



Oral History of John Mashey

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Markoff: Today is Wednesday, July 18th, 2018. And we're at the Computer History Museum in Mountain View, California. I'm conducting this interview with John Mashey, who was an early contributor to UNIX at Bell Laboratories, beginning in the 1970s. He moved to Silicon Valley in the 1980s. And has since been involved with a number of the Valley's most significant start-up ventures. So why don't we begin with your family life? Could you give us some family background? I'd be interested in your parents, where they came from, what they did, maybe your earliest memories, and whether you had siblings.

Mashey: Okay, so I grew up on a small farm in Western Pennsylvania, about 20 miles north of Pittsburgh, just at the edge of Allegheny County. The farm ... and here's a sketch from the 1850s, right? The barn and the farmhouse are still there, although the farmhouse is now a community center for a retirement community. Since it's no longer being farmed, the trees have all grown to take over the pasture that was in front of it.

Markoff: And what was farmed when you were living there?

Mashey: Oh, what was farmed? Cows and chickens, originally, but you know, we'd grow hay and corn and wheat and oats to feed things.

Markoff: Would you call it a dairy farm?

Mashey: It was a dairy farm, but it stopped being a dairy farm when State law said, "You must pasteurize milk." And basically small farmers stopped doing dairy, because the economics didn't make sense anymore. You either had to have the equipment or sell to somebody, and that knocked out the economics.

Markoff: And so would you call your dad a farmer?

Mashey: Oh, yes, yes. He had a BS in Agronomy.

Markoff: Tell me his name.

Mashey: ... from Penn State. My mother, who he had not met at Penn State was a physical therapist. They met at the ... towards the end of World War II, where dad had caught some disease over in North Africa, and they met at Walter Reed Hospital, where he was getting to walk again.

Markoff: And tell me his name.

Mashey: Okay, it's Fred.

Markoff: Fred.

Mashey: Fred. Frederick Mashey.

Markoff: Okay, and your mom's name.

Mashey: Is Ann.

Markoff: Okay. And he served in the army then?

Mashey: Yeah, he was in the Army Air Force basically, Air Force part of the army. And he was a Captain in the army. She was a First Lieutenant. She ... I am awed in having two parents who were both in war zone in World War II, because she as in England part of the time.

Markoff: Oh. And do you know what generation Americans they were?

Mashey: Okay. That's complicated, okay, right? Let's see. The folks from whom the name Mashey come, we have old family Bibles with seven or eight different spellings. They came from Buren, which is a village of Switzerland in between Basel and Bern. And they were farmers, I think fleeing the Little Ice Age basically. Right, for the happier climes of Western Pennsylvania. So that's where one set came from. So that's back in the 1850s. So there's like three or four generations in there. I still ... stereotypical Swiss, I have a family journal from the one owner, from 1850 to 1900, where he recorded to the penny every income and outgo every day for everything. Typical, My wife thinks this is why I tend to be meticulous in analyzing things. Okay, now so there are other sides of that family, though, that go back 12,000 years, because there's two women ... great-great something or other, grandmothers that were Delaware Indians. All right? And the other side, mom's side was more from the British Isles. And they go back to the 1700s. So it's ... there's Swiss, there's Native Americans, there's all over the British Isles, and I don't know what all else.

Markoff: Okay. Early memories from growing up on the farm?

Mashey: Yeah, one that probably the earliest memory is when I almost cut my finger off. You know, farms have dangerous stuff on them. I still have the scar right here. This is with a draw knife. Okay, this, so you have two handles a blade across like this, And I was in the wagon shed doing something when I was about five, and I, you know, kind of like cut this, and the scar's still there, and that was a reminder to not play with sharp things.

Markoff: Yeah. And I would imagine farm chores were a big part of your early life then, because you grew up on a farm.

Mashey: Yes, yes. And that actually is relevant to later things. Because, okay, small farm, 44 acres. Not very big. Hilly. And there's everlasting chores. You generally do not take much in the way of vacations. And we occasionally get away for a couple days, and that would be it. All right? And if there's something you learn, it's how to do tasks efficiently. Now, you know, later lives, I did a lot of computer performance analysis and tuning. <laughs> Because I was always looking for how do you do this thing a little bit faster? And so among the chores is stuff like this. So here we are bailing hay.

Markoff: Excellent. And which one is you?

Mashey: I'm the older kid.

Markoff: Okay. Is that a younger brother?

Mashey: That was a younger brother.

Markoff: Okay.

Mashey: And my father. Here we are.

Markoff: So hay bailing was a regular chore?

Mashey: Yes, well, in the summer, yes.

Markoff: Yeah, yeah.

Mashey: Okay. And you know, you collected eggs, you cleaned eggs, you shoveled manure. You did all this good stuff, okay, right? And that's what you did. Okay, now one of themes I think will come up is that an awful lot of what I've done has been a lot of luck in being in the right place, and being able to work with good people. All right? So a piece of luck here was we have Northern Edge of Allegheny County. We were in a ... North Allegheny School District, which is a very good school district. It's one of the better ones in Pennsylvania. And it's a big suburban school district. We were a farm right at the edge of [where] suburbia sort of ended. Had we been a few miles north, we would have been a completely different, much more rural school district. Now my father, again, both parents had bachelor's degrees, which at that time was fairly rare.

Markoff: Were you the oldest child?

Mashey: I was the oldest child, yeah.

Markoff: And was it always ... your parents were on the farm, but they were educated. Was it ever ... was there ever a question but that you would go to college? Was that sort of expected?

Mashey: Yeah, it was pretty expected.

Markoff: That was part of the family culture.

Mashey: The thing is in some sense it wasn't actually that we were on the farm, because I think dad may well have been doing other work after he got out of the army. But his father died of a sudden heart attack. And he had to sort of come back and keep things going. We had my grandmother and dad's uncle living

in the farmhouse. We had a separate house. And he sort of had to come back and keep things going, which he did for a while, and then it eventually sold the farm off.

Markoff: I see, how old were you when the farm was sold?

Mashey: Oh, I was in college by that time.

Markoff: Oh, I see, so yeah, so it happened.

Mashey: But all through high school, we were farming.

Markoff: What can you remember about high school and your interests?

Mashey: Oh, yeah, well, sure, so I expected to go into some area of science, likely from when I was in first or second grade, I read science fiction books. And the librarian for first and second grade, that was the school was those two grades, Gave me a hard time because I was trying to read all those science fiction books, and she made me read one of something else for every science fiction book.

Markoff: That's so great. Well, what do you remember, what were the ... I mean, besides Heinlein and Clarke and Asimov, was it all of the usual? Was there any ... what do you remember?

Mashey: Well, there weren't that many science fiction books. You could read almost everything there was.

Markoff: Yeah, yeah, yeah.

Mashey: So yes, so it was the usual ones, Paul Anders, I mean, just the usual, okay. So right.

Markoff: And this was, let's see ...

Mashey: Okay, so I was born in 1946, so you're now talking early '50s. And let me set the stage there. I said this was 20 miles north of Pittsburgh. If you went to downtown Pittsburgh at that time, the steel business was still going. Of course, the power around there was coal. You generally saw the sun hardly ever downtown, and businessmen took an extra white shirt to work to change into at lunchtime. And that becomes relevant later. Right?

Markoff: Okay. Were you far enough out that the air was good?

Mashey: Oh, yeah, we were okay.

Markoff: And when you went to town, was there a town besides the City? Like what ...

Mashey: Okay, well, all right, the town there that our address was Wexford, Pennsylvania. And it's right near the intersection of Route 19 going north from Pittsburgh and the Pennsylvania Turnpike. So what happens there is the hilly country of Appalachia/Pittsburgh turns into rolling hills and a lot more farm country right about there. I mean, see, it's a very odd area, because of course, Pittsburgh is not the East Coast. Philadelphia is the East Coast, Pittsburgh is not. It's the other side of the Appalachians, right? It was coal, steel, you know, heavy industry stuff. But it was, you know, where we were could have been Eastern Ohio, farm country. So it was sort of at a confluence of completely different kinds of things. And of course, downtown were things like Pitt and Carnegie Mellon. Okay, right?

Now, of course, the Pittsburgh area was going through tough times over the next couple decades as the steel industry collapsed. So anyway, I knew I was going to be in something in science from real early. Because I'd never actually heard of engineering. <laughs> There weren't like a lot of engineers around. One of my friends' father worked for Westinghouse, and you know, he was the only engineer that ever heard of around, right? So anyway, I took all the science and math and stuff that I could, all right? Although one of the best courses that I had in high school was American History, and Advanced Placement American History. Seventy-five minutes periods, five of those a week, plus lots of homework, and they on purpose gave us textbooks and readings that contradicted each other. Now that, I loved that, but that was very stressful for some people. Now, I've had an interest in history. I mean, I read all the books I could in our house, and we had a fair number, right? But particularly downstairs was a giant trunk full of *Stars and Stripes*, which is the U.S. Military magazine, you know, that mom and dad had collected from World War II. And I read all that stuff and I loved that history. Got interested in cryptography, that kind of stuff, yes.

Markoff: I neglected to ask where you were born and what your birthdate was.

Mashey: Oh, okay, well, 1946, all right. May 22nd. And it was actually out in Dayton, Ohio, where Wright-Patterson Air Force Base is.

