and I think I took off. You know, the takeoff and flying around is the easy part, and so I had enough experience in flight simulators <laughs> I wasn't going to do anything too crazy, but I think he let me, you know, basically fly out, kind of fly around a little bit, and then start the approa-- of course he was guiding me verbally, you know, what to do. The important thing is don't make any like real major jerky movements, right, and of course-- yeah, there are two sets of controls so he can override me <laughs> if he needs to, and then I was like coming in for the approach, at the point, which I said, is like, "Okay. That's far enough. You take it from here." <laughs> Because that's the hard part. I eventually-- it was in 2001, 2003 time frame, I guess I-- I actually learned to fly in it. I ended up getting my pilot's license, instrument rating, bought a plane and all that kind of stuff, but... That was years later, but yes, I did get my-- get a chance to play around with flight simulators.

Weber: And you said Snoopy was also on the original chip, the image of...?

Hannah: Yeah. You know, it's academic. You could kind of do everything you want <laughs> without the copyright infringement lawyers getting involved until it went to publication. Then it was like, "No, you can't put that in there," so we lifted that cell in the layout. It was just-- I don't know, it's over the-- and it was just a reference to the demo, the Snoopy demo, is why it was put in there.

Weber: Did you have...?

Fairbairn: So getting back-- we didn't quite get to the funding part of it. Did you have a big celebration and do you remember who was the first non-Stanford person to be hired?

Hannah: Oh. Well, the first person was Diane Wilford. She was the like secretary/administrator, assistant... So, like, Jim's employee number's one; mine is seven.

Fairbairn: <laughs>

Hannah: But there weren't of the any other founders <laughs> like lower than seven, so... So there were--

Fairbairn: There were--

Hannah: There were, you know, two through--

Weber: Okay, those were--

Hannah: I-- that were like temporary people or contractors or people that ultimately didn't stick around or I don't know. I think Diane Wilford was in that, like, between one and seven. But I think-- yeah, was like one-- in terms of the founders, one, seven. I think 10 maybe was the next one and then, you know, whatever after that. So there were some people that were hired temporarily.

Fairbairn: So on the chip itself, things you were directly involved in. So you did the updated Geometry Engine. Do you remember taping that out and getting it back? Did the first one work? Did you, you know, was there big-- there's always this big thing about, you know, when the chip comes back is it going to work?

Hannah: Yeah. Yeah, and so I was, you know, in addition to doing layout, design verification, all that kind of stuff, I also was the wafer tester, so...

<laughter>

Hannah: So yeah. We had a wafer test machine, you know, probe card and, you know, hooked up to the computer to run a set of diagnostics, so you know, you have your wafer and a bunch of individual dye and you just have the probe card with this precise positioning, XY positioning, and you drop the little probe tips on the pads and then you run a test, and then you-- the ones that worked I didn't write on. <laughs>

The ones that did not work I, like, wrote a little dot on it. I think I just like a marker. You know, didn't have, like, little-- anything to--

Fairbairn: Yeah, there's supposed to be an inkjet thing--

Hannah: Yeah, an inkjet thing. <laughs> No. I think I just, like, reached over it and <laughs> put a little mark on it with a marker.

Fairbairn: So did the first one work? I mean, did you--

Hannah: Yeah, the-- yeah. There were some-- yeah, it worked-- there was a circuit on there, like a phase locked loop on-- chip clock generator circuit that was on there that did not work. There was a floating node, a floating gate. Unfortunately the simulation tool, like, initialized everything to a value and so if the value happened to be okay then, I mean, that node didn't get toggled but it, yeah, but it sort of worked in simulation. In practice it was a-- yeah, was a floating node. So that clock oscillator circuit did not work, but we also knew that was a possibility, and part of it was just an experiment, and then the raw paths were there on the chip to bring the clock in from outside, so... But all the-- I think pretty much all the functionality worked. I don't remember like a bug in the code or data path or anything.

Fairbairn: Did you ship product with the first chip or did you have to do a rev?

Hannah: No, I think-- I think so. I think so. I don't remember.

Fairbairn: And did you actually ship a terminal or, you know, terminal only is the first product?

Hannah: Yeah. It was in these black, you know, wasn't a custom package or anything. I think we did 10 terminals. I think Robert Abel, like, the commercial visual effects kind of stuff, was one of the early customers, but I remember like-- Abbey Silverstone was in charge of manufacturing at that point in time, and yeah. So I remember there was a picture somewhere like outside of the backdoor <laughs> of SGI, you know, with this black box of a terminal. Was about so wide and whatever, so tall, with all the cards for the terminal would be about to shi-- be shipped off to some customer somewhere, and I think that, like, this initial run was 10 systems. Yeah. So at that time there was no, you know, there weren't any ready applications. This was a piece of hardware. You had a graphics library that you could write code, but you had to write code, so...

Weber: So who bought it?

Hannah: I think a lot was sort of military contractors. They're developing some product for something or other but, you know, some military contract they're developing, they're using new technology, and so they have the programmers to go in and write the code to do something. Yeah. For a long time, you know, we didn't-- applications were not a part of the company, right, so it's just the library that you use, the API, in today's terminology, right, that you get people to write applications and, you know, over time there were commercial companies that developed applications that would run.

Weber: But were you actively trying to get third-party developers with a stable of things or not?

Hannah: I do-- I was not actively involved in that, right. I totally focused on the hardware.

Fairbairn: What was the project? You got this Geometry Engine, started shipping product. What was the next project that you worked on?

Hannah: So evolutions of the Geometry Engine and then the-- so the overall graphics architecture. The-- on the low end, and then when we split into three different divisions, the low end and midrange. So the system had a Geometry Engine, a raster engine, you know, and a few other random parts, so the-- sort of display back in, and so the architecture of those parts of the system, that was my focus, and then it was a connection back to the host CPU and there were other people that dealt with the CPU side of things.

Fairbairn: Did you ever integrate the rasterization stuff that you had originally done that prototype chip of or is that always stay...?

Hannah: I mean, the architecture was basically the same, right, even that-- there was a slight modification of where functions, I think, in terms of the levels of, you know, the stages of the pipeline, but ultimately, you know, basically the same basic architecture. It was done using discrete components. The-- and then-- and I'm just trying to remember like which was the product where that was integrated into a custom chip. It was fairly early on but it-- not the first product. There was a raster. It's possible that Personal Iris was the first one where that was done. There was a custom raster engine chip is what we, you know, called that, that did the rasterization functions. Done using probably gate arrays, I suppose at that time, and yeah.

Weber: And what period would that have been? That would've been...?

Hannah: Yeah. Maybe... when's RE1[2]. So the first product came out, what, '80-- ew. I think first workst-- '83? If you know the right answer... <laughs> You can wave your hand. <laughs> Yeah. I think in the-- toward the end of maybe September of '83 or something. I don't remember exactly. Was the terminal product, and May of '84, I think, was the first workstation product. So very, you know, short time later, and that was the Iris. So the terminal was the Iris 1000. The workstation, bigger box. The Iris 1400, and then there follow-ons, 2400 or whatever. I'm thinking that those initial products were still a discrete back end and it wasn't perhaps until the Personal Iris. I think we might've gone through the 1000, 2000 and 3000 before it got to the Personal Iris, which was a smaller box and nice plastic skins, and the original goal for that was actually to be a desktop thing. I-- you know, I remember sitting, playing around with form factors and I had a, like, a set of desktop speakers on my desk and just like, "Okay. That's a nice form factor." I tried to do something like that and made a little Styrofoam thing that was kind of that shape. Smaller than it ultimately ended up being, but, you know, it's like generally that shape. But yeah, so it ended up being a floor sitting thing, and, you know, about so big, about so tall, and so that probably was the first one. Again, trying to drive the price down. Maybe the price point for that was 20,000 or something. I think the price point for the original was maybe more like 50,000.

[2] Uncertain transcription

Weber: And 75,000 I've heard for something.

Hannah: No-- it's possible, yeah.

Weber: Yeah, the--

Fairbairn: Given your interest in low end, at some point there was a debate about the role of the, you know, the personal computer and should you have graphics add-in to the personal computer; is that correct? And what can you say about that whole--

Hannah: Yeah, so... So anyway, you know, the drive was to, you know, push the price points down lower and lower. First step was the Personal Iris, and then there was-- it'd probably take me a second to try and remember all the names of the stuff, but there was, you know, a desktop one that was kind of a pizza box, and then the-- we were moving the price points down 20,000 and 10,000 and then something-- target was 5,000 but I don't-- I think we were little bit above that. But yes. The competi-- I always felt that you need to broaden your market and, you know, push price points down, not only because that's what I was-- motivated me but because that's where the-- ultimately computer companies tend to get eaten up from below, right. The cheaper stuff becomes fast enough to do the job that you need to do, and so that was the real danger, your bottom flank, and so some of my activity was trying to introduce the, you know, those graphics technologies into more of the consumer space either way. And I think certainly-- when was that going on? Maybe '93 I started working more closely with Jim to push the technologies into the consumer space, and so--

Fairbairn: That was quite a bit later.

Hannah: In '90-- yeah, '93, in--

Fairbairn: Ten years after founding?

Hannah: Yeah. I mean, so PCs were nowhere close in the early years.

Weber: But Jim says that he was worried about the low end from early on. Do you remember--

Hannah: I mean, it's certainly possible. I mean, it doesn't-- yes.

Weber: I mean, do you remember him being concerned--

Hannah: Talking about it?

Weber: --about it or...?

Hannah: I don't know. I suspect it might've been-- when did we start? '84. You know, I think probably by the late '80s it was becoming more of a threat.

Weber: Okay. But not in the early days really.

Hannah: No. Yeah. Yeah. I mean, ultimately, that's, you know, that was the thing that-- the reason I left SGI was that whole evolution of-- and where I thought the industry was going where SGI needed to go and SGI wasn't doing the right things.

Weber: And the-- at the founding era-- so I know this was probably not your-- but, I mean, the relationship with Stanford was pretty friendly, right?

Hannah: Yeah.

Weber: You don't remember any, and there was $25,000 from Ronnie Goldfield as a initial sum, but I think that was just between Jim and him, right.

Hannah: Yeah, probably. I don't remember that name. I know there was some initial funding, which I think Jim had a, like, a consulting contract or something, and I think he took some of the money from that and used that to, like, to rent the office over on East Bayshore and stuff like that.

Weber: What was the address? Do you remember?

Hannah: I don't know. I-- a number pops into my mind but I have no reason to believe it's correct, so I'm not even going to say it. But it was just down the street from Bayshore and Embarcadero. If you go little bit farther down the street there's Palo Alto Airport but, you-- yeah, you cross over 101, you hang the first right and you go a short distance down and <pop> there you are. The first office owned by SGI, and it was just maybe one or two offices. <laughs>

Weber: And then we-- I think it was when we were off camera we talked a little bit about the graphics library, which I've heard that it was Jim and Martin Newell who had developed some of that for the course they taught based on Ivan Sutherland.

Hannah: Yeah. So I never took that course.