Markoff: Because there was a military hospital?

Mashey: Yes. So high school, again, was an excellent high school. Class size was about 400 people. Lots of folks went to college, very high percentage. I did stuff like being on the chess team, I got to play Bobby Fischer once, that was fun.

Markoff: How'd he do?

Mashey: Well, it was a simultaneous, you know, 50 person kind of thing. I lost. I think one person out of 50 managed to draw him? <laughs> We used to play the Avalon Hill War Games, where you modeled D-Day and stuff like that.

Markoff: Stalingrad!

Mashey: Pardon?

Markoff: Do you remember Stalingrad?

Mashey: Stalingrad, yes, Averett, Gore all those. So there was a lot of interest in military history, right, okay. And we played these games, right? Okay. So that was high school. And you know, it was a pretty good time in high school. I played football, I was on the track team. I was in the orchestra, I played flute and piccolo, so.

Markoff: If you had to sort of assign yourself a category of what you were, would you have called yourself a jock?

Mashey: No.

Markoff: No, no. So, because you were academically oriented.

Mashey: Yes.

Markoff: Yeah, okay. But you did play football. So I remember those kids. Those were sort of the, yeah.

Mashey: Well, it was nice to stay in shape and do stuff, okay, right? Okay, now let's see. So I was tied for Valedictorian. A couple of us tied. Okay, right? There was the ... however, far and away the most brilliant computer scientist, that turned out to be, wasn't me, it was a woman named ... well, her name now is Sue Owicki. Ever know Sue Owicki?

Markoff: No.

Mashey: Look her up. She's ... there's a Wikipedia feature.

Markoff: She was a classmate?

Mashey: Yeah, she was a classmate. Still, she lives in Palo Alto, so.

Markoff: Oh, okay.

Mashey: She was a professor at Stanford. I think she may have helped recruit the fellow named Hennessey.

Markoff: Interesting, but she as CS at Stanford?

Mashey: Yeah, well, yeah. She did her PhD elsewhere. She did her PhD at Cornell, but she ended up at Stanford for a while. And she got solid into lots of stuff, Anyway, it was a good class. Okay, so anyway, I went off to college to Penn State. It being a choice, it was Penn State or MIT.

Markoff: CMU, why not?

Mashey: Too close.

Markoff: Too close.

Mashey: Yeah, you know, I wanted to be somewhere not too far away. I, small farms don't make a lot of money, right? But I wanted to be somewhere else. Okay, parents had gone to Penn State, I had a National Merit Scholarship, so that was helpful. But I liked being ... you know, I was used to hills and trees. I didn't really want to live in the City. So Cambridge, maybe okay, but yeah, all right. And I sort of felt like, I mean, I figured I was going to do a PhD in physics sooner or later, right? Partly because I had decided I was going to be a physicist by the time I was in seventh or eighth grade. And for a while I thought I was going to be in nuclear physics. I had a ... I won a trip to Chicago in Argonne National Labs. A thing called the National Youth Conference on the Atom. The utility companies were trying hard to attract kids into nuclear engineering, nuclear physics at that point. There actually ended up being an odd coincidence there that turned up to be very relevant later. That was we had tours and we had lots of speakers that came in. And one of the speakers was a guy named Henry Pollack, who was the Director of the Math Research Center at Bell Laboratories. And what was interesting is you could pick whoever you wanted to listen to, but after about 20 minutes, half of everybody was all listening to him. And he gave a nice talk about a theoretical problem in graph theory called the minimal spanning tree. And how this seemed like a theoretical problem, who would ever be interested in it? And he explained it saved them millions of dollars a year, because it helped them figure out where to put transmission lines and switches, and minimize the cost of doing it. And what was impressive was he related the theory, the practice, and he communicated very well. And it just sort of ... that stuck in mind. Oh, that's pretty cool. Anyway, I thought I was going to do nuclear.

Remember, I said, coal pollution? Right? I knew coal was not the answer. Which is ironic, given something else that happens. But then there were issues with nuclear power, too. All right? Shipping support, okay, first reactor core was not that far away from this area, right? But I got interested in fusion power. And I read Project Sherwood about work done on fusion. Which said with any kind of luck, this will be commercial in about 30 years. This was 1960, <laughs> Okay. So when I was going to college, my goal was to be a fusion physicist, and work on fusion power.

Markoff: Okay, energy was early in your priorities. Let me just jump back before we ...

Mashey: Sure.

Markoff: Just your family view, did you consider yourself middle class?

Mashey: Yes.

Markoff: So yeah. And your parents political views? Were they sharply one way or the other?

Mashey: Okay, very apolitical. Okay, right? Now, oddly, let's see. So farmers, right, at least at that point, tended to be sort of ornery independents. Now dad was certainly involved in politics. He was the

President or Vice President of the local school board for 15 years. Which is hard work, given he was a farmer who got up at 5:00 a.m. every day for a long, until we got rid of the cows. Let's see, but his style, which carries over, was how do we solve problems? What can we do? How do we think ahead? That school district, what they ended up doing was having sort of a fairly small number of people who sort of rotated around, you know? One would be President for a few years, then somebody else, okay, right? And they would think hard about what's the demographics? Are we going to need more property someplace? Well, let's buy it when it's cheap, and figure out where we're going to put another school. And so I never heard anything of real, you know, partisan politics just wasn't a thing.

Markoff: Yeah, okay. And brothers and sisters, how many?

Mashey: I had one younger brother.

Markoff: And his name?

Mashey: Is Joel.

Markoff: Joel.

Mashey: But he is, sadly, not alive.

Markoff: Oh, sorry.

Mashey: So, nor are my parents.

Markoff: Yeah, yeah, okay.

Mashey: My mom died of cigarette smoking, which comes up later.

Markoff: Okay, okay. So how attracted were you to math in high school, and was that ... that was a big ... you were already ...

Mashey: Oh, yes, yes. I read Martin Gardner's stuff, okay, in *Scientific American*. I, you know, I took every math course I could get. I studied Statistics and Probability on the side. I looked at Game Theory, blah, blah, blah.

Markoff: Okay, and were there any computers on the horizon in high school before you got to college?

Mashey: No.

Markoff: So you ...

Mashey: Okay, so I graduated from high school in 1964. And at a few high schools, I think had computers, but not very many. There might have had, oh, IBM 1130s, or maybe there was a 650, or something around, but there wasn't much.

Markoff: Yeah. So Penn State. You're a freshman.

Mashey: So I went to Penn State, okay, right? And again, the ... what I felt was a good idea was to get a fairly broad education as an undergraduate. Because I knew if I was going to go to grad school, you get specialized. So it was certainly, you know, it was ... mom and dad didn't have a lot of extra money to help me out with. A little bit here or there, and then they ... I knew they would need money to put my younger brother through school. I had a National Merit Scholarship, so that covers a chunk. I wanted to be away, but not so far away that it was expensive to get back and forth. You know, I worked every summer.

Markoff: Back at home?

Mashey: Well, I came back to Pittsburgh, yeah. And I'll talk about that later, all right? Because I was extre ... when I say a lot of luck, I was very lucky to get a really good job. Professional grade job. Okay, of course, the last other thing was having seen the demographic statistics of MIT, I didn't really want to be a monk. <laughs> The male/female ratio was really not attractive. Okay, so it turned out what I ended up doing was I ended up doing for most of when I was at Penn State, I was a dual Physics/Math major. And let's see, so because it was a reasonably easy thing to do and I liked the math as much as I liked the physics. All right, now, so that finally got derailed, but part of the derailing was that in my sophomore year I got a summer job as ... at the U.S. Bureau of Mines, Pittsburgh Mining Research Center, which is ... it was right on Forbes Avenue, right next to Carnegie Mellon. In fact, now it's a building of Carnegie Mellon's, because they moved out. So the first year, the first summer was more research and looking stuff up for people for the geologists. And Pittsburgh Mining Research Center is coal. Coal, more than anything. That's why is say it's sort of ironic given other things, right? So that was sophomore year. After the sophomore year ... after the junior year ... during the junior year I took a program and course or two, sort of helped me with my physics, It seemed like a good thing to do. And this was on a IBM 7074 with 10,000 words of storage. All right? And of course, keypunches and cards and all that good stuff.

Markoff: Did you start with Fortran? Or where did you start?

Mashey: We started, well, with a thing called DAFT, Dual Auto-coder Fortran Translator, which was a locally done Fortran compiler that would let you mix assembler code in it. Okay. Well, that was fun! And then now I was back at the Bureau of Mines, okay, for the summer. And now I was programming all the time for them. And there were programs to keep updated. I used the Olivetti Programma 101, like we have one of right here [at the Computer History Museum], which had ... was basically a desktop about this big. It had little magnetic cards, and you could write programs. It had 128 locations. You used something like eight of them for a number, and an individual location as an instruction, right? And I got my first taste then of writing code for other people to use, which was a lot of fun. That was a big kick. And this basically was doing statistics routines for the geologists.

Markoff: And was this keyboard entry, or was it still punched cards?