Weber: Oh, okay.

Hannah: And I know the name Martin Newell. I-- yeah, I think I've met him. <laughs> Yeah. At some point. But didn't interact a lot, and yeah, I must've met him.

Fairbairn: He was at PARC for a period of time.

Hannah: Yeah, yeah, yeah. Right. No. I mean, I hadn't thought of that name for a long time, and so it's like, "Wait. I think--" you know, a face pops into mind and, yeah, I think while we were at Stanford I-- yeah. There was some interaction there, for sure.

Weber: But do you have any opinion on why, why did SGI do its own standard, in essence, and not look too much at, I mean, there was think mostly vector-based things. I mean, what, FIGs and various other-- there were some proto-standards around.

Hannah: I was not at all thinking about that.

Weber: Okay.

Hannah: Yeah. <laughs>

Weber: Not your department. And then I've also-- I think it was Jim that said there was trouble-- there was some attempt to license to IBM, Apollo, HP and DEC, who were not interested in licensing the technol--

Hannah: To license-- so I-- yeah. So I don't-- I'm not--

Weber: Oh, this-- okay.

Hannah: To license what specifically?

Weber: I thought it was to license--

Hannah: The GL or...?

Weber: The design for the chip or...?

Fairbairn: Was probably before the company was formed, right. It was--

Hannah: Yeah.

Weber: Pro-- yeah.

Hannah: No. I was not at all involved in any of that discussion.

Weber: Okay. And then it was finally-- and that half of the Sand Hill VCs turned it down, but then Hollywood came in as kind of the-- one of the major applications. When did that start the, you know, the Lucas ILM connections? And again, if this isn't what you were concerned with--

Hannah: Yeah. Right. So it wasn't what I was focused on, but I do remember, as I said, you know, Robert Abel and Associates was one of the early customers, and I think as it started being used it was basically the only thing that was available that had the kind of performance to do those kinds of things, and I suspect another part of it might've been the GL, which made it perhaps easier to program to do those kinds of things than perhaps other hardware that might've been out there, and so ultimately that became what SGI was best known for perhaps. I think it was only maybe 10 percent of the business or 15

percent at most, but the most visible part, the primary target, was, you know, more computer-aided design and...

Weber: So what were the core-- the core customers or markets?

Hannah: Yeah. Yeah. I mean, so, you know, car companies, you know, Boeing. You know, designing machines. There were lot of military.

Fairbairn: Industrial designs stuff.

Hannah: Yeah.

Fairbairn: Mechanical.

Hannah: There was general scientific stuff. So people-- let's see. Oil and gas. You know, whatever. Computational chemistry and visualization. But yeah, there's kind of the general scientific, the computer-aided design manufacturing aspect of things, and then I guess, yeah, I think oil and gas was considered a separate thing in terms of-- trying to figure out where the oil is, right, <laughs> so, you know, you send these shock waves, measure reflections and you visualize all that stuff, trying to figure out what the shape of the junk on the ground is and figure out where the oil's going to be. The-- yeah, and then this whole visual effects space, which is, you know, of course, very exciting, and, you know, had the most. That's... You know, people talk abou-- in the general public talk about SGI. It's like, "Oh, 'Jurassic Park,' 'Terminator.'"

Weber: <laughs> But was that fun for you guys?

Hannah: Oh, yeah. Yeah, yeah. Yeah. You get to meet a few celebrities, you know. <laughs> And, you know--

Weber: Coming through.

Hannah: --I met George Lucas and, you know, few other folks.

Weber: And then talking about your career within it and the company. When did-- what roles-- or your role stayed fundamentally the same? No. You later became a--

Hannah: Well, you brought--

Weber: --VP, didn't you?

Hannah: Yeah, I mean, yeah. I mean, sort of my responsibilities became broader over time, and so MTS [Members of the Technical Staff] focused on the Geometry Engine initially and then over time, I mean, not huge amounts of time, but the overall graphics architecture. I mean, it was all always the overall graphics architecture but became multiple products and at some point there were two different divisions and I was

looking at architecture on both. But in terms of title, member of technical staff, principal scientist, chief scientist, and then VP of chief scientists was kind of my final title.

Weber: And when did Ed McCracken come in? fairly early, right?

Hannah: Yeah, fairly early on. Vern Anderson was the original president, and that may have been for about a-- I was about to say a year, but for some reason I'm thinking of '84 is when Ed came in. But yeah, fairly early on. Out of HP, and I give him a lot of credit in terms of sort of building up the company and steering it through the early years. I mean, there were some other executives in sales and finance that sort of came and went very early on, but I think ultimately with any company, any tech company, there's a-- the initial path, the initial vision ultimately needs to adapt as technology improves and the market changes and so forth, and I don't know. There are bunch of reasons why SGI ultimately peaked and went in its decline, and I could-- I'm sure Jim saw it coming and I could sort of see it coming, initially trying to steer things in a different direction, and then when it didn't happen... There was a period-- when was it? Was that '95? I think Apple was at its weakest, and there were like rumors floating around the company that we were looking at, you know, acquiring someone, and-- but I wasn't in the conversation so I didn't know what was going on, and so I was thinking, fearing, you know, the threat from the low end. It's like, "Oh, we should merge with Apple," and then, you know, push those technologies down. Ultimately it was Cray. We bought Cray, and that-- so it was a high-end play, which I said, you know, it's like, "Okay. Well, there must be a good reason for this." Maybe the-- tactically it's an important thing but, you know, the real strategic threat is at the low end, so-- and I had started working, like said, in '93 I, you know, Jim and I were going around, so I was helping Jim sort of more sort of visualize or speccing out, kind of proposing an architecture. It's like if we want to go into a video game or these consumer applications, kind of this is the architecture we would use, and, you know, making that pitch, so-- and we talked to Sega Nintendo and Namco and, you know, these game companies, and I mean, ultimately we did a deal with Nintendo to develop a 3D game system for Nintendo. There were two actually activities, because I was trying to figure. It's like we talked to Barry Diller. Why was that? <laughs>

Weber: For cable, for--

Hannah: Yeah, it was interactive cable.

Weber: For the telecomputers, right.

Hannah: Yeah, it was intera-- yeah, exactly. It's interactive cable, and so we ended up doing a deal with Time Warner to prototype some interactive cable stuff.

Weber: So, I mean, from around-- I think we've talked about up until around '84, right?

Hannah: Well, '84 is the, you know, basically when things first started, right. The first workstation product came out in '84, and then the-- we grew, and then we failed. End of story. <laughs>

Weber: All right. Well, thank you so much--

Hannah: Okay. We're done.

Weber: --for the--

<laughter>

Hannah: Nah, it--

Weber: That's the Silicon Valley story.

Hannah: Yeah, right. <laughs> They failed. It wasn't my fault.

<laughter>

Fairbairn: That's true.

Hannah: Yeah. So it was, you know, start off, you know, did a workstation, you know, so follow-on products, growing the software side of things to enable people to write applications. You know, company grew. I don't know. The first year maybe did five-- I missed this year. I think it was 2 million, 5 million, 22 million, 42 million. Those numbers may not be accurate, but something like that. So, you know, good growth. We were growing rapidly. The-- and as we grew and hired more talent that had a broader experience the product line expanded, right. So there was like a split between high end and low end, so there was a division that focused on the lower end workstations and the higher end, and then we got into not only these much larger graphics, higher cost graphics boxes, but then the computing multiprocessor parallel computing systems to go along with that, and then you're selling, you know, bigger and bigger systems, these, you know, million dollar, multi-million-dollar systems where, you know, there's primarily computing focus. So essentially you're not just a graphics company, you're a high-performance computing company, we'll call it, <laughs> and some of that is graphics and some of that is on the CPU side of things, and people might be buying SGI systems that were totally focused not on the graphics but-- although probably, you know, ultimately you like to visualize stuff, but a big part of it was just, you know, how many FLOPS, megaFLOPS or-- you can do. There was a point at which there was a split again where it became three divisions, the--

Weber: And do you remember roughly the years and the names of the divisions? Or which products they corresponded to?

Hannah: Yeah. So let's see. So Personal Iris was when they were two divisions. By the ti-- maybe that was '91. Or maybe it was not. <laughs>

Weber: Was probably not '80 or 2000, so you're saying.

Hannah: <laughs> Yeah, I don't know. Yeah, I'd really have to, like, dig that up. Personal Iris, Indy. No, so-- maybe Indigo was before that. It's kind of a blur, so I-- it's hard to pin down exactly when the split was. The sort of the Indy, 02 were kind of after the three-way, three divisions, where Indy and 02 were

the lowest division, and Indigo, Indigo2 were, which was a bigger box, and there was another one that was like more vertical. Maybe that was Indigo2. I don't know. That was in the midrange division, and then the higher end was-- oh, I'm not sure I can remember all the names, but, you know, the VGX. There was, you know, I think something called Crimson. I don't-- <laughs> I don't remember whether that was internally or externally, but, yeah, I don't remember all the high-end names. Just bigger boxes.

<laughter>

Weber: And more money.

Hannah: <laughs> Yeah. You know, single stack, double stack. So yeah, I don't know. Another, you know, a big turning point for me was, as I said, you know, I had graphics architectural responsibility over the low end, midrange. Somewhere in there we-- on the CPU side, we were using the MIPS architecture, so MIPS was a separate company, you know. All our stuff was built around MIPS, a critical component. MIPS had their own workstations that they had come out with, but they were not considered, you know, stable in the long-term, right. So we had this critical piece of technology that we were dependent upon and yet we weren't sure of the long-term future, and I think that was the rationale behind the acquisition of MIPS.

Weber: Which was roughly what year?

Hannah: Yeah. So that was <pauses> I'm guessing in the so early mid-'90s. Maybe it was '95 or so.

Weber: That sounds right from what I've read. Yeah. But prior to that you were--

Hannah: It was-- yeah. I mean, it was actually-- maybe it went back to '94. I don't know. But that was an event that sort of triggered the beginning of the end for me, because it was a period where the threat from PC graphics and-- was becoming more real and more imminent to me, and so I always felt that the lowest end was the most important part of the product line in terms of our long-term sustainability or our long-time growth maybe, and when we acquired MIPS, that engineering organization, the VP of engineering became the general manager of our low end. And I-- yeah, there was a point where there was discussion about the architecture of a next-generation low end and the people from that team, which, you know, the general manager certainly came out of MIPS and I think the chief architect came out of MIPS. They wanted to do a certain architect-- they want to do a unified memory architecture, you know, basically. So one big wide bus, I think 256 bits, and you put your graphics and your CPU stuff in there and, you know, that's the way to get the cost down, and, you know, I understand the advantages of unified memory. That was the architecture I proposed for Nintendo and that's-- and it was ultimately used, you know, whatever, couple years before, so-- but it's tradeoff, right. It's-- Nintendo you had to do that because every-- you know, saving every penny was important. I felt that our prices were still too high to suffer the compromise of a unified memory because you're sort of mixing up graphics and CPU accesses and, yeah. I don't know. In the details of-- yeah. Everything's a tradeoff, right, and so I felt at that price point you were compromising the graphics performance, and it wasn't the right level to go to that kind of an architecture. But yeah, I basically lost that argument. I think there, I mean, there was a meeting. The general manager of that division spli-- I mean, sort of technically we're reporting to the same person, right.