Mashey: No, this was ... you should go downstairs and look at this thing. Okay, it's got ... it's like a big calculator, but you could program it. So I made them up a library of statistics routines, and they loved it, Because as it stood, you know, if there were programs to run, I'd either walk across the street to Carnegie Mellon's Computer Center, or go down the street to the Cathedral of Learning and run programs at Pitt, All right, okay, so and it'd be pretty much an overnight turnaround. Okay, so, and it would be overnight, you know, pretty much overnight turnaround, right? Particularly if it was stuff like graphical plotting on the Calcomp plotter, you know, it was overnight.

Markoff: Yeah. But for the small machine, the data sets were relatively ... they were still ... you could do things that were useful for it.

Mashey: You could do things. So for instance, it might well be that you had a hundred numbers to type in and do mean and standard deviation and so forth. Well, you'd put the program card in, and then you'd start typing your data entry, and you'd get some results.

Markoff: Yep, yep. So it was interactive computing.

Mashey: Yes, it was interactive computing. That was very limited, and you had to type code. <laughs> Okay, all right, so that actually went on a couple years. It turns out my very first technical report ever was on a program that I created to help the geologists analyze coal cleats. [A 'cleat' is a natural fracture in a coal bed] ... which sort of breaks into coal. And they were doing this thing where they would plot these things, and then they would go around with a little circular thing and count the number of dots in each place, and then make a density plot out of this. And I went, "You do this?" Okay, and every time they had new data, they'd have to redo the whole thing. I go, "You know, a computer could do that." "Really?" Okay. So I wrote up a program that did it and then it did output, crude output on a line printer. <laughs> But it was way better than anything they had. So that was fun.

Markoff: Did you have mentors or professors who really stood out? Were there people who influenced you in your education at college?

Mashey: Yeah, there were in various flavors. More later. So I'll explain. Okay, so here's what happened. All right? So now I'm in physics and math with some odd side things. Like my senior year, I was the editor in chief of the Penn State yearbook. Which is a peculiar thing for a Physics/Math major to do, but that's okay. I did that, and that was a lot of fun, right? Okay, but the fall of my senior year, I had a theoretical mechanics course in Physics, taught by a guy with a real heavy German accent, who started at the left side of the blackboard, scribbled stuff in weird handwriting, going around the room, and then coming back and erasing while talking to the blackboard. <laughs> This was not much fun. And I had a computer course, and I'd find myself hanging out in the computer center writing code. Okay, now winter term, I sort of went on and I actually at that point picked up the last math course I needed. And I actually could have graduated right then. But the way the scholarship worked, you got four years, basically. And what happened then was that my ... the spring term in my senior year, I said, I'm just having too much fun with

this computing stuff. So I skipped the last physics course that I should have taken for that degree, took four computer science courses, with the expectation I was going to go on for a master's and a PhD, if I didn't get drafted.

Markoff: And so the ... I'll come back to that. But the courses, the CS courses were undergraduate courses already being taught. Was there a CS program, or was it ...?

<overlapping conversation>

Mashey: Yeah, there was. There was a CS program at that point, and State had ...

Markoff: Oh, really?

Mashey: And it was very new, When I was there, and the years after ... so we're talking about 1964 to '68 is undergraduate. Let's see, Penn State had a very large program when I was there, in grad school anyway, 400 undergraduates and about 130 grad students. It was a large program.

Markoff: Yeah. And tell me a little bit about college just outside of that. Where did you live? Were you ever a member of a fraternity? Did you play sports?

Mashey: Okay, all right, well, if you were at Penn State, you played intramural sports. I'm way too small to play football up there, <laughs>

Markoff: Was that glory years for Penn State?

Mashey: Pardon?

Markoff: Was that glory ...

Mashey: Those were glory years, okay. These were the times of Mike Reid, Dennis Onkotz, so I'll give you variances. My first two years I was in the dorm. West Hall's next to the gym. Penn State never had football dorms, but we had a bunch of football players and wrestlers and stuff in that _____. So Mike Reid was in our dorm. This guy was about 250 pounds of solid muscle. Looked mean. Was really a nice guy, though, He was All-American multiple times. He was All-East Wrestler till his knee sort of got a little twitchy, but he was really a musician. He composed classical piano, because he could play in the basement. He went on to the pros, was All-Pro five years in a row for the Bengals, but he had a group in the off-season and composed songs, and has won several Grammys. All right. So that's kind of who was there. Well, then I moved off-campus to an apartment for two years with a friend, and then when I was in grad school, I had an apartment very near campus for four or five years.

Markoff: And when you decided to stay, did you consider going to other ...

Mashey: Okay, well, here was the deal, So let's see, I thought about it, but you know, again, money was always tight. And the thing is I was switching departments, you know? I was lined up ... I was already well-known to the Computer Science folks. I was lined up for a Teaching Assistanceship, if I didn't get drafted. Right? Turns out high blood pressure saved me from the draft. But it was, you know, I could have been gone. It was one of the things, too, where I thought, "Well, you know, okay, it's the Vietnam War, but I suspect that the army can find something better to do with me than send me off to Vietnam," due to all the computer courses, right? So the thing was it was sort of ... I liked it up there, the Happy Valley, it's a very pleasant place to be, it's clean, it's nice, it's picturesque and everything.

Markoff: How far from your home?

Mashey: It's about two-and-a-half, three hours. So it's far enough away, but close enough to get back and forth.

Markoff: Stay in touch with your family. Yeah. And were there other things? So was the term hacker a term of art at that point?

Mashey: Yeah, hacker was still a good term at that point.

Markoff: Yeah, yeah, and you knew it, though. And did you consider yourself one?

Mashey: Yeah, somewhat, somewhat. I mean, you know, I went ... there was a time I was a pretty good programmer.

Markoff: And this was Portland State a ... I'm sorry ... Pennsylvania State did not have an ARPANET connection early on.

Mashey: No.

Markoff: So you were in the mainframe computing environment.

Mashey: Definitely mainframe computing environment.

Markoff: Was it an IBM environment?

Mashey: Yes, okay, so I said we started with an IBM 7074, which was a relatively unusual machine for academe, By 1968, we had an IBM 360/50, and then we got a 360/67, so we had that pair of machines. And the Penn State setup was pretty aggressive for the time. We had remote job entry machines around, usually 360/20s or something else, okay, right, running card reader/printer/punch around the State for the commonwealth campuses, Penn State as much as satellite campuses. And around the campus, okay, all right? And so we were starting to run WATFIV, fast Fortran, okay, for that, right? And that led to something else we'll get to. So the idea was to give students reasonable access for short work, and most student runs bomb, or don't even compile, so.

Markoff: Was the operating system of those machines at that time timeshared, or was this a pre-timeshared environment?

Mashey: This was pre-timeshared, this was OS/360, okay, the batch system. They got the 360/67 with the hope of running TSS/360, and very quickly decided that it was not up to what they needed, okay, all right? Most universities at that point tried it, it was just so slow. The one that was popular was the Michigan terminal system, University of Michigan wrote their own. And it just ... you know, it wasn't practical to do it. We had an online RJE [remote job entry] system, so you could edit, you know, edit code and submit it from there, all right? But it wasn't really interactive. I mean, the editing was interactive, but that was about it.

Markoff: Yeah. And how much did life change for you when you became a graduate student?

Mashey: Well, let's see. It was somewhat the same, because it was the same place. When you're in a town called State College that wouldn't be there except for the University, you know, the University is the thing. Okay, so it was still eating in the same restaurants and going to the same student union, living in the same Computer Center, but now I was a ... for the first ... end of 1968 through the end of 1969, I was a Teaching Assistant, And I was teaching, helping out with basically systems programming type classes, operating systems, right?

Markoff: And were most of them undergraduate classes?

Mashey: Okay, let's see. There was Comp Sci 102, which was undergraduate, sort of computer architecture and assembly language. Comp Sci 411, which was a junior/senior graduate class. So upper level type course. And sometimes Comp Sci 420, which was compilers and languages.

Markoff: And had you already sort of headed in the software direction at this point?

Mashey: Yes.

Markoff: Was there a hardware curriculum?

Mashey: No, no, so you know, Computer Science programs in that era originated from different other departments. Ours was a Math derivative. And the first year or so I was in grad school, we were in the same building with the Math Department, Comp Sci programs that come out Electrical Engineering tend to be more hardware oriented. Comp Sci programs that come out of business schools tend to be database oriented. The one at Pitt came out of Library Science. Computational Linguistics, that kind of thing, right? But ours was from Math, and so it tended a bit towards the more theoretical, but it had a lot of software in it.

Markoff: And was there any currents of AI Did you dabble at all in AI

Mashey: No, I didn't get anywhere near that. It was mo ...

Markoff: So it was a real sort of Engineering ... Math/Engineering approach, software.

Mashey: Yes.

Markoff: Was the idea of Software Engineering around as a ...

Mashey: Yeah, it was starting to appear. Let's see, and that actually came up. I actually did some stuff later. So what happened goes like this. We were teaching, you know, assembly language, computer architecture, and operating systems. And it was hard work. Particularly at the time, if you're writing in assembler code, and there weren't ... you know, C language didn't exist. And if you wanted to do systems programming, it was mostly assembler language. And it was a lot of work to get students even to get going! Because the work you had to do just to open a file and get data in and out and everything, it was just a lot of work. Okay, all right? Okay, so one of the things that I did about that time was start writing a IBM assembly package called X-Macros. And I don't know, these still may exist now, we'll see. And the idea was to simplify stuff, or give you macros that would do useful stuff, so you didn't have to learn all these really ugly details. Okay, all right?