There's the senior vice president that was over those two divisions and I reported to him and-- but, I mean, basically there was a meeting where I said, "I disagree," and-- but lost that argument, and so I felt that looking down the road a couple years that that, you know, we were going to become less competitive at that entry point. I mentioned before that when-- just before the merger with Cray, which was, I guess, you know, little bit later, yeah, I was hoping we'd do something to address the exposure on the low end, merge with Apple, and it ended up being a high-end play, and the work that Jim and I had done-- Jim left I guess in '95 to go off and do the Netscape thing.

Weber: '94 I think.

Hannah: Maybe. It may have been.

Weber: '94. Yeah.

Hannah: Yeah. Yeah. So yeah, he went off to do Netscape. You know, I stuck around, but the follow-on to the Nintendo I felt also wasn't there. It's like, "Okay. It became this one-off thing and..." and the trial with Time Warner to do interactive cable was going on, but I don't know. Oh, and then the other thing was I felt that the architecture of the way people would do computing was changing, that-- so we were selling all these expensive workstations, $50,000, $100,000, $200,000 workstations, but, in my mind, that ultimately-- smaller things will become faster. That was one thing, but also that was inefficient in that a better ar-- networks were becoming faster, certainly local area networks. And so, I felt if you're going to spend that much money on computing, it really should be centralized. And so, I-- so, what I was pushing for was-- high-performance, high-cost workstations was a flat to declining business and that, ultimately, we needed to be designing for centralized computing and graphics, and then you send pixels down the local area network--

Weber: Thin client stuff.

Hannah: Yeah, it was more thin client. And that may have been the terminology used at the time, yeah.

Weber: Because I mean I don't know if that was Sun or – but it was in the air for--

Hannah: So, design your-- I said yeah, it's-- is it like the old mainframe terminal kind of thing? It's like well, it's similar, but no, it's different because the architecture of the-- I mean you're designing these different scalable modular things that are centralized, but people aren't running those full out all the time. And so, it's just centralize that. If your wire is fast enough to send the pixels down, then it's-- do that, and people can-- I gave-- it's easier to deal with system management, and performance can be shared and yadda, yadda, yadda. So, anyway, so that was the way I felt things were headed. So, there was a combination of I felt, at the high end, sort of the way people would be buying systems was going to be changing, and then at the low end, PCs were going to become fast enough. Yes, we'll be faster, but the PCs will be cheaper, and they'll be fast enough to do what people want to do for a lot, right? So, if you can buy a $2,000 PC and a 5 or $6,000 SGI machine, then more and more people are going to be buying the $2,000 PC. And so, bought Cray. I'm skipping over some stuff. We can come back to that, but bought Cray, and then I think there were some tactical just sales issues that caused us to miss our sales

projections, or whatever. And again, this was about the time that I was talking about evolving our high end architecture and addressing more tactical issues at the low end-- I mean strategic issues at the low end. So, we missed our numbers. Stock price took a dive. There was a lot of focus internally on just execution, just like very tactical short term execution. And I felt like the sort of the more strategic, longer term vision I wasn't getting any traction on. And that's sort of when I decided to leave. I felt it was the start of a death spiral. This is kind of the end of '96, early '97. I thought it was the start of a death spiral, and it didn't seem like there was anything I could do to stop it, so I left.

Weber: To the outside world, that was almost the peak of it's--

Hannah: No, that was the peak-- I mean, yeah, so we peaked, but so-- but a couple of years before the peak, I felt that the downturn was coming just for these longer term sort of strategic product reasons. And so, I was projecting. It's like I've got a couple more years before things start to downturn, and if we can keep our stock growing at a certain rate, then I'll be able to cash out with this much money. It came a little bit sooner, you know, probably at least a year sooner than I expected, but, like I said, it may have been triggered by the Cray acquisition, where, for tactical reasons or execution issues, we missed our numbers, but then like once we were in that downturn, I think maybe it was because, yeah I mean Ed was running things, so there's maybe issues associated with how things were being managed, but anyway, I'm just looking at purely from the product architecture side of things. And I thought we were exposed at the high end, exposed at the low end, and--

Weber: Exposed at the high end, or just because--

Hannah: No, this whole thing about making, selling these expensive deskside boxes.

Weber: That there's no future in the high end, right. And when-- the peak stock price was around '96 or '97 or something.

Hannah: Yeah, once we--

Weber: So, you left before it.

Hannah: No, I didn't-- I mean I left at the downturn, at the start of the downturn because I didn't see-- I felt it takes a couple years to do a product, right, so if your product line is not properly positioned, aligned, and it's going to take you two years to fix that. Plus, that's if you decide to make the necessary changes, and I didn't see the changes being made. So, we weren't even starting to do this kind of new kind of product. And so, best case, it was like a couple years of tough times. And worst case, it would never be done, and we'd be in this, like I said, this death spiral. So, yeah, so I sort of left and ultimately got into a few other things, but nothing nearly as successful <laughs> or at all successful <laughs>. I guess that's not nearly. <laughs> So, let's see. Let me just back up for a moment to see if there any major things that I'm jumping over. Of course, the whole thing of Jim and conflicts-- there were conflicts between Jim and Ed. And it was over, I think, the whole strategic direction of the company. And Jim had the founder's vision, right, and then Ed was brought in like as the manager to-- there's a lot to growing a company that has to do with just day to day operations, right, making sure all your Is are dotted and Ts are crossed and

people are executing and your sales force is growing and you're meeting your milestones and yadda, yadda, yadda. So, but when you change, then who wins out? And so, Jim was butting heads with Ed, I think over--

Weber: But not from the start, right?

Hannah: No, no, no, this was years later. So, this is-- I don't know how many years it was into it, but I think part of the-- I think it was '93 timeframe where I started working more closely with him to try to push SGI technologies into these more broad applications, consumer applications, interactive TV, gaming systems. I think that was a period where, basically, Jim was kind of checked out of current things and more focused on kind of the future.

Weber: Because between the founding and then, I mean, you had been off doing your own thing. You weren't working very directly with Jim or--

Hannah: Right, right. I think he was very-- Jim was I think very involved in the whole GL effort, but not so much-- not in the hardware side.

Weber: So, it was in '92, '93 that--

Hannah: Yeah.

Weber: So, why do you think-- why did-- I mean because it sounds like both of you had doubts about the high end direction, but I mean why did you come together '92, '93 then to work more with him on these different--?

Hannah: Yeah, well, I'm just the resource, right? <laughs> So, if Jim, chairman of the company, founder, comes to me and says-- I think he might have given a telecomputer talk or something, and it's like oh, I have this idea for-- it's like, okay. And give me something to think about. I like thinking about oh, here's a new kind of problem, a new set constraints, like how would I design a system that is optimized for that set of constraints. And in general, my role by the end was always thinking out two, three years, four years even. It's like projecting the future. I would be involved in sketching out the early architecture, but at some point, it would be handed off to people who would do the more nitty gritty details. And then some of them, ultimately, by the time I was VP and chief scientist, I had a few people reporting to me, but they were principle or chief scientist types and independent. It wasn't a really a management thing, but they could carry through those concepts into execution. And so, I suppose I just-- I had some free time. I like thinking about new stuff, and Jim and I had this relationship. And so, I started thinking about architecture in the context of those spaces.

Weber: And so, the telecomputer idea, so he talked to you about that. Tell me about your involvement with that, with the telecomputer.

Hannah: Yeah, my recollection is just proposing the architecture, and again, it was a unified memory style of architecture. It's like you can put enough in a chip, and it's like just make one memory subsystem

that has wide bandwidth, and that's the most cost-effective way to do all this stuff. And then basically everything else in is this other chip. And you spit out pixels to the screen. And so, it was that kind of-- and I probably did some estimates of how much this whole thing would cost. And so, but he would set up these meetings with various companies, high level executives in various companies, and we'd give the pitch. And so, that was-- in general, I-- more than in general, I didn't spend much time thinking about the business aspects, except for sort of positioning within a market, meeting a customer need, but so the whole legalities of business interaction is like not where I spent my time. So, but yeah, so we would go out and give this presentation, and he'd talk about his ideas, and I'd get up and talk a little bit about the architecture of things we were proposing. And ultimately, very lucrative, these couple of very lucrative contracts for SGI came out of that.

Weber: But the final thing cost-- the cost ran over quite a bit, right?

Hannah: The cost of what?

Weber: Didn't they build a prototype that was much more expensive--

Hannah: Oh, for example, for Time Warner, for example? Yeah, I mean-- so, that was not-- I don't know that there were any cost objectives for that. That was more technology demonstration, and what was used for the technology demonstration was a $5,000 workstation, an Indy box, and maybe there was another card that was plugged into that to deal with the cable. So--

Weber: So, it never got to the point--

Hannah: And there was a bunch of software work that was done, but there was never any attempt to try and commercialize it. And so, I don't know that cost was an issue there. And then on the Nintendo project, I don't know that-- yeah, I don't know the specifics. Fairly early on, there was a team hired. And I was not directly involved. I just kind of, in the early days of discussion, spec'd out the general, very high level architecture, but other people drove it from there, Phil Gossett, Tim Van Hook, I think is other guy's name, but-- and I think it's possible that the price targets were a little bit off or something. I don't know. The one thing I do remember in that context is the decision from Rambus was a new high bandwidth memory technology, so how to get high bandwidth from a small number of pins. And so, I was involved with discussions with Rambus about understanding their technology and so forth. And so, that was the proposal to use Rambus technology. And there was the discussion around one channel or two, two memory chips or one. Yeah. I think it might have been a two megabyte-- it's not important, but yeah. And then by going to channels, of course there are more pins. There's a cost implication, and then if you have two memory chips, as opposed to the possibility of one, then there's potentially more cost associated with that. So, but I felt-- so, I was a big proponent of two channels. Ultimately, it was a one channel design, but I felt it's like you can double your performance if you have two channels <laughs>. And yes, you may save a few dollars, but anyway.

Weber: But the Nintendo project was before the telecomputer, right?

Hannah: It was outgrowth of that discussion.

Weber: Oh, so it was an offshoot, okay.

Hannah: I think it was Jim had the telecomputer ideas. So, and then I sketched out some architecture like this is how you would build a system to implement this. And then he set up the meetings. We would go out and give the pitch. And over, I don't know, maybe it was a course of a year or something, but what came out of that activity were these two contracts, one for Time Warner to do this experimentation with interactive TV, video on demand kinds of things, and the other was the Nintendo project.

Weber: And what was-- so, maybe I'm mixed up. So, what was that product going to be, the Nintendo?

Hannah: It was the Nintendo 64. It was the Nintendo 64.

Weber: Okay, so it did become the 64?

Hannah: Yeah.

Weber: Okay.

Hannah: So, it was the first like real 3D, as opposed to like 2D character, stuff in video games.

Weber: But I didn't realize that was out of the same origin as the telecomputer, then. Okay. So, the same thinking.

Hannah: Yeah, I mean in my mind it's an evolution. I don't even remember specifically all of what he was talking about in the context of the telecomputer, but that was all about this, in my mind, the push into consumer spaces. And as we were promoting that activity, these two contracts came out of that.

Weber: But there was no shared technology, per se, between them, or there was between Nintendo and the Time Warner?

Hannah: No.

Weber: Right, okay.

Hannah: No.

Weber: So, the commonality is lower end as opposed to the high end graphics.

Hannah: Yeah, and then sort of the genesis of the deal probably was the telecomputer that sort of ended up spawning-- there were some activities-- so, we talked to game people on one side, and we were talking to cable people on the other side. So, there were both discussions going on, and that's probably because they're linked through the telecomputer.

Weber: And of course, the telecomputer could be used for gaming, as well, presumably. There would be literal-- yeah. And I mean the telecomputer, did you-- the whole idea of sort of interactivity, multimedia interactivity online, did that excite you? Was it of particular interest?

Hannah: I don't remember. I think, for me, it was just pushing the technology down market, like drive the price down, deploy it as widely as possible. And yeah, there are some new things-- yeah, I am certainly excited by the ability to like video on demand, sort of watch stuff you want. At the same time sort of my mind was in that space, and the technology evolution, thinking about putting random access storage in the home so you can-- what ultimately became TiVo, right, and Replay was another company, but so I was thinking about that in terms of being able to-- I mean I was thinking about it from the standpoint of making it easier to access stuff, but the thing that came to mind immediately was being able to skip commercials, right? If you're going to watch some program, and it comes on a seven o'clock, don't start watching it at seven. Start watching it at 7:15, and then, as the commercials come back up, you can just skip over them because-- what did I call it? In my brief description, I called it view lag recording, where you just, you know, you record the thing, but you're viewing can lag it. And so, as the commercials come up, you just skip over them because you've built up this buffer. And so, I was thinking it's like okay, what's going to happen to like all this commercial-supported TV when people can just skip over the commercials, but I guess they survived, right? All this stuff has happened <laughs>.

Weber: Well, they took over the Internet.

Hannah: And they survived. Yeah, so I'm sorry. I've gotten off track from the question.

Weber: And yeah so--

Hannah: But yeah, it's, again, the whole telecomputer stuff and going down the interactive TV, what excited me about those things was-- yeah so, if there's a new sort of experience capability that you're delivering to the population, yeah, I get excited about that kind of thing.

Weber: And the-- because SGI was clearly not going to do a really low end PC, this was kind of an alternative, and end run around that, or--

Hannah: Yeah. I mean there were some efforts before that. There was a group down to try and do a board that would plug into a PC. It didn't really gain much traction, I don't think. I remember thinking at the time even-- like I don't even know if SGI was really set up to succeed in the computer gaming graphics card market because they have to turn designs so quickly. It seemed like every six months, they have to come out with something new, and not that they develop a chip in six months, but it was just operating-- we were always at the bleeding edge of technology and pushing things, and it really did take two years or probably half the time we were six months late or something <laughs>, but so there was the whole sort of ability to execute on that kind of consumer schedule.

Weber: So to become an Nvidia would not necessarily have been-- I mean that's--

Hannah: Yeah, I mean there a bunch of 3D companies. I don't remember the names of them, 3D Effects, or Nvidia is one that I think started in '93. Yeah so, but yes, that would have been the competition. I felt-- so, for me, it was always about a certain level of capability and driving it down to the extent you could, as opposed to like here's a price point, what's the best you can do at this really low price point. That's just my way of thinking. I don't know. Yeah, so there's a certain level of functionality that I wanted to provide and try to drive the price down as low as possible. I wasn't concerned about PC products that couldn't do what we did. It was more they could kind of do what we did for the application, and then they were fast enough to satisfy people, and they cost half as much. And so, I don't know. In thinking about-- I can say that oh, I could see these architectural directions on the high end were changing, and we weren't addressing it, or there was competition from below that we weren't addressing. Sort of understanding that what you're doing is wrong isn't the same as being able to execute on what is right <laughs>. So, I will say that, right? Just because I thought I knew-- there's the whole question about-- so, I didn't have the power. That was Jim's problem at SGI, right? You can see what needs to be done, you think, but you don't have the power to execute it. And that was, ultimately, my issue. It's like there's a phase of the company. When you first start, everybody's aligned with the vision. You hire people that are in line with the vision. Ultimately, the vision needs to change, and then if there's a split between the power and the vision, the power wins, right? And so, Jim got frustrated with that and left. And I, ultimately, got frustrated with that and left. And you think about it's like why couldn't-- it seems obvious, right? It's like why can't you convince he people who were managing the whole engineering structure that they need to change. And I don't have a definitive answer to that, except it's probably-- I mean it's hard to change, right? And so, it's easy for me to sit back and say, "Hey, this is what you should be doing," but, ultimately, there's a bunch of execution steps that need to be executed upon. And even if you sort of see maybe that, ultimately, something needs to change, maybe you don't think it's as urgent. That person doesn't think it's as urgent as I do because my head is always a few years out in the future. And then it's tough to change, tough to execute.

Weber: Well, and I don't remember if it was Jim's interview or others, but also the whole pricing structure was everything from commissions to the way the whole organization was set up was for high end sales.

Hannah: Yeah, I do feel like yeah, we got fat on fat margins. So, you had this divisional structure. I know that was another thing I was thinking was like we're just inefficient. Autonomy within the divisions, and there was enough money flowing that if there was a disagreement between the divisions about what should be done, then each did their own thing. It wasn't a big deal. And so, there wasn't the-- yes, the GL brought everything together, the Graphics Library. So, at some level, there was unification, but in terms of specific architectures, everybody was free to do their own thing. And I felt that wasn't the best for customers. It was duplicated efforts. And so, as you move down, your margins shrink. And I felt like, organizationally, we weren't really set up to-- I didn't get into the whole compensation structure of the sales force and all of that kind of stuff, but I do agree that, organizationally, the company was not efficient because we were used to these high margins.

Weber: And the-- talking about the roles of some of the--

Hannah: Some of the founders, or--?

Weber: Yeah, also I mean Forest Baskett, what was his role after? I mean he was on the board?

Hannah: He joined at some point, yeah.

Weber: Yeah, and what was he doing?

Hannah: I think he was CTO at some point, right?

Weber: Right.

Hannah: I think he was primarily focused on the CPU side of things, had I think a lot to do with sort of architecting the high end multiprocessor things. Because I was low end focused and graphics focused, I didn't interact much with him at the time.

Weber: And did you know-- oh, let's see. And Greg Chesson was--

Hannah: Networking.

Weber: Okay.

Hannah: I think of him as the networking guru. I think, I may be wrong, but I think he came out of Bell Labs, as well. And yeah, great guy, very funny <laughs>. That's what I remember about Greg. Again, I wasn't, again, day to day interacting with him because he was on the networking side of things, but--

Weber: Which, by the-- I realized I forgot to ask, so you were thinking of this sort of thin client, that the high end stuff was a bit better to be centralized to some extent--

Hannah: Actually, I--

Weber: So, how did that interact with-- well, maybe with this guy, but also with the idea of telecomputer and the-- you know, it seems like--

Hannah: Different part of my mind.

Weber: Alright.

Hannah: No, but I do-- yeah, so the whole idea, I felt people would have PCs on their desk, period. So, but it's like buy a PC in the 1 to $2,000 price range, or whatever it was. It's like you do as much as you can. You can put a PC graphics card in there. You can do a bunch of stuff there, but once you go beyond that threshold of what you can do for $2,000-- this was my thinking. Once you go beyond what you can do for $2,000, then don't build up your desktop, just then you just connected to this higher end system down the wire.

Weber: That can crunch the numbers and send pixels back to--

Hannah: Yeah, and send pixels down. And so, the stuff on your desktop will be more powerful. You'll be able to do a bunch of stuff at your desktop, but my thinking was just it's almost like there was a hard price cap. It's like people are not going to spend 5, 10, 20, $50,000 on something that's dedicated to one person. They'll spend $2,000 on something that's dedicated to one person, and any-- this was just thinking of it purely from an efficiency standpoint. Your desktop gets faster. I'm not saying-- and I don't think I was thinking so much about thin client where you can't run an operating-- you're not running an operating system or applications in the client so much, everything's remote. I was thinking about it more from the standpoint of buy a PC, do what you can there, but don't spend more than a couple thousand bucks on your desktop. And anything past that, put it in a server room.

Weber: So, a form of client-server thinking at least, graphical client-server, something.

Hannah: Yeah, and then it's just I think twisted pair was a hundred megabit was common at the time. And plus, that only used four of the eight wires. So, it's like oh, well, you've got four wires in there, let's use them too, double our bandwidth. Anyway, the idea is you're wiring for twisted pair. They can do a couple hundred megabits per second. That should be enough to send pixels down.

Weber: And I mean from the beginning, the SGI workstations were well-networked because they were sort of UNIX-adjacent. So, you could network them as you would on any UNIX network, right?

Hannah: Yeah. Networking, yeah, I certainly assume that any company that's using our stuff is fully networked. There's twisted pair running all over the place.

Weber: And I mean connectivity was considered important from the start for these?

Hannah: Yeah.

Weber: Yeah. And then Tom Jermoluk?

Hannah: Tom Jermoluk.

Weber: Jermoluk. So, he was another important person, right?

Hannah: Right. So, I think he was probably hired on as a-- might have been as a manager but quickly rose through the ranks. He might have been hired as director, I don't know, but ultimately came to run the show <laughs> very quickly, very quickly. And he was I think hired into the higher end division.

Weber: Okay. And Kurt remained on the high end--

Hannah: Mike Ramsey was the low end/mid-range.

Weber: Oh right. Okay. And Rocky Rhodes was in which division?

Hannah: I'm thinking high end. I think he was GL focused, and that would have been the high end.

Weber: And Kurt stayed in the high end.

Hannah: Yeah.

Weber: And Kurt was not as worried about getting into low end stuff then, presumably.

Hannah: No. We didn't spend time talking about it, no.

Weber: But I mean as far as you know, he was happy with the high end direction?

Hannah: As far as I know. Maybe that's my flaw. I should have talked to him more.

<laughter>

Weber: I mean how much did you-- you know, you guys, as founders, you then went off in your own niches. Did you get together-- did you see yourselves as a distinct group and get together regularly, or what was the--?