So there would be things to save and restore registers and do tracing if you wanted for debugging. There was a thing to, you know, one simple command that would let you read or print compared to this mass of other stuff. Okay, so I started working on those, they helped to teach stuff. Another terrible thing was if you got a crash and a core dump, it could be thick pages of stuff. Okay, all right. Okay, so when I finished that up, what we wanted to do ... and a professor named Graham Campbell managed to get the money to do this, and he taught these classes sometimes. I got a Research Assistanceship for about nine months. And this actually paid a thousand-dollars a month, which at that time actually was pretty nice! It was like, "Oh, okay, good!" Right? And I then started writing a thing called ASIST, Assembler System for Student Instruction and Systems Teaching. It was basically a stable mate for WATFIV. But it was basically a very fast assembler and interpreter. It could do things like, instead of just giving you a minimal kind of core dump, it would show you the last 20 instructions to execute. I mean, it was all kinds of stuff you could do.

Markoff: And did that get used beyond Pennsylvania State?

Mashey: About 300 places.

Markoff: So this was early open source, basically.

Mashey: Okay, very open source. Here was a list of the ... well, about 250 places. So we had bug lists, you know, we had updates. There were release numbers, all that stuff, you know, was stuff I was doing in grad school.

Markoff: And there was a community of users.

Mashey: Oh, yeah, there was a real community of users, all right? And so what we did at Penn State, and Penn State was one of the leaders in this, along with Waterloo, is there were a small set of very fast,

low overhead student oriented compilers. So there was WATFIV, there was ASIST, there was PLC from Cornell, and there were a couple other ones. And they did an arrangement where they dedicated a partition in the computer to these things, and you would swap these high-speed student things in and out. And students, you could get five seconds of runtime. That was it! <laughs> But it made all the difference in the world to teaching at that point. Okay, it did get to a large number of students. And we had a lot of students. Okay, right? Okay, so anyway, I spent about nine months writing the first round of this stuff, which was very intense programming. You know, lots, many thousands of lines of assembly code, very tight. I actually had a terminal in my apartment.

Markoff: Wow.

Mashey: That's very rare at that point.

Markoff: With a 300, or what kind of modem?

Mashey: It was an IBM 2741 kind of thing. It was like 100 bits per second. You know, pretty minimal, but it was something you could have and you could work [on]

Markoff: Encouraged you to work around the clock. <laughs>

Mashey: Yeah, at one point, I discovered my natural day was about 27 hours, because I'd ... particularly during gaps in the school year, you would just work, and you'd work till you got tired. Hacker time.

Markoff: So your sort of flow into computing, you described it as gradual, but was there a moment where you fell in love with computing? Was there something, or some event or ...

Mashey: Well, here was the thing, you know, the ... it was an accumulation that I was just having an awful lot of fun writing code. I was having a huge amount of fun writing stuff and actually seeing it getting used. Okay, right? And when it came time to ... towards the end of the senior year of figuring out, "Well, am I going to go to grad school in Physics, or I'm going to go in Computer Science?" it became clear.

Markoff: And those summers as a graduate student, did you stay at Penn State, or did you ...

Mashey: Well, as a grad student, I stayed at Penn State. Penn State had a four quarter type setup.

Markoff: Okay, so it was around the ...

Mashey: Well, normally, you went three, but grad students often stayed all four. I mean, when I was an undergraduate, I went home. But otherwise, yeah. Okay, so, starting then in 1970 in the Fall, I was an instructor, so I was actually not a graduate assistant anymore. I was a young faculty member. And I taught operating systems and you know, the assembler, early assembler thing and compilers and all that kind of stuff while I was working on a PhD.

Markoff: While still working on your PhD. You were sort of ABD by that point, or were you still ...

Mashey: Well, no, I ended up finishing up in 1973. So there was another three years there. Well, let's see ... the end of '70, '71, '70, '73.

Markoff: And you taught both operating systems and programming languages?

Mashey: Yeah.

Markoff: Yeah, okay. And how active was the CS theory part of the world at that point? Was there a theory?

Mashey: Oh, yes, it was quite so. And again, we had a slight, in fact we had some terrible wars in the department between theory and practice. Some of us thought both were important. Okay, right? Okay, so now to calibrate, we had this ... we had these weird ten-week terms. The deal was, they wanted to keep the same credits as a typical 15-week semester, with three 50-minute periods. Be a three credit course. These would have three 75-minute periods a week for ten weeks. Well, but you would take less classes.

Well, you know, that's all well and good for some kinds of courses, but for Computer Science, where there's a lot of programming? It's hard! Okay, right? So I would come in and Comp Sci 411 was the Operating Systems class that I taught the most often, and I'd give them all the assignments the first day. I'd say, "If you can get started earlier, go for it!" <laughs> And I said, "I gotta warn ya right now ...," Comp Sci 411 was sort of a drop-out course. We sometimes had too many students, you know, and so this was the tough ... known to be toughest, okay, right? And I'd say, "You know, if you work hard and get this stuff right, you'll get an A. If you're not quite as good, you'll get a B. If you really struggle, but you try hard, you'll probably get a C. And if you cheat, I'll flunk you." And every term, somebody cheated.

Markoff: Wow. And what was the male/female at that serious level?

Mashey: At that point, yeah, that's actually an interesting thread that's going to come up later. About 35 to 40 percent female. Remember this was a math-derived thing. So not only that, but we're talking about the age group right after ... we were in high school right after Sputnik. Where there's a lot of encouragement for science. But anyway, what would happen was it was very interesting. This class that I taught was almost always the hardest rated in terms of how much work per credit. It was almost always the top-rated class. Both during and after ... immediate after class surveys and in a couple year post type things, right? The students, they would try to make sure this was their only Comp Sci class that term. <laughs> They would live in the Computer Center. They'd be up there. This was fast turnaround at night, kind of stuff. They ... but so they kind of knew who else was doing the work. And what the students didn't know is that I got a report every week that showed every run every student made. So if somebody suddenly produced a 2,000 line piece of code, not having run much, I knew. Also I changed the assignment slightly every term, and there were red flags, Now what happened is students later would come to me saying, "Yeah, we knew that guy was cheating. Boy, I'm glad you got him!" <laughs> Well, the issue was ... and this actually was a lesson from that time was that the students ... I appreciated ...

when they were getting ... when they learning stuff that they thought would be useful, they appreciated that. And they cared about the fact ... they didn't want people to graduate from Penn State who didn't know what they were doing. Because they got feedback from employers that they were getting good students. So I always felt good about that. That also, you know, what was feeling good, I mean, Penn State's a good school, but not an elite school. There were lots of kids there who were the first kids from their family in college, who this helped get ... to have good careers.

Markoff: Did you have mentors in graduate school? People that ...

Mashey: Oh, yeah, sure.

Markoff: Anybody in particular?

Mashey: Well, Charlie Hughes, was my PhD Advisor. And Graham Campbell, again, who helped get the money and stuff for this. But there were a bunch.

Markoff: And what was life like outside of computing while you were in graduate school? Was there anything, or were you pretty much all-in?

Mashey: Well, I mean, there was plenty of other stuff to do. For one thing, again, you do play intramural sports or other sports stuff up there. Penn State had two lovely golf courses you could play for a buck-fifty. <laughs> And you know, and it has a very good theater arts department. I mean, it was lots of stuff to do, and you know, there were a reasonable number of women around.

Markoff: You had a social life. And did you continue to live in an apartment off-campus. Was that the ...

Mashey: Yeah, I had just an apartment just like a block off-campus during that period.

Markoff: And what was the focus of your PhD thesis?

Mashey: Okay, it was called, "Semantic Error Detection in Programming Languages." It was basically about, okay, we know how to find syntax errors, that's fine, but how can you better do things like finding undefined variables, or subscripts out of range, As a sort of like dataflow analysis to see what can you do to generate efficient code that is still safer? That was the crux of the stuff.

Markoff: And in graduate school was there a more than Penn State graduate community. I mean, were you a ... did you fall into the ARPA's arena at all?

Mashey: It was particularly in the ARPA, I don't think we ever had an ARPA connection at that point. But you know, there were conferences. We had an ACM chapter, okay, right? Gee, we had this little old lady who carried a nanosecond around with her.

Markoff: She was still around?

Mashey: Oh, yeah, sure!

Markoff: Where was she at that point?

Mashey: I'm not sure, with the Navy.

Markoff: Okay.

Mashey: So she came in to do ... it was Grace Murray Hopper, of course, right? She came in to do a talk and then we had a reception party afterwards, and the grad students were dropping like flies and she was still going strong. <laughs>

Markoff: I just learned about the nanosecond ruler. That's great.

Mashey: Oh, yeah, she had that already. Yeah, right. But anyway, we had regular speakers coming by. We sometimes went to conferences. I went off to Cambridge for a virtual machine conference, because at one point I thought I might do a dissertation in that. We went, you know, I mean, back at that point, you know, there weren't a lot of conferences in computing. There was the Spring Joint, and the Fall Joint Computer Conferences. We went to one of those.

Markoff: Now you didn't go to see ... you didn't go to the one in San Francisco to see Engelbart. That was '68.

Mashey: Yeah, no.

Markoff: No. You started going later.