Hannah: Yeah, the company had Friday beer blasts, and we had various events, the annual Christmas party and all this stuff, and certainly everybody was friendly. I'm not an overly outgoing person, so maybe that's-- I'm just focused on whatever task, and, again, perhaps the flaw is I'm not maintaining these relat-- I'm not at all focused on what you might call political, but it's not just polit-- I mean it's not really political. It's just maintaining the relationships and engaging other people who are focused on other things. So, you have sort of allies if you're trying to get a change of direction or something. And it's best to keep those-- ping those relationships periodically <laughs>, as opposed to waiting until the time where you need something and then going and say, "Oh, oh, can you help me out here?" or "What do you think about this?" It was like, "Well, I'm busy." Not that anybody ever said that, but just in a general sense.

Weber: But there wasn't a very-- there wasn't a strong continuing group of foun-- I mean you guys went off and did your own-- into your own roles, pretty much, right?

Hannah: I don't think of it as our being isolated in our own spheres, but I don't know. Yeah, we were each focused on our own things.

Weber: And did you know John Kohler?

Hannah: Kohler?

Weber: K-O-H-L-E-R.

Hannah: Name sounds familiar, but--

Weber: Yeah. No, he was one of two--

Hannah: It was--

Weber: SGI and later Netscape guys, but--

Hannah: Oh, really?

Weber: He was a sales guy, originally, but--

Hannah: Okay, no, then I definitely don't if he was more on the sales or software side of things--

Weber: And Bob Bishop, was he here, or--?

Hannah: Yeah, so he was brought in to be in charge of sales early on.

Weber: Then he went to Geneva later on?

Hannah: Oh, that's right because he was to be in charge of international sales, right? We were primarily a domestic sales thing initially, and he was brought on to build up international sales. Yeah, so I don't know if he was always overseas, or probably he started here and may have moved overseas at some point in time, but his focus, certainly initially, as building up the international sales force.

Weber: Because I interviewed him in '95 for this magazine, a "Many-Media" magazine, where we also interviewed Jim who had just done the Netscape IPO, but I know that Bob was there, yeah, mid-'90s, and I think well-established. And then he became the final CEO, right?

Hannah: Mm-hmm.

Weber: So, when Jim recalled, you were the only person he told that he was leaving before he left, but shortly before he left. Does that bring back any memory, or--?

Hannah: Not specifically. There was probably some discussion about-- at the time, I felt well, I'll stick around here and see what I can do. I wasn't convinced of the failure of the company at that point in time.

Weber: That was '94, right, pretty early.

Hannah: Yeah, this oh, Internet stuff was happening, but I was focused on hardware stuff. The hardware side of things was what excited me. And so, yeah, I decided to stick around, and then when I think Netscape was started, there was people from SGI that left and joined that activity, and then I did meet with them, and he invited me to join, and, at the time-- maybe this is a case where I really should have done-- I said before there were numerous times in my career or life where like somebody would suggest something, and I was like not interested, and maybe I should have really been interested or, ultimately, in many cases, I, on a second pass, like I had the opportunity to go down that path. In this case, I didn't, but the reasoning, my reasoning, was just I'm a hardware guy.

Weber: There wasn’t a whole lot going--

Hannah: And it wasn’t expected to be a hardware play, and, yeah, I knew how to program, but that wasn't-- I still thought SGI would be a good place to develop these technologies.

Weber: And as the web grew, though, wasn’t there-- there was some thought of SGI providing servers, I thought, or maybe I'm misremembering.

Hannah: Servers for Netscape?

Weber: No, no, just getting into the server market with having the high end-- I mean like competing-- competing with Sun for servers, that kind of thing.

Hannah: I think we did compete with Sun for servers.

Weber: Yeah.

Hannah: Yeah, yeah, yeah. No, no, but so, there was low end/high end. The high end was high end graphics and high end servers, but, ultimately, there were a bunch of systems that were just computing servers.

Weber: Right, but how early did that go back? You were not involved with that?

Hannah: No, I mean that was fairly, certainly pre-Cray because the reason for acquiring Cray was because we were competing against them. That's why I was kind of ambivalent about the whole thing. It's like we're beating them in the marketplace. Why are we buying them? I just assumed it was like a geographical sales force kind of thing. We'll get into Cray accounts, but whatever, but yeah, we were definitely selling big server supercomputer things for a while.

Weber: But that went back even pre-web. I mean you'd been selling--

Hannah: Yeah, that was pre-web.

Weber: But I mean did those become a significant part of the business in the web explosion, or not really?

Hannah: Don’t know. I don’t know that that was the case. I don’t think that was the case because servers, you know, web serving and supercomputing serving are two different things, not that they're not related, but--

Weber: And then the-- oh, John Hennessy, I mean he-- I'm trying to remember how closely he stayed connected with MIPS in its later years, but was he-- how much--

Hannah: Yeah, so he was at MIPS.

Weber: He founded--

Hannah: And I think when we bought MIPS, he became part of SGI. It's a little bit fuzzy for me. I don't know that he was necessarily always-- I don't know that he necessarily completely cut himself off ever from Stanford, and, of course, ultimately, became president of Stanford, but he was definitely a founder and key player in MIPS, and then when we acquired them, I think he was involved in SGI.

Weber: So, then-- so, post-SG-- yeah, so you decide-- oh, by the way, though, in this-- so, you got married at some point back then, or-- just fill in your personal life?

Hannah: Yeah, no, I mean it's just-- I'm-- uh oh, I'm in trouble. I'm not wearing my wedding ring <laughs>. I still take if off at night.

Weber: <laughs> Mine doesn't fit anymore.

Hannah: <laughs> Let's see. Yeah, I didn't actually-- so, my now wife, Nerissa, and I, we didn't get married until a few years ago, but we've been together for, I don't know, 15 years, or maybe it was more like 17 years. I don't know. I'm sorry. Why did that come up? <laughs>

Weber: Oh, no. Just to fill in, but back in the days of SGI, so you were married. Where were you living?

Hannah: No, no, no, no, no. I was single.

Weber: And were you living in Mountain View, nearby?

Hannah: Yeah, in the very early days, I rented a place. When I was at Stanford, had a roommate, David Gelphman, and then moved off campus, shared a house, rented a house. First, there were three of us, Aaron Zick, myself, David Gelphman, and then like Aaron went off, and there was a house David and I rented in Menlo Park and then at some point moved out of there, and bought a-- what did I do? I know, bought a place-- yeah, I built in Los Altos in terms of where I live, live in Los Altos. I think I bought a place in Los Altos that I was going to tear down, bought a condo with another SGI friend, employee and friend, Vince, and so we shared a condo together, and then, ultimately, when the house was finished, moved in there and sold the condo and have been living there in Los Altos ever since, moved in, that was '93 that I moved into that house.

Weber: Still in the SGI period. And were you-- I mean would you and the other founders sort of hang out with Jim, or was-- in the SGI years, or really more of a business--?

Hannah: Yeah, off and on.

Weber: Go on yachts or--?

Hannah: Occasionally. I did a sailing trip with him up to Victoria, I guess, British Columbia. And it was not exactly what I envisioned. I'd gone before in the bay, just go out for the day, sail around the bay, and I

was into sailing, not hugely into it, but I was thinking, at some point, I would get a boat. I mean, at some point, I was thinking, in projecting my future, I'll get a plane and a boat and vacation home somewhere. But yeah, I enjoyed the activity of a sailboat and running around the bay. And so, he invited me to go up to-- I think I did two trips with him at some point. One, I think I flew down to Puerta Vallarta or some place and sailed around there, but this trip up to Victoria, British Columbia, yeah actually I think I flew up there, right, and then sailed back, expected it to be the same kind of experience of sailing around the bay, but it was not because <laughs> it's like the weather off the coast is not the same as the weather in the bay. So, a lot of it was it was cold and wet, and you have to man the deck. Somebody has to be at the helm like 24 hours a day, right? And so, I was-- you know, I had my four hour watch in the middle of the night, where you're in bed, you've gotten a few hours of sleep, it's like okay, your watch. And so, you get up and sit there and like make sure you don't run into things. So, interesting experience. Victoria was really nice, but like the trip down the coast, it was an experience. Yeah, but not exactly the relaxing experience I expected, but yeah, I mean different people hung out more or less with him. But yeah.

Weber: And thinking about diversity and SGI and, to some extent, Stanford, I mean have you-- I mean in Illinois Institute of Technology, so there are certainly other African American engineers you knew through that, but I mean have you generally been alone within groups? Were you the only minority? Or I mean what's the--?

Hannah: Not the only, no. If I-- you know, Kenwood High School, where I went to, there were probably very few minorities. I don't-- my freshman year at U-High, probably very few minorities. I don't really recall. But not, I wasn't the only one. Kenwood High School, a very diverse student body. IIT, there was a small percentage minority, but the fraternity that I was in had two. When I joined, I think there were two other Blacks in the fraternity, and subsequently, there were a few more that were there. And so, yeah, so I don't know what percentage it was, but a small number, but definitely never had the feeling that I was isolated. Stanford, maybe-- the general comment is I never-- I certainly had the benefit of these programs, the Bell Labs programs that were focused on bringing more minorities into these professions, and without those programs, I would not have advanced as far as I did, for sure. And so, without getting into all the historical reasons why minorities are disadvantaged, but they are for all these historical reasons. And so, I'm a big proponent of these programs, certainly a beneficiary of these programs. And, yeah, I don't know. There's probably more I could do in terms of, like I said, in general, I'm an introvert, right. And so, I'm not out there trying to work with people to get like present options, role models. I should have done more of that. There's still an opportunity to do more, I suppose, but it goes counter to my whole keep a low profile aspect of my personality. But I never felt, within the context of a work environment or a school environment, I never really-- apart from that little thing in like elementary school is where I felt like what's wrong with the quality of education I'm getting, I never felt disadvantaged by being minority, was never overly focused on being one of the only people in the room, if that was the case, that was a minority. And so, my background is relatively middle class. The neighborhood wasn't overly dangerous. And certainly, since coming out to Stanford, I live in nice neighborhoods and nice places. So--

Weber: And at SGI was there like a corporate diversity program or any--?

Hannah: Yeah, I believe so. So, Ken Coleman was a VP there, Leilani Gayles is another name that I remember, but yeah, I mean very much-- oh, and an early engineer, Howard Smith, a Black VP of

engineering. So, there were Blacks in high places, and there was definitely an emphasis on trying to recruit minorities at the time.

Weber: And women? How about women?

Hannah: We had women.

Weber: <laughs> Both of them.

Hannah: At the company, not that we had women. <laughs> Let's see. Unfortunately, yeah, I can't speak too much to what programs there might have been to bring more women into-- I mean, you know, I don't-- sort of by nature I think the whole electrical engineering/computer science has been more male than female, but there were a lot of like female engineers is my recollection. And so, I don't remember feeling like this is a male-dominant culture or environment.

Weber: Because some people feel the number of women programmers has dropped, actually over time.

Hannah: Recently?

Weber: No, well, that it reached its peak in the '80s, early-'80s or something.

Hannah: Yeah, it's possible. I don't know the statistics.

Weber: But nothing you've noticed-- you haven't noticed it--?

Hannah: It's certainly possible, but if-- just in my own mind, I'm just trying to visualize walking around and the people in the cubicles or-- actually, the engineers had walled offices. The people-- or in a meeting. Upper management was male dominated. So, now that I look back on it, it's like okay, well there's a case where the mix wasn't right. And I'm trying to think now like female directors, VPs, EVPs. Nobody comes to mind.

Weber: Some Non-White, but no--

Hannah: Yeah.

Weber: Right.

Hannah: So, we were probably guilty of some of that in terms of rising-- women being brought in or rising through the ranks. Yeah, I'm sure there were a fair number of female managers, but, like I said, at the highest levels, I don't remember a lot of female representation.

Weber: And there was-- because it's the period when, I mean DEC and other, some other, IBM did some pretty active diversity programs, but SGI had probably comparable, typical for the period--

Hannah: Again, I think that was a big thing for Ken Coleman and Leilani Gayles was in HR. I think they were definitely-- that was a piece of what they wanted to do.

Weber: But probably by then you were already-- I mean there were a number of South Asians coming in as engineers, East Asians. So, I mean the '80s is sort of when that shifted in some ways, right?

Hannah: Yeah, I don't even know if I think of it as a shift because sort of in the early-'80s when I jumped into it, there were a lot of Asian representation, whether from Japan or China or India. My manager was from India, Raj Parekh.

Weber: But not Latinx, probably very few in this area.

Hannah: Not so much, don't think of that so much.

Weber: And I'm partly asking because we're also looking for people to interview or collect recollections from, but you've mentioned some. And then so to jump back to-- so, what was the first thing you did after SGI? Take a vacation?

Hannah: I don't know. I wasn't-- so, there were some-- actually, my girlfriend at the time wanted to go off and do something. And this was the Internet boom kind of timeframe, right? So, there were a few of us that got together and put together a business plan associated with a minority focused web portal.

Weber: Omniverse Digital--

Hannah: Omniverse Digital Solutions, yeah. And that wasn't-- I don't know. Part of my involvement was just because it was my girlfriend at the time <laughs>. Maybe that's a problem of mine. It's just okay, it's like I'm-- rather than try and think through a plan and say this is what I need to do, it's like I'm just kind of chilling. And if somebody comes to me with a decent idea, it's like okay, that's interesting to think about. I do feel like drop me into any space, right, and give me a few months, and I'll come up with something interesting to do. So, maybe that's a problem. It's feeling it's like I see there's an opportunity there. I'll ride this train and figure out exactly <laughs> what I want to do within that space as we go along. And so, also when I left SGI, I went onto a consulting contract with them because in trying to sort of formulate a next generation Nintendo architecture-- Nintendo was trying to decide who was going to do their next one. And so, I was hired as a consultant to work on that. Ultimately, the team that had done it at SGI went off and formed another company, and Nintendo went with them. Part of the gripe I had with them at that time was like they sort of architecture is all about tradeoffs, and I could not get any guidance from them about it's like what are the tradeoffs. And their response was, "Okay, give us a proposal." So, I made my tradeoffs. They made their tradeoffs, but anyway. That was the team that had done the previous generation. So, on some level, it made sense to do that team. So, that was one bit of working with SGI. The other thing was, basically, I think mentioned, at the low end, there was this whole thing about a workstation with a unified memory architecture vs. and I wanted to something that was not unified, lost that battle. So, they were coming out with a low end system that had a unified memory architecture. And I said, well, if you're going to a unified memory architecture, then at least take advantage of the fact you can have a giant frame buffer and drive two monitors. So, it was like you need more screen real estate. And so, they went down

that path but didn't put in the ability to do two monitors. And so, I said it's like okay, well you can do it. You have access to them, the digital video output stream for a different purpose, so I can do a plug in board that lets you take that video stream, and, in memory, it would be one big widescreen, but it would output as two screens split, just a dual head display option. And so, I did a contract with them where I developed that board sort of outside, independent of SGI resources, and but working in the building, and then they would include it in a product line and pay me royalty. So, I did that for this low end product dual head display, and then for a mid-range product, I did that. So, always been a proponent of more screens. You're paying a bunch of money for that computer; you need more screens.

Weber: And then the Omniverse--

Hannah: So, kind of Omniverse is going on kind of at the same time, the whole Nintendo thing, trying to win this contract, but so still involved in SGI, more as a consultant or developing this technology. Omniverse is going on, tried to raise venture funding. I funded it for a little bit, but, ultimately, we didn't get venture funding, and I stopped putting in money. And that sort of died before it ever developed into anything significant.

Weber: So, was it an act-- I mean there was a site up.

Hannah: No, there was never a site up.

Weber: Ah, okay.

Hannah: No, no. It was all in the business plan, trying to raise money. I mean we did hire a couple people, Tim and Daphne Reid. They were building a-- trying to create a movie studio in Petersburg, outside of Petersburg, Virginia. And so, I know we kind of set up an office there and were doing some work with them and doing some special effects or whatever, but, ultimately, just never got to the point where it was funded enough to execute anything.

Weber: But the idea was, what, do be a general portal for African American content in multiple forms, so written or video or whatever?

Hannah: Yeah, I suppose. I don't remember <laughs> exactly what the business plan was right now. I was-- I was-- I thought there was definitely some interesting things you could do in that space, but I hadn't really formulated opinions because I was actually pretty busy at the time dealing with this SGI related stuff.

Weber: Yeah, no, I don't-- you probably read the book *Black Software* or seen it.

Hannah: No, I haven't.

Weber: Okay because, yeah, it gives some of the history of content, African American content, Ne Noir, and there's things on the web on AOL, on CompuServe, but I'm just wondering where you guys saw potentially fitting into that.

Hannah: It's probably not the best bit for me anyway because, like I said, I'm not into social networking. So, I feel like I don't have any intuition about what would be successful. There are some things that I could say oh yeah, I can see how that-- people would want that, or this is what I want, but I don't have a great deal of reliab-- or a sense of that-- confidence in what my opinions might be in that space. Whereas, in a different set of spaces, I have a lot of competence that if I think about it, I can come to a conclusion that I have a lot of confidence in. So, Omniverse, basically, I stopped funding, wasn't able to get venture backing, then sort of went back into semi-retirement mode, got called by someone. I'm not sure how they found out about me, but anyway. Pulsent, I think, might have been the next thing. And that was a company that was-- it was hired by-- I mean started by math/physics types developing an algorithm for doing much higher compression ratios for video, video on demand. The future is in video on demand. You need, at that point, they were trying to do high quality video at one megabit per second because it didn't have all the high speeds of today's Internet, and I think there was megabit DSL might have been the target. And they believed that, yeah, so they said the algorithm is pretty close to being finished. And we need somebody to develop the chip architecture to implement this. So, I joined to drive some of the chip architecture to implement that.

Weber: And they were a startup then?

Hannah: Yeah, so that was a startup. But basically, the algorithm was good on a lot of stuff, but there was-- some of the corner cases, it had really nasty artifacts. So, basically, it was trying to-- if you think of like this context where I'm talking, it's easy at an intuitive level to say well, I'm not moving that much, you shouldn't have to send that much new data, right? But as I turn my head just ever so slightly, the shadows on my face change, right? And if you're trying to say, essentially, take where his head was before and move it a little, there are subtle changes that, if you don't pick it up, your eye picks up on it right away. So, if the shadow stays where it is and the rest of my face moves, it's really ugly. And so, your eye is drawn to that kind of stuff. And so, other cases where there's a lot of stuff going on, a waterfall or something like that, it would get super blocky and so forth, but maybe you can deal with that. But I think the bigger issue was just it was trying to-- all this compression stuff, right? It tries to reuse as much from previous frames as you can and then just talk about the differences. And to the extent that-- this was more-- most compression I think is you have these small blocks, and that's-- your unit of compression is dealing with these small blocks. Whereas this was more let's take an arbitrary shape and deal with that.

Weber: Big block.

Hannah: Yeah. And the problem when you do that is, like I said, if you move this big thing that maybe is your face, the shadows change a little bit, and that doesn't get captured properly, and it just-- so, there were these corner cases where they had really ugly artifacts. And so, it was constantly trying to adjust the algorithm to get rid of these artifacts. And the bottom line is there was a team hired to develop the chip, but the algorithm wasn't frozen. And after-- basically by the end of a year, I felt-- and there was a decision made that we can't keep trying to make these incremental changes, let's rethink the problem, not that you'll radically change things, but let's step back a second and see how do we--

Weber: And you can't do hardware design during that.

Hannah: Yeah. And it's like it's going to take you a cou-- finding standards is a hard thing anyway, right? And so, you have to be a lot better. And then so if we're doing this reset, it's going to be another year before the algorithm is frozen, and it's going to take you another two years to develop the chip. It's like you're going to miss your window. It's like standards are improving. Maybe you'll be twice as good, but that's not going to be enough. And so--

Weber: This is when Flash was rising, too, as a-- I mean at least it made it easier to deal with video online, right?

Hannah: Yeah.

Weber: Was that seen as--

Hannah: And I don’t know what the Flash compression vs. this...

Weber: No, but I'm just saying that there started to be other ways to solve--

Hannah: I think the objective of the importance of video and being able to do video on demand, that was correct. It was just-- and so, that's why I joined. People tell me about an idea. I see the opportunity in the space, and it's like okay, yeah, I can see there was huge opportunity. And that's an area that I'm excited about like I want to drive some of that technology, but I got in there and it's like-- it's just going to take too long. You're going to miss your window. Even if you ultimately have something that's good, you're going to miss your window where people are going to adopt it. And part of that time I was focused on streaming servers, the server architecture, because I felt video was such a well-behaved data stream that can make video serving more efficient, but anyway. But I left there after about a year. At the end, sort of back to hanging out, semi-retirement mode. And then a friend of mine came to me with the idea, he had been working with-- had a license to do a product that would plug into a Nintendo Game Boy. And so, the idea there was to do a cartridge that could play videos on a Game Boy.

Weber: To put music into the--

Hannah: Music videos, yeah, I mean that was the initial-- I mean, ultimately, you could play movies or whatever, but I felt like the killer app was being able to do music videos on your Game Boy.

Weber: Right. Okay.

Hannah: And that was before, of course, iPhones and all that kind of stuff.

Weber: Because from what's in--

Hannah: That was 2001 maybe.

Weber: So, this was-- got it. I didn’t realize there was a video aspect. I just read--

Hannah: Yeah, I mean-- yeah, the first thing was just music and stills because the technology, but that was what I was working on was I think looking at PortalPlayer chip, which could have done a small form factor, done the video playing. And that was considered the killer product was to be able to play videos on your Game Boy.

Weber: Yeah, and I mean for music, at the time, MTV was king, and there was--

Hannah: Yeah.

Weber: Yeah. So, did that get a prototype or--?

Hannah: So, the video version did not. There was some sort of hacked together version that could demonstrate the video, but it wasn't a standard video algorithm, video compression algorithm. So, you could kind of display it, and that's what people got excited about, but it really wasn't the final technology because the hardware wasn't sufficient to do the video compression standards. And so, that's what I was looking at is designing that system to make a, whatever, $50 cartridge or something that could play video on a Nintendo Game Boy.