Mashey: So but I did go. And you mentioned open source. Okay, an awful lot of people think open source started with Linux or something like that. That's completely bogus, okay, all right? There was a group called SHARE, which is the IBM Users Group. And that started in the '50s, and we were involved in SHARE. The Assistant Director of the Computer Center, Chuck Forney, was the leader of the IBM HASP project. HASP was Houston Automatics Spooling Priority System. It was a much better way of managing all the card readers, printers, punches. You know, in the background, it would be reading cards in all the time rather than having you have a program wait for you. Now this was an open source thing. In that IBM ... it was almost ... I mean, I don't know how this happened, but the IBMers who did it, ended up having cooperation with a bunch of the universities and research places that used it a lot. And they contributed code, and you could get the code and people would make changes to it and give it back, and they would have meetings. Okay. So I came out to San Francisco around 1971. I sort of with some of the Computer Center folks, partly by that time, ASIST was going. And so we talked to the other educational people. And there was regular communication there. I drove up to Waterloo in Canada one time. So despite the fact that Penn State College is kind of equally inaccessible from all places, we talked to lots of other people.

Markoff: That community was thriving. And in the sort of the computer world, on your horizon, was there anything besides IBM? I mean, there were the Seven Dwarves at that time. Did they have a ...

Mashey: Yeah, so we had a graphics system from some company, I don't remember. And you know, they were starting to get to be many computers around. The main computer center was essentially IBM, plus this one graphics system. But you started to see a few minicomputers in the departments.

Markoff: DEC was ...

Mashey: DEC was around. You know, DEC existed, yeah.

Markoff: Were you still reading science fiction?

Mashey: Oh, yes!

Markoff: <laughs> Okay, so that was a ...

Mashey: Yeah, that actually comes up relevant later, yes.

Markoff: Okay.

Mashey: Okay, so all right, now, and this is what I talk about when I talk about luck. Okay, now I still had a lot of friends in Physics. And we're now talking about, let's see, you know, 1973, early 1973. And my poor friends in Physics would send 200 resumes off and get one or two tickles, okay, right? And you know, you do a PhD in Physics, it's a lot of work. All right, well, I'm sitting in my office one day, and a guy I've never seen wanders in, introduces himself as Morey Irvine, who's a Director at Bell Labs, and said, "So, have you considered not going the academic route? And have you ever heard of Bell Labs?" And I allowed that, "Yes and yes," <laughs> See, this is where I remembered, you know, "That Henry Pollack guy was pretty sharp that I heard ten years before." So I ended up ... well, let me put it this way. I ended up spending a couple days in interviews at Bell Labs. Half a dozen departments. And getting offered a job in Morey's lab, Which is basically the most elite Software Engineering place in Bell Labs, Not maybe the most elite Computer Science place, that was where UNIX was done. But this was like probably the number one software engineering tools and whatever.

Markoff: And physically, where was it?

Mashey: Bell Labs, Piscataway, New Jersey. It was Business Information Systems Division, had a thousand programmers. Okay, all right? So anyway, you know, that was a good deal. And let's say, now somewhere in there, I got engaged to a woman who'd been one of my grad assistants. After she was a grad assistant of mine. And she got a job at Bell Labs, too, and that didn't work out long term, but that's okay. But what a deal! We both had jobs at Bell Labs! Well, she got finished and went off there first, and then we got married and then I got there, you know, a couple months later, right? So I got to Bell Labs Piscataway and we were building a thing called the Programmer's Workbench.

Markoff: It was already ... the project was going when you ...

Mashey: Well, it was about to start. We got our Digital Equipment [Corporation] PDP-11/45, which was the second one at Bell Labs. Ritchie and Thompson already had theirs. They'd already ... you know, there were about 20 UNIX machines in the world, period. Mostly PDP-11/20s, pretty little things, all right? Small things. They had done the '11/45 and that was the first version, you were talking about September of 2 ... let's see, September of 1973. And they had rewritten UNIX in C. All right? So there was a C-compiler, there was UNIX in C. When I got there, basically, what you got was the C programming memo. It was about 20 pages, that's what there was. <laughs>

Markoff: So you had not been exposed to C and UNIX before you arrived there?

Mashey: No, no.

Markoff: This was a new world for you.

Mashey: A new world. Well, you know, I had ... in doing the interviews, I had heard about it. Okay, right? And there was a paper in Communications of the ACM about that time.

Markoff: That's right, UNIX wasn't out in the world. It wasn't like you would have run into it at another ...

Mashey: No, but there was a paper in Communications that came out sometime in 1973. Basically because Ritchie hassled Thompson until they wrote it, okay, right? Okay. So but the thing is the vision, you know, we talked about the vision that they had, which was we had this, again, a thousand person programming organization doing big database systems or switching stuff or whatever, and they had IBM mainframes, UNIVAC 1100 Series. Okay, all right, the 36-bit word things, okay, all right? Xerox Sigma 5s. I mean, there was this whole mess of stuff, right? This was the Software Tools Department, who kept getting asked to build software tools, but they were all different environments and things. So the idea was, "Let's move the interactive part of source code control, editing, document preparation, all that stuff, off onto UNIX front ends, and do remote job entry to send jobs to the mainframes.

Markoff: But philosophically, it was write once/run anywhere was the ultimate goal at that point?

Mashey: Okay, well, no.

Markoff: That wasn't what it was about.

Mashey: No, not the point. Because the operating systems over on those other things were so different. Okay, you're thinking of the nice portable stuff that people do now. No, no, no. That didn't exist. But what you could do ... look this is where the ancestor of most source code control systems comes from, was done between my office and the one next door. Okay, so Mark Rockhind and Alan Glasser, were the guys who did this, particularly Mark starting, right? You know, the document preparation, all right, there was a whole lot of that stuff that had to go on. The automation procedure. All ... a whole lot of stuff. Doing

remote testing. We set up a whole system that would fake being a bunch of people with terminals running repeatable scripts, Okay, so the idea was we wanted to get UNIX into a more mainstream environment than just small research groups.

Markoff: But this program just works bet ... the inspiration of the vision there, it was programmer productivity or ...

Mashey: Yes, well, programmer productivity and trying to get more consistency amongst tool sets and better tools. Okay, now, remember Bell Labs had some long history in software engineering stuff, okay, all right? And you remember that there was all the work on Multics that preceded UNIX. Vic Vyssotsky, okay, all right?

Markoff: And Peter Neumann, right at ...

Mashey: Yes, yes, okay. Now Vyssotsky was our Executive Director. And you know, they had done all this work on Safeguard, and it was heavy duty software there, all right? [Safeguard was a US Army anti-ballistic missile program]. I think Bell Labs was very involved in very serious software engineering already at that point.

Markoff: What was the onboarding process? What was it like coming to Bell Labs, and how did you get sort of drawn into the culture there?

Mashey: Okay, well, Bell Labs was an interesting place. I'm not sure anything is quite like that anymore, all right? Let's see, by the time I left, there were 25,000 people in R&D, plus another couple thousand support, okay, all right? And it almost seemed regimented in that there's very clear levels of authority, okay, right? Every department had a number. If you lopped off the last digit that you had the number of lab it was in, if you knocked off that digit. Okay, so you knew exactly where everything was. Now in realistic practice, there were an awful lot of informal relationships. That's one of the things you learn very quickly. That's the sort of grease that made everything work. Because that got disrupted later, which was unfortunate.

Okay, so that was one thing. I mean, so you learned there was a real structure there. There was a very sophisticated hiring mechanism. So Bell Labs did not have ... did not send recruiters to campuses. What they sent were management teams, The management teams were there for years, they got to know the professors. They were always asking ahead of time, "Well, who looks good?" We were trying to hire so many people in computer science, there just weren't enough. Because you had to be a member of the technical staff, you basically had to have a graduate degree. So what they would do is they would get really good undergraduates, they would come in for the summer, and then they would send them off to grad school at half-pay, which was really pretty nice. Off to Michigan or Stanford or MIT, wherever. Okay, another thing you learned was, "Hey, you're a new PhD feeling your oats, there's always somebody around who knows more than you do about what you know most, and may well be smarter than you, too. Okay, right? And so you better learn to go ask questions."

And the way Bell Labs works was that it was expected. You know, if you were going to be serious there, you would figure out who were real experts in things. You'd know ... you'd start asking around. And you would go ask people. And even people in Research. You could never make Research do anything in particular, but you could take problems to them, and if they got interested, okay, right? So if you had serious statistics stuff, you'd go to a fellow named John Tukey. Ah, yes, okay, right? <laughs> Wait a minute, actually if ... Bell Labs, when you wrote a article to be published outside, you learned ... here's how it worked. You're a member of technical staff, you write something, it goes to your supervisor, goes to your department head, goes to your director, goes to your executive director. They send it to two other executive directors. It then goes down their side till it gets to somebody who can review it. It then comes back up and over and down. All right, now this actually goes quicker than you would think, right? Basically, they didn't want junk getting out ever. Well, if you were doing anything with statistics, it was a pretty good chance it would get over to Tukey's turf, okay, right? And it was probably a bad idea career-wise if it came back saying, "The statistics is junk." All right, okay, so but it was a very well-structured organized place. If you knew how to play the games, you could get terrific leverage, like we made UNIX happen, and a lot of other stuff, too. Okay, right? I mean, if you think of what came out of there at that point, there was a lot of stuff. Okay, right?