Weber: And that was SongPro, Inc.

Hannah: SongPro, yeah. And so that was, you know, that was probably about a year also. Raised some money and hired a CEO that was out of Disney, and there I think it was just that, you know, on paper had a good resume but hadn't done a startup before, and so we ended up blowing through like the original funding, were unable to raise more money, and basically that died before what we felt was the real product could ever make it out the door. Unfortunately.

Weber: And then that's when Strategic Urban Development Alliance, that's the--

Hannah: So that-- yeah. So that-- a very good friend of mine, Alan Dones, who I met back in maybe '89 time frame, and invested in another business of his. So there's always been sort of this friendship and affiliation with SUDA, and so invested in some of his stuff sometimes, but more recently there were these major projects that he was involved in, and one was 2100 Telegraph, which started off as a, you know, sort of a L-shaped, city-owned property, and he got the rights to develop that, and then ultimately evolved. Another developer ended up buying all the other lots on the same box and so it became this one giant square block development that was, you know, again, evolved into this 1.6 million-square-foot building that was under contract for Kaiser to buy to move in there and become their headquarters, but unfortunately the CEO died unexpectedly. I think he was one of the big proponents of that deal and then the whole COVID thing hit and they backed out, and so that project is still there. It's being reformulated into a two-phase project and now I think it's 2.1 million square feet total, but anyway, it's there. So I'm involved as an investor in that, sort of the technology adviser. Whenever I'm dropped into a space I tend to think about how technology can be applied and so, you know, I've spent a fair amount of time thinking about the whole parking thing and it's-- there are also evolutions that involve sort of transportationwise how you fit into that downtown city environment and are there links to autonomous vehicles, and that's more an issue in the other project that SUDA's involved in, which is the West Oakland BART Station.

There's a, again, a one-square block that sits around the West Oakland BART Station that sort of the-- SUDA's the primary driver for that, and that's sort of a mixture of a commercial building and an apartment tower and 240 units of affordable housing, and again, thinking about parking is expensive to build and so-- and if you walk into any parking garage you'll see there's a lot of empty space there, right, so I look at that and say, like, "How would you pack the cars together optimally and get them in and out?" but there's two combinations. One is the sort of how densely can you pack them in and the other is the whole user experience of, you know, if I come and drop off my car, how easy is that, and when I go to pick up my car, how quick <laughs> and easy is that? So... And there are problems I have with, you know, I want something that has the density of a tightly packed queue, mesh of things, but also the experience of handicapped parking, <laughs> sort of. I don't even like valet parking because the pickup experience is not right. You have to wait for your car, right. So the first handicap spot. That's what I want. I want to drop off my car right at the door, and then when I walk out I want it to be there, so... So yeah, I've spent a lot of time thinking about the, like, structurally and mechanically and what the whole user experience is of a high-density automated parking system.

Weber: But SUDA's goal-- oh, sorry.

Hannah: Yeah. Yeah, yeah. No. SUDA is a developer. It's a straight developer. You know, we have these--

Weber: But straight commercial developer.

Hannah: Mixed use.

Weber: Because I-- all right.

Hannah: Commercial and, you know, there's certainly a bigger aspect to the commercial side of things, commercial space, but there's also, like I said, West Oakland BART.

Weber: Oh, no, but-- I'm sorry. But it's a-- this is development, I mean, for profit.

Hannah: Yeah.

Weber: Sort of normal developer, not a--

Hannah: Right.

Weber: Because what I'd-- okay. No I--

Hannah: There is-- yeah. I mean, no. There is, you know--

Weber: But was there a community--

Hannah: But Alan Dones--

Weber: --community benefit--

Hannah: Yeah. So Alan Dones is black and a big emphasis is the whole issue of development that benefits the community.

Weber: Right. That's what I--

Hannah: And so there's, I think, a history of, you know, especially in a majority/minority area, you know, developers will come in. They'll-- there's a lot of displacement that can go on, right, whether you're building a whole lot of replacement homes or tearing down a bunch of stuff and building commercial buildings. You know, one, there's displacement of the people who have lived there, and two, there's a lot of economic development that really is not done to the benefit of the community and/or minority contractors, minority developers, right. So all the big deals go to the ol' boy network of developers and so forth, and so it's very large emphasis on doing development in a way that provides benefit to the community, equity, participation, at all levels, and so involving the community very early on and helping to define what the development is. Involving minority contractors in the construction. Trying to allow for minority businesses to be, like, occupying some of the spaces and all of that, and so, you know, he's formulated this sort of framework for trying to define that, of LEEP. I'm spacing out. Leadership in-- I should know the what it stands for, but it's analogous to LEED, so LEED is a way of talking about building efficiency [Leadership in Engineering Equitable Participation].

Weber: Energy. Right.

Hannah: And it's you have these measurable benchmarks that say, "Okay. This is a LEED – Silver or LEED Gold or Platinum or whatever. But there are specific things and measurable outcomes that you can-- so trying to define that in this development of equitable outcomes in a way that is measurable, repeatable. You can say, you know, "I'm a LEAP Gold development," right. That means, you know, I'm doing these things to address what do I leave for the community? What's the minority participation, and so on and so forth, and so that's definitely a big part of Alan's focus and SUDA's focus in terms of how to do development in a way that benefits the community.

Weber: Okay. That's a-- and you were involved 10 years ago, right?

Hannah: Yeah. So--

Weber: Yeah.

Hannah: --my involvement with Alan's been, yeah, goes back a number of years.

Weber: And so did he develop the scale, I mean, like the LEED?

Hannah: Yeah. So it is there. He's, you know, he's still promoting it. It's sort of those principles are being used in the development of, you know, they're these two major projects, as I said, 2100 Telegraph

and the West Oakland BART Station, which is called Mandela Station, so that, or will be called Mandela Station, but--

Weber: Oh, to replace the existing one.

Hannah: Well, the station itself doesn't really change. There's be some updates, but right now there's a parking lot surrounding it, and that will be replaced by-- there will be some parking, but a commercial tower that's maybe 500,000 square feet, maybe a 500-unit apartment tower and 240 units of sort of low midrange-- low midrise affordable housing.

Weber: Great. So then was-- did you want to-- I think that we're almost up to the present, right.

Hannah: Yeah.

Weber: Did you-- is there anything you want to say about NVIDIA quickly or--

Hannah: Yeah. So I, you know, for a number of years I, you know, I had my involvement with SUDA thinking about various things but not really trying to execute and commercialize them, and so recently, within, you know, few years ago, you know, basically decided that I've wanted to, you know, I'm getting older in years and <laughs> it's like, "Do I want to try to, like, get back into industry and have some major impact with somebody who already has some resources?" and that was kind of the big thing. It's, you know, there's a lot to starting a company. I thought about doing something on my own but my focus was always on the technology and there's a ton of stuff to starting a company that I just didn't want to deal with, and that's probably by, you know, I haven't really executed on anything before in terms of executing my own ideas. So it's like let me find a company that's doing interesting stuff that already has the resources and have an impact there, and so I ended up joining NVIDIA and there was-- within the marketing department, actually. Originally I was looking for technical stuff, but I've been away from the technology for long time, so actually when I think about it, perhaps that was the right entry point, <laughs> although I-- yeah. I still think you-- the technology is dealing with all the same issues, right. It's all about, you know, hardware utilization and bandwidth and latencies and throughput and yada, yada, yah. But so I think I could've come up to speed on the technology, but I guess I'm more interested in the big picture <laughs> and, you know, strategies and architectures that can deliver something to the end user experience, but-- and so-- but I joined NVIDIA. So that was a reintroducting to graphics in a way that, yeah, you know, you see fancy special effects or you see video games that look impressive, but that was when I first took another look and I had always-- I thought of NVIDIA as a graphics company, right, but then when I got a call from someone I knew, you know, from SGI who is now a VP at NVIDIA, I took a closer look at NVIDIA and I was just blown away by the amount-- yeah, all the stuff that they're doing in terms of the technology, the AI, the whole software stack that they've developed, and so I joined there looking at, you know, I basically was to try and sort of find a home for my next few years, <laughs> right, so-- and I-- so for a while I looked at their embedded products and was suggesting certain things that they could do or product positioning within that embedded space. You know, they liked they ideas but said, you know, "Now's not the right time," and then I turned focus to this new software package, Omniverse, which is, again, a like very impressive software platform for doing simulation and rendering and collaboration, and more specifically, how do you take that into the education market and what are the implication-- work with universities. What are the implications on education in the future and so forth?

The whole teaching in the metaverse and so forth. You know, rapid prototyping as digital twins and so spent some time thinking about that, and again, sort of came up with a set of suggestions about these are the components that-- the great thing about NVIDIA's they're developing so much stuff that any time almost I would think, "Oh, you know, there's this one other piece of hardware," or if you-- that, like, "You should turn this into a product," and, you know, I look around, it's, "Oh. You've already actually got it. It's just not productized yet," or you've got the piece here and the piece here you haven't put together and there's so many cases where <laughs> it's like you're-- like all the technology pieces are there. It's just if you're going after this education market, you know, pull them together and sort of go after it in this way, so... But I spent about a year there. Again, that was a case where I think they liked the ideas but I think so much about-- it's easy for me to think about the way things should be two or three years from now, but there's, like, a big part of running that company is execution, right, and especially I think in the marketing department. They're an amazing execution machine, but they're-- what? I don't know. It's just, again, I-- the feeling that I couldn't get traction on these other things which I felt were important to, like, making the big impact two or three years from now, so-- and so I ended up joining another startup company that was formed by a person that I met through NVIDIA, at NVIDIA, and that's Voltron Data, and so Voltron Data is in the data science, data analytics space, dealing with huge amounts of data, and the way it's done right now is a lot of CPU-based things. They're starting to take advantage of, you know, GPUs, these-- that are used for graphics and became used for artificial intelligence. So there's tremendous amounts of computing power in these GPUs. But it's not so much being taken advantage of in the data science space. There are some things that use it, but so the idea for Voltron Data is really to design a software platform that can talk to all these different languages and frameworks that people deal with at the high level when they're dealing with databases, and at the lowest level can take advantage of all these accelerated hardware architectures, and so to put something in the middle that makes it much easier to-- for people to develop their data analytics applications no matter what language they want to deal with and no matter what hardware they end up talking to. And so I'm Director of Silicon Strategy there and so I'm looking-- it's only been a few months there now-- looking at what are the architectures of the future for hardware that's focused on data analytics and data science and sort of how we interface to that hardware, so-- and then the sort of strategies associated with that, so now I'm excited to be, like, in this new space. Again, it's along the lines of, you know, drop me into an interesting space and, you know, it's fun to think about, like, all the ways that you can improve the cost and efficiency and performance of those systems.

Weber: I mean, some people have talked about like GPUs being used in AI and different things almost making traditional computers less relevant, that it's almost--

Hannah: Not so much-- yeah. So I understand what you're saying.