Markoff: But you were a technical member of a group ... was this of this group of a thousand when you started? Or was this business ...

Mashey: Well, that area within Bell Labs, okay, right? An executive director had typically a 1,000/1,500 people.

Markoff: And they were doing these applications for Bell Labs.

Mashey: For the operating companies.

Markoff: Okay, for the companies, okay.

Mashey: So these were like big database systems of one kind or another.

Markoff: But there might be a billing system, or a engineering ...

Mashey: Yes, or a backend ... like keeping track ... you know, the Bell System would keep track of every telephone pole. Every cable? Okay, all right? And that led to problems sometimes, because with the database didn't match reality, bad things would happen.

Markoff: And these were not relational databases at this point.

Mashey: Not at that point.

Markoff: Like file or whatever.

Mashey: IBM-IMS, you know, or equivalent stuff over in UNIVAC.

Markoff: Yeah, okay.

Mashey:

Markoff: But you were creating ... I mean, the notion ... I'm still fascinated by the Programmer's Workbench. And the notion that you were creating almost an Engelbartian environment.

Mashey: Yes, yes.

Markoff: For people to live in.

Mashey: Yes, so for instance, okay, so it's probably relevant to talk about some of the things that we did there, So one thing that we did, most ... very tiny number of UNIXes that existed at that point were typically in somebody's lab by a small group of people. We were actually running what was for many years the largest UNIX Computer Center. This was the first UNIX Computer Center, okay, right? And we were serving multiple departments. What was funny was, when we were looking for budget every year, it would be like, "Oh, well, I don't know. No, we won't use it that much," and by the end of the time they would be saying, "We need more service! We need more service!" We had multiple departments sharing the same computers. And we had to worry more about security and making things work in that environment, which was different. So here's some things that happened during that. Okay, so in 1974, I was doing a little project for one of the bigger departments there. They needed a little database to keep track of their error messages. And using mainframe database for that is like overkill. So what I did was put together UNIX shell scripts to do this. Well, some things were easy, and some things were very painful. When I finished doing that, I made a long list of things of, "Here are things we ought to do to make this shell a real programming language."

Markoff: So this is what led ... this is called the P ...

Mashey: PWB shell.

Markoff: aka the Mashey Shell.

Mashey: aka the Mashey Shell.

Markoff: Is it still in existence?

Mashey: No, it's long ... I mean, yeah, you can get a copy. It's on the network someplace. Okay, all right. So anyway, I convinced folks that this would be a good thing to have to automate the procedures. A whole lot of what went on was people trying to automate what they were doing. All the kind of grunt work. Remember I said automating what you're ... thinking how you do stuff efficiently like on the farm? Yes, okay, right? Okay, so this is where shell variables came from. This is where path search, Where instead

of just going through /bin, /user/bin in your own directory, you have your own list of stuff. Okay, right? Because we had groups that wanted to have their own individual commands. Okay, this is ... we should have better control structures, not just if go to, right? So, some other folks put some of that stuff in, and then I ended up taking it over and putting a lot more in and tuning it and making it faster.

Markoff: And did this create your reputation? Was this a significant part of your reputation at Bell?

Mashey: Yes.

Markoff: So this is a contribution ...

Mashey: So I sort of ... I mean, it wasn't that shell scripting didn't already exist, but I made it practical.

Markoff: Now this was separate from the Workbench?

Mashey: No, it was part of the Workbench. This is ... that's why it's called PWB shell.

Markoff: Okay. Oh, oh! PWB, gotcha, okay!

Mashey: Yeah, right? It was the PWB. I called it the PWB Shell, but everybody called it the Mashey Shell. There's actually a course later on called Mashey Shell Program ... sorry. Bourne Shell Programming for Mashey Shell Programs. Okay, right? And I always called it the PWB Shell, because the constraint was we really had to be minimalist in terms of change, and upward compatible, right? And so that ... there was some less than elegant things that were done,

Markoff: And did it give you control over C, or was C separate from that?

Mashey: C is completely separate, yeah, yeah.

Markoff: Okay. And then just to dive off a second. Where were you living? Where did you come to live when you ...

Mashey: Oh, I was living most of the time in Somerset, New Jersey.

Markoff: Okay, and how far is Somerset from New York City?

Mashey: Call it an hour to get to Manhattan?

Markoff: Did you ever go?

Mashey: Oh, yeah!

Markoff: So for music and entertainment and all that.

Mashey: Yes, music and theater and stuff like that, yes.

Markoff: And how close were you to the UNIX group? I mean, you were doing this stuff.

Mashey: Real close, okay, all right? So okay, we ... lots of ... at that point, lots of people were starting to think of doing more things with UNIX. In some sense we were more philosophically aligned with the gang at Computer Research at Murray Hill [New Jersey], okay, right? And because we were focused on a broader audience, but of programmers. We were not making it embedded into something, because the people there sometimes wanted to do different things. So we were quite close with Ritchie and Thompson and Kernighan and everybody up there.

Markoff: So you met those guys early on.

Mashey: Yes, yeah, I'm going to go through a story there. Okay, right?

Markoff: Let me just ask a couple things before. Had you become part of an email culture before you came to Bell Labs? Was email something ...?

Mashey: Okay, there was a little bit of email at Penn State with this RJE System with terminals but not much. It was a little bit email, but for sure, since 1973 my email name has been "mash."

Markoff: "@" yeah. And so that was part of the culture.

Mashey: Yes, absolutely.

Markoff: Yeah. And besides email, where there ... so Usenet was not ...

Mashey: Usenet started around ...

Markoff: Usenet came later, '79.

Mashey: ... 1985.

Markoff: Okay, all right. Yeah, I just looked, it started in '79, but at a school.

Mashey: Yeah, but really it got to be serious, okay, right? UUCP existed earlier.

Markoff: Yeah.

Mashey: Okay, but then, you know, real Usenet really is mid-'80s.

Markoff: But did you meet these guys online, or physically?

Mashey: Yes, both.

Markoff: Both, yeah. And both cultures existed, there was an online culture and there was a ...

Mashey: Yes. Yeah.

Markoff: Yeah, okay.

Mashey: Yeah, I mean, anyway, we were pretty close with the Murray Hill folks. We generally had the biggest machines, the biggest configurations, we had the most stress on stuff, we had 16 users all the time on PDP-11/45s, we got 48 on [a] PDP-11/70. So we found bugs that nobody else saw, okay. All right. Again, we had the largest configurations. We ran into security problems that nobody else saw. And so we would be up at Murray Hill talking to folks about, you know, "Well, what do you think's a good ..." I mean, you didn't want to just change stuff, you wanted to do something that might plausibly get in the next research edition. So we were ... we and they were pretty close. I was especially close to them for various and sundry reasons, okay, all right?

Markoff: And was it Doug McElroy who ...

Mashey: McElroy was running part of it. He was the supervisor.

Markoff: Who were some other important people who ...

Mashey: Well, Allie Ho, theory, okay, right? Let's see, well, Ravi Sethi was up there, another theoretician. Thompson, Ken Thompson and Dennis Ritchie, Brian Kernighan.

Markoff: Kernighan. Was Morris around?

Mashey: Oh, yeah, he's there, and he's going to come in a story here, shortly, <laughs> Okay, so anyway, one of the first projects, and a continuing one for a couple years was this, "What do we have to do with the shell to make it really good for helping people automate procedures?" Okay, all right? And some of these are little nit things, like you know, suppose somebody interrupts a procedure. You know, Control-C, okay. It's a good idea to be able to say, "On interrupt, go to this label to clean up temporary files and crap like that," okay, right, you know? It's just ... it's one of those trivial things, but it makes a difference. Well, we had a small number of shell variables. We had these path search thing, and we had the system cull that would do it that way. Anyway, all those sort of pieces to do stuff. And all that stuff ended up eventually over in the standard UNIX in a more generalized form, okay, all right. Okay, we ended up ... writing shell procedures became what everybody did to automate their stuff. Okay, that was one thing. Another thing we did was to take good old NROFF and TROFF and do a macro, formatting macro package general enough to cover all the stuff that was done there. There were other older macro packages. We did one that had the characteristic that we tried to split the structure of the document apart from its appearance. I think of style sheets. Okay, all right, okay. And a reason for this is that sometimes the Bell System had all kinds of standards of how documents were supposed to look. And sometimes all

the information when the structure was the same, but how they had to be numbered was different. And so we wanted to get that into one good form. Now what that meant, and this was another very satisfying thing, was that we completely changed how the Bell Labs typing pools worked. Which made a big difference to people ...

Markoff: Which had been on typewriters, right?

Mashey: Yes.

Markoff: I mean, originally. Yeah.

Mashey: Yeah, they were doing it on typewriters.

Markoff: So that must have taken you into the world of text editing.

Mashey: Yes, oh, yes, for sure.

Markoff: Tell me, I mean.