Weber: I mean, moving away from general--

Hannah: Yeah, exactly. Like--

Weber: General purpose computers towards specialized--

Hannah: If you look at-- yeah. Yeah.

Weber: --hardware for everything. So you lo-- you know.

Hannah: Yeah.

Weber: Do you see that as a trend and is there--

Hannah: Yeah.

Weber: --any down side to the, you know, losing gen--

Hannah: No.

Weber: You've sacrificed generality for performance, but also--

Hannah: Which you're not sacrificing it.

Weber: --more of a-- okay.

Hannah: So it's not like the CPU's going away.

Weber: Right. But--

Hannah: It's--

Weber: --more and more of might be done in special.

Hannah: But more and more of the computation is done in special purpose hardware because it's so much more efficient and so much more performant to do it there. So for example, in the data science space, you know, you've got these storage subsystems that store, you know, petabytes of information and do you really want to move all that data over into some CPU subsystem? And then within the CPU subsystem, yeah, you can get 16 cores or 32 cores or 80 cores, you know, but it's still the stuff you're doing there are bunch of transistors on that chip that aren't being utilized and you could put a lot more stu-- if you design the hardware specifically to do the task at hand or set of tasks then it can be much, much more performant, much more efficient, and so especially in these fields where there's a ton of activity, a ton of-- there's a huge market for AI, of course, right, so yes. You may have started on a CPU but if you're selling, you know, a hundred billion dollars' worth of stuff, then maybe you should design an architecture specifically for that task.

Weber: So you think there, I mean, there'll be, in the future, more and more architectures for specific domains.

Hannah: Yes, so-- yes is the short answer, and some of it is that there's this new opportunity and so their people throw-- the VCs throw a bunch of money at it and so there're 20 different companies developing 20 different architectures to address this opportunity, and, you know, it'll all be shaken out at some point

5, 10 years down the road, so there's not going to be 20 different ways, perhaps. But yes, AI will be done on special purpose architectures.

Weber: Graphics will remain on special.

Hannah: Graphics will be done on special purpose architectures. What Voltron Data's saying is data analytics will be done on special purpose architectures, and so--

Weber: And what else? What's the next one that'll most to special purpose?

Hannah: I don't know. I haven't thought about it, actually. Good question. <laughs> But-- and, of course, like NVIDIA dominates in this, you know, the GPU space, the graphics space, and they evolve that to graphics and AI, right, because, okay, you've got all these, you know, megaFLOPS, teraFLOPS, you know, petaFLOPS, so power, we can apply that to the AI task, and then their architectures evolve to something, "Oh, let's take a bigger piece of the chip to make sure it's performant on this AI-specific stuff," at the same time we're doing all this stuff that makes the 3D graphics rendering really like realistic, and there's a physical simulation, you know, simulating the physics of things, because ultimately that's, like, how you make things realistic so that you get-- it comes down to like simulating reality. Simulate the physics of the stuff, right. You don't artificially generate the look. The look is a function of the physics behind it, and so they're expanding their architectures so that it encompasses those big, big and upcoming sort of domains, yeah, computational spaces, and... But it's-- yeah. I mean, it's not-- it is trying to do a lot of stuff and so in certain applications it's maybe not the most effective architecture but, you know, they're amazing. The other thing they've done is using AI within the rendering task, right, and so if you're doing a 4K image, you know, don't render it at 4K, render it at, you know, 1K and the use the AI to fill in all the extra pixels, which, yeah, is just amazing technology, but it's actually you have-- you do have these parts of the chip that are dedicated to more AI inference and so-- but you can actually apply that to the rendering task and so it's not sitting there wasted. It's like, "Okay, yeah. Build up the AI because we need it to do the rendering." So anyway, yeah. So, I mean, my whole career, it's always been like special purpose architectures to accelerate things, so now I'm trying to apply that in the data science space. I feel like the data science-- data science space is highly fragmented. There're all these different, like, data formats, file formats, frameworks for applications and it's a mess. One of first things I tried to do was come in and understand like the existing state of things and it's just-- it's so complicated I finally just, like, <laughs> we're trying to fix all that, so don't spend so much trying-- time <laughs> trying to understand the existing way of things. Understand what you'd like it to be and then focus more on that and understanding the way things are will come over time, so... But I am excited about the potential to significantly decrease the cost of these big data analytics things because I think it's, yeah, there's lots of room for improvement. I'll just say that.

Weber: And then let's see. One-- there was one question further back that I wanted to ask about. How many-- hold on?

Hannah: How many engineers does it take to screw in a lightbulb?

Weber: <laughs> How many?

<laughter>

Weber: How many transistors were on the first working Geometry Engine and who made the wafers?

Hannah: Forty thousand. Pretty confident of that number. Transistors on the chip. Who made the wafers? AMI is the company that comes to mind. There may have been another one in there somewhere, <laughs> but...

Weber: AMI was one.

Hannah: AMI is the company that comes to mind.

Weber: Yeah, what are your-- what suggestions would you offer to young people interested in this sort of career?

Hannah: Yeah. Yeah, I think it's-- for me, you know, you need to be passionate, excited about something, right, so it becomes fun to work on the problem. Because ultimately if you're going to be very successful you're going to be spending a lot of time <laughs> at it, right, so you want to be having some fun. In terms of a startup, you know, don't go into startups to make a ton of money. Yeah, that's nice, but, you know, you have to be excited about the process, because lot of startups fail, so, you know, if you come out at the end of a failed startup you want to feel like you had a great experience and learned a bunch of stuff. The other thing is just be open. So I think, you know, students, kids, whatever, adults, they make their choices from things that they're exposed to, right, so try to expose yourself to more things so you'll have a better set of options to choose from, and then if somebody comes to you and says, "Hey, did you think about this?" or, "Would you be interested in this?" or even more, suggests, "Hey, you know, you should really take a look at this," don't-- listen, I guess. Keep an open mind, right, and so not that you're going to take their advice necessarily, but maybe it's a suggestion that you really should just, like, go down another level and dig a little deeper, and so, you know, that's one thing is just sort of be aware of when people are making suggestions to you and don't necessarily dismiss them out of hand. Another is just the whole, like, education is important and I, for me, graduate education is important. I think once you jump out into the profession it's easy to become more narrow and focused on the tasks to-- that you need to do for your job and in school I feel you can go very broad, you can maintain a certain breadth of knowledge that will be helpful in one way or another, and so try to stay in that educational environment as long as you <laughs> can tolerate and afford, right. So the more-- yeah, the higher levels of education you go to the more you learn, the better you become at doing a broader range of things, and hopefully the faster your career will progress once you get out, because you can draw on all that knowledge. And, of course, it's also a continuous learning experience once you get out there. You try not to get yourself too narrow, let yourself get too narrow, and then so coming back to the one word. I don't know that there--

Weber: Oh. Well--

Hannah: Oh.

Weber: And any advice specifically for BIPOC students?

Hannah: I'm sor-- what students?

Weber: BIPOC, black, indigenous--

Hannah: Oh, okay. I'm sorry. I hadn't heard that term before.

Weber: Oh.

Hannah: So not-- you know, maybe in that case it's just more don't let yourself be defined by what other people sort of read onto you. Don't, you know, don't go for the-- these ex-- don't settle for low expectations. You know, if that's the vibe you're getting from other people, you know, you can become whatever you're willing to put into-- in the work to become, right. Not everybody is good at everything, but find the stuff that you're enjoy, that you're good at, and just focus on that and becoming the best you can at that and don't accept the limitations that others may try to impose on you.

Weber: Good. And then the one word, if you...

Hannah: I don't-- no. This is not an advice word, but it's like the one word that sums up, like, the way I view the world, is efficiency. <laughs> Right. It's the efficiency of utilization of hardware, efficiency of data movement. The efficiency of user experience, the efficiency of if I'm a person trying to accomplish something, you know, going from Point A to Point B, how easily and efficiently can I get there. So whatever-- if I'm looking at a menu-- there was a coffee shop. Looking at the menu, I didn't know what it was, and so it's like I'm reading down and it's like, "Is that the most efficient way to present the information to someone who hasn't come here before?" So to me, you know, I'm all about efficiency of experience and efficiency of utilization. So that's the one word I think that summarizes my career, and if I'm like a word of advice it's, one word, it's maybe openness. You know, open yourself to new opportunities.

Weber: And then my last question is just that we're sitting in this building that your company built, but say, which building were you in, I mean, not here, and if you have any...?

Hannah: Yeah. There were, of course, you know, from the time we started until the time I left there were a number of buildings. I think '90-whatever, '96 might've been the time frame where these engineering moved into the brand-spanking-new buildings that were the first ones owned by SGI that is now the Googleplex, the Google campus, buildings 40 through 43, I guess, and I did move into that, but that was-- into those buildings-- but that was just as I was leaving SGI. But the other buildings, you know, 630 Clyde Court, you know, and then we accumulated buildings in Mountain View there around that location, and then we moved to the campus here on Shoreline, and there were bunch of red brick buildings that I was in, and then the final move was to that-- the building-- I forget which my building number was, but-- I don't know what it was, 41 or 42 or something, and what else? I remember the earthquake <laughs> that happened when? When was that, '89 or something?

Weber: '89.

Hannah: In like-- yeah. But--

Weber: But the-- building the campus was a big event for you guys.

Hannah: Building the campus-- the new campus, yeah, the Building 40, that was a big milestone, and you know what they say. You know, the-- sort of when you build a big fancy building that's the beginning of the end of a company, a tech company, so I guess that held through in SGI's case.

Weber: Still a beautiful building.

Hannah: Yeah, no. They're great buildings, yeah. Yeah. I think both in term-- the Valley culture, the people who got their start at SGI and went on to do great things within the industry, yeah. There's a lot of legacy of Silicon Graphics, I think, that I'm proud of, whatever small role I had in helping through that.

Weber: And if you have time, one I forgot to-- so if SGI had not put graphics basically on a chip, do you think it would've-- would someone else have done it in short order or would it have taken a while?

Hannah: I mean, people would eventually get there, yeah. I mean, that's sort of the natural evolution of things. I think-- yeah. So other people would do graphics chips and other people would, I mean, define some graphics library, but I think it's not so much a question of would somebody do it or not. Yeah, it's just--

Weber: But would they have done it-- I mean, it was 10 years until there were really other companies doing comparable things, right, or maybe I'm getting that wrong.

Hannah: Yeah. I don't know if it's 10 years, but yeah. Certainly one company can sort of lead an industry to advance years earlier than it otherwise would have. So maybe that's the case with SGI and 3D graphics and so forth. Just like, you know, for electric vehicles, you know, Tesla, Elon Musk and Tesla. It's like would there have been all these electric vehicles eventually? Sure. They were in science fiction movies, so they would've been done, but there's no question that he drove that, right, so it's-- and yeah. I mean, it happened years earlier because of Elon Musk, so maybe to some degree it's like that with graphics and SGI. Who knows.

Weber: Okay. Well, thank you. Wonderful interview.

Hannah: All right. Thank you.

END OF THE INTERVIEW