Mashey: Yes, okay, well, okay, so well, text editing and text formatting, okay, right? My boss, I was doing this was a fellow named Ted Dolotta, who was really fanatic about typesetting and getting it all right and everything. And we, again, we had a large number of mostly women in the typing pools. And particularly because it was a software organization, it moved faster than building a telephone. A lot of the Bell System documentation was geared for long-lived hardware. And we had this big increase in software. And this gets back to this thing ... you asked how many women were in there. We actually had quite an uptick in women, particularly in computer science and human interfaces and all that stuff. Bell Labs, Piscataway had a group called the Women's Rights Caucus, that I was actually a member of. And by and large, you know, Bell Labs had very sophisticated management. There were a few older guys that didn't quite understand what to do. But what's interesting is the effect it had on the women who were in the typing pools: basically it broadened the work that they could do, it got rid of a bunch of the more monotonous retyping of stuff. Right? They learned to work with the authors about getting the formatting like they liked it. And particularly some of the better ones ended up becoming managers of these groups, because they were pretty good at doing this stuff.

Markoff: Were there markup languages? Did you go in that direction?

Mashey: Well, I mean, TROFF.

Markoff: TROFF, yeah, yeah.

Mashey: Yeah, TROFF, and then this layer on top of it, okay, right?

Markoff: Yeah, yeah.

Mashey: So for instance, what you do is you'd say .h1 is the first level heading, and its stuff, exactly how that thing appeared was what amounted to a couple parameters at the front that were like a style sheet. And we tried to abstract away what was, you know, the ... just like the X-macros had done in terms of hiding the detail. We were trying to abstract the structure of the documents, as opposed to exactly what it looked like.

Markoff: So this was ... by now what year are we in?

Markoff: Okay, well, we're in ... we're talking about '73 through '75. But there were odd things that happened. We had not talked about the Programmer's Workbench outside at all. Just for fun one day, we got a letter from the Bell Labs President who said, "Two guys from the National Security Agency will come and spend a month with you. Give them whatever they ask for, and don't ask questions." <laughs> What they were doing, it turns out, was they were setting up Programmer's Workbench type things in shielded rooms with RJE to their mainframes, Or supercomputers. So that was interesting. And a related one comes to this. And this is the one science fiction book in the Computer History Museum.

Markoff: One of my favorites.

Mashey: Yes! "Shockwave Rider," All right.

Markoff: Which was '71.

Mashey: '75.

Markoff: '75?

Mashey: Yeah, '75. You know, I recommend this book to everybody right now, okay, in that lots of people are worried about what other people know about them. Okay, but what is it? It's got a guy who has a, let's see, who has a worm with an infinitely replicating tail that you can't kill, that can rewrite his identity everywhere. And I saw it and I laughed. I said, "You know, hey, cool story! I love the book! But you know, nah!" And within a week, I saw one. This was the topic of Ken Thompson's Turing award lecture. And he had a very clever sort of hack. What he was exploring was how much could you trust the people you get software from. This was an era in which a release of UNIX ... well, I mean, it wasn't like this. Where things are well-done. It was you drove up to Murray Hill and you got on Ken's machine, and got what was new. Okay, all right? You get email, "Hey, we got new stuff." Okay, "Hey, Dennis has a new C-compiler, good, come get it, okay." Well, Dennis Ritchie was bootstrapping C quite frequently. That is, he would add a feature to the language, and then having now gotten a compiler that would compile it, he would rewrite some of the software to use that feature. So now you would get a C-compiler <coughs> source and binary, but your old C-compiler wouldn't compile it. Okay. All right. And the deal here was is that there was this thing that in the C-pre-processor that if it ever saw the line in login that said, "If login ... encrypted login matches, okay, if magic password." So if you ever compiled login, you now had a giant trapdoor in your system. And then it also looked for itself in the C pre-processor, and re-inserted the code. Having gotten a binary that did this, they took it out of the source code, so you never would see it.

But it would replicate, Now it turned out ... I think it was my officemate was looking and found a name of a function that he couldn't find in the source code. So it was in the binary, but it wasn't in the source code. All right, "<inaudible 00:39:38> what? What is going on here?" Okay, and I went up and got on Ken's machine, and I found the stuff, As far as I know we were the only group to find it.

Okay, now you asked about Robert Morris. So Robert Morris, Sr. sometimes consulted for the NSA. Robert Morris, Jr., of worm fame, was a high school kid who came by now and then. So I was up not too long after this in the terminal room that those guys had. I was talking to Ritchie or Kernighan or one of those guys. And Thompson and Morris were sitting there chortling away about this exploit. And remember, they weren't trying to cause any real trouble. They were exploring at that point how safe are you, what do you have to do? Okay, right. Okay. And they're chortling away, "Ah, cool, cool, cool!" And it had to have been Ken said, "think we could put this over in the NSA?" "Oh, that'd be cool! That'd be cool!" Okay, but and then it must have been Bob said, "You know, they don't really have a sense of humor." <laughter> So anyway, by '76, we actually ... this is my second trip out here. I'd been out to San Francisco. But second trip, we came and had six talks about the Programmer's Workbench.

Mashey: Okay, we finally went public with it, for a compsec [computer security conference] or some IEEE thing, right? So I either wrote or co-wrote three of the six. So I was pretty heavily involved, So we had one on the overall Programmer's Workbench, we had one on using a command language as a high-level programming language, that was the shell stuff. And then we had one with the document preparation stuff. Okay.

Markoff: And was any of the other stuff, it was just starting at that time, on your radar? Did you know about the Alto work at ...

Mashey: Yes.

Markoff: Smalltalk work at ...

Mashey: Yes, absolutely.

Markoff: And was it interesting to you?

Mashey: Absolutely.

Markoff: I mean, were you guys doing similar things at that point?

Mashey: Yeah, we were or shortly thereafter. I'll come to that. That's in the ne ... this is sort of the first half is Piscataway, and then after in '77, I moved up to Murray Hill in the UNIX Support Group. All right? Bell Labs Management had noticed that almost every project around Bell Labs by then was depending on Unix somehow or other, and they were different. People got the code and changed it, and we were trying to consolidate versions and stuff. So there's sort of five years of Unix ... main Unix stuff. But anyway. Important, '76, we came out here. We presented this stuff. Some people came up afterwards almost

crying, saying, "I can't believe you guys have this stuff." And I was, like, how can we get this? Well, sorry, we don't distribute it. Okay. Okay. Well ... but the interesting thing was I had never been really down the [San Francisco] peninsula. We had one member of our team, his wife's parents lived in Los Altos Hills, California. So it's November. It's already gray and miserable in New Jersey. We come out here. It's not bad. We go to Los Altos Hills. They have apricot trees, a pool looking over the bay. I said I can imagine living here, maybe. <laughs>

Markoff: And Silicon Valley had just been named.

Mashey: Yes. Right. Yeah. So I thought, hmm, I think I can remember this. This is not bad. Okay. All right. Come early '78, once again, one of these guys walked into my office, fellow named Bob Martin, who went on to become Bell Labs' CTO. That's pretty good ... very good. Very good architect, very savvy manager, really knew how to play the game. And he was actually looking for a manager of a development project and ... but, as he said later, I wasn't the right one for the ... what he was ... but he wanted to get me anyway. Basically, to help bring new technology to what they were doing. He was running a thing called the automated repair service bureau. This is the thing [whereby if] we have a telephone problem, you call up. Okay. So ... anyway. So he went to promote me to supervisor and the deal was I was going to run a development project and inherit a couple pieces.

Markoff: This was one of your first management positions?

Mashey: This is my first management job, yes. Okay. Well, I had run the computer center for a couple months, to fill in for somebody down at Piscataway, but, generally, yeah. Right. Okay. So I then, having bought a house a mile from Murray Hill, <laughs> now, I've got a job at Whippany, but fortunately, that's about 20 minutes. So I'm at Bell Labs Whippany. Right? And now, we're in building operations support systems for the Bell System. And the existing system they had out there were mainframes with big permanent databases and triplexes of PDP-11s in front of them to run the active problems, because they had to be up all the time.. The thing I was to do was to build a backend data mining system that would basically look at cable repair problems. There's the cables that go from the switch out to your house. Those are hard to automate away. What you can do, though, is see where the cost is going. You can identify cable boxes where there's been a lot of trouble and go out and clean them up. There's a lot of delicate balancing of reactive problem fixing to preventive maintenance.. This is a data fusion problem because you have trouble reports coming from one direction and you have payroll records all different and the operating company's coming from other places. Now, the software is inherently very sensitive to the organizational structure out there, which varies, and was in the process of being changed. So I looked at the specs that I got for this and said these are squishy specs. So I wanted to do ... let's see. I wanted to do a very fast development sort of prototype turning into a real thing. Okay. Because I knew when we got it out into the field that things would get changed. And I had been doing a talk, okay ... well, it was a reaction to something else. We had made great progress in tool-oriented, component-oriented software in the Programmer's Workbench. But there was a big force going on in software engineering of "waterfall" diagrams, okay, really strict requirements before you build anything. Okay. And some of us didn't like that. So I did a talk called "Small Is Beautiful and Other Thoughts on Programming Strategies."

Markoff: '78.

Mashey: Well, this was '78, but the first one was 1977. So that's right before I got promoted. But basically, Martin liked the ideas, is what it amounted to. So this is sort of like, okay, you got ideas on how to do develop and this is ... when it makes sense, build prototypes that you can turn into the real stuff. Right? Use tools, build it fast, then tune it up later. And iterate pretty quickly. You may recognize agile development, but I didn't think of that thing. Unfortunately. Okay. And was basically, okay, try it. So we did. And we had a thing that was partly on ... in PL/1, an IBM mainframe. And then, it was 20,000 lines of C ... about 5,000 lines of C and 15,000 lines of shell script. <laughs> Okay. So I took ... I at one point took the printout of that part and put it on Brian Kernighan's desk, he being the K in OK, of course. He freaked out. Was, like, we never built it for this kind of thing. I go it works fine. Okay. And it did.

So later on, when things had settled, because you know what, we did it ... our field trial in Boston and the second one was in St. Louis. And right away, when we went to St. Louis to set it up, the Southwestern Bell guy said, "Well, we don't do things here the same way those Yankees do in Boston," and they were right. They didn't. But after we got the third one, things had settled and I had somebody go back in and write the high runner parts back and see. We made a little kit of stuff to do that. Right? Okay. So ... anyway, that thing was ... it was the only way in the world to get it out the door fast enough. It also gave us the excuse to do something we wanted to do. Which is I had a couple folks that were working with me from another group, but at least one or two of them ended up in my group later. We wanted to fix the documentation problem, and that was that documentation went through a completely different path than the programs. And it was never very satisfactory for fast-moving software. Right? So what we wanted was a complete electronic delivery out to the operating companies. We wanted an organization that would let us package up software and documentation in one coherent thing. It would arrive on your system. You'd push a button and it would be put out and all that kind of stuff. The documents were modules with names, like URLs. This was all in the late seventies. Okay. So this kind of violated a bunch of the Bell System standards, but I told the AT&T project manager, well, if you want to get this ... I'd be happy to do the standard stuff. It'll just take six months longer. Oh, no. Okay. And he went to bat for me. So we were able to do this. Okay. All right. Well, that sort of got out the door. An offshoot of it was the very first expert system, done at ... produced at Bell Labs and shipped to the companies. And it was a backend thing to ... what would happen is a cable analyst job would learn how to use the reports pretty well and then they would transfer them. So this was an expert system where the ... it had the rules of where to go look and that ... to help find stuff.

Markoff: When did the name agile software actually emerge? How many years after ...

Mashey: 2000.

Markoff: Oh, way later. Yeah.

Mashey: Two decades.

Markoff: Okay.

Mashey: I mean, it wasn't that some of these ideas hadn't been floating around. We were just starting to really apply them to real software projects. We used to use ... this talk used to be used in the software project management class at Bell Labs, which was fun. Okay. So then, the next thing was they ... having sort of gotten this out the door, I got to be running a supervisory group and we made up a name for it called the Information Processes and Architecture Group, which basically meant do whatever we want to do. Okay. Well, what we did was take this software structure that we had built, okay, and turn it into a thing called SOLID, System for Online Information Development. One of the very few software environment systems that ever got use. It got used in about 50 places in the labs. The trouble was people would build their software control systems and everything again and again. And the trouble was too many of them had embedded assumptions about how you did stuff that didn't fit other places. This is one where a lot of the structure was there, but didn't make many assumptions about workflow and what you want to do. So it actually got pretty wide use. Right? We also did ... oh, I had folks doing research in speech handling. Turned out the hardware was just not up to it. I actually had a group that was half cognitive psychologists and half software folks. Which was pretty useful. We did human interface stuff. You asked about bitmapped display terminals. Yeah. We had the Bell Labs Blit terminals, right, that are done by Rob Pike and Bart Locanthi over in Research.

Markoff: This is hardware and interface?

Mashey: Yeah. So the Blit terminals, right, were Motorola 68K terminals ... they were terminals, not actual workstations at that point. This is 1981, I think. Something like that. But they were multi-window, multi-tasking kind of things. And then, you could have applications that could have nice interfaces. And they had a mouse, you know.

Markoff: Was Thistle involved in that?

Mashey: He was in the same department, but not in that. No. So I certainly knew about Altos. I already knew Adele Goldberg by that time.

Markoff: How did you cross paths?

Mashey: We met at a conference in 1981 in New Orleans. I think I was talking about SOLID and she was talking about Smalltalk or something or other. And let's see. So ... and then, I came out here to give a talk. I got her to come to Bell Labs to give a talk. I mean, some of this new, that is the cost came down, bitmapped displays is what was going to happen, period. I had already ... always pushed for better terminals. I did a bunch of work on CRT support well before this. Okay. So we got Blit terminals. I got us ... I got our lab to have more Blit terminals except anywhere but Research. I got Martin to have one on his desk.

Markoff: Did you have one on your desk?

Mashey: Oh, yes. Yes, for sure. And what we were doing was working up an agent system ... a prototype of an agent system for the operating companies, where there were people whose jobs had half a dozen

terminals on their desk, all hooked to different things. They have to take information from one place and put it in somewhere else. So we did a repair service bureau application ... just a mockup. Right? Where there would be a list of incoming trouble reports. There would be a list of work crews. Instead of doing a whole bunch of commands, you would click on a trouble report. You would click on a work crew and it would assign it to their queue. But the idea was to show, look, as this stuff gets cheaper, this is stuff we can deploy and it'll save a lot of time. Well, there was this problem that we ... my boss at that point ... or my boss' boss was a fellow named Dan Stanzione.

Martin had gotten grabbed to go, fix up, drain the swamp, somewhere else. Dan Stanzione came in. He was sort of the father of digital signal processors at Bell Labs and he later was Bell Labs' president. So it's a pretty good management chain. And he asked around, was anybody doing a microprocessor-based workstation? Talking about 1981. And nobody would admit to it. So there was an under the table project that I ran, right, called Phoenix, which was basically we used Sun [Microsystems, Inc.] [circuit] boards and we were putting together what we said was a small server to go in the garages to control little hand-held computers that would run the mechanized loop testing. There were hard requirements. [It] had to be usable by one gloved hand while somebody is up on a telephone pole. <laughs> Okay. And we said we need these little computers in the garages. Okay. What we really were doing was heading towards workstations. You'd have one of these with a couple of the Blit terminals.

Markoff: And you had your own processor. Right?

Mashey: Well, that's a little bit later. We started with [Motorola] 68000s. The Blits had 68Ks. Now, it turned out somebody was doing their own computers, 3B2. And there was a Bell "MAC" chip, which was a 32-bit thing. We ended up getting pulled into the 3B2 project. And the problem was, it was run by an executive director of that whole stuff that he said, oh, well, you know, these Blits with Motorola chips. No. We got to have Bell MAC chips in there for the volume. Okay. Here we are. The 68K chips, guy named John Reiser [ph?] had written a wonderful dynamic code-generated bitblt to make this slow 68K actually be good. All that had to be thrown out. I mean, I talked to the engineers who did the official Bell Labs Blit equivalent and they said they made it work and, of course, this chip doesn't fit this at all. Oh, good. Yeah. The trouble was we had done some really cool demo applications with the idea of being able to get things lined up to get volume for the thing and just completely wrecked it. We got pulled into the 3B2 thing. I mean, it was amazing. We in Research fought this switch of chip, but the executive director I won't name said, oh, we got lots of software people who can do this. Well, the day after the decision, I got a call from the department head out at Chicago saying, "We hear you know about these Blit terminals. Can we get some help on software? Oh, thanks." Anyway, we got pulled into the 3B2 thing, which had its ups and downs.

Markoff: So this took you into hardware? To what extent did you ...

Mashey: Well, I was ... already had had a lot of interesting computer architecture. And our lab at Whippany was about 40 percent hardware. Digital signal processors, stuff hooked into things.

Markoff: And you were still called the architecture group, in part?

Mashey: Well, "information process and architecture group" -- let us do whatever we wanted to do.

Markoff: Yeah. Right.

Mashey: Okay. So to sort of finish off the Bell Labs stuff, well, of course, it was the good old Bell System Technical Journal. Here is one on the automated repair service bureau, including this project that I was talking about. There was, of course ... there were multiple issues of Unix stuff, so I wrote papers for those things. Let's see. There was another funny thing that happened. So during this time, I was an ACM national lecturer for about four years, which meant that chapters of the ACM would put in requests. There was a list of speakers and what they would talk about. And you would try to arrange trips, and this was, by the way, perfectly well supported by my management. They liked us being out there talking to folks and saying, hey, this school looks pretty good. We might do recruiting there, so forth. And I did the "Small is Beautiful" talk, so at least a couple thousand people heard that talk at that point. I talked about Unix and Programmer's Workbench and there was one more talk that came up in a really weird way. There was a workshop on fast prototyping. And this was ... finally, by '82, there was a bit of a reaction to this heavy requirements waterfall thing. But people were still having trouble. They were talking about requirements for the fast prototypers. I was at this conference and this freaked me out. I said wait. Wait. Fast prototypers are like scouts on motorcycles at the head of the army. I thought, wow, that'd make a great talk. So I invented a talk in the middle of a conference and begged my way onto the program. <laughs> It was a workshop kind of thing. Well, anyway, that became software army on the march.

Markoff: That's great.

Mashey: <laughs>

Markoff: It's projects, strategies ...

Mashey: Strategies and tactics, a tale of bulldozers and motorcycles. The idea was that there's heavy-duty software engineering. You got to build stuff that's pretty rock solid, but you got to know what to build first, and I talked about the way projects fail, all that kind of stuff. And ... so that ended up being a popular ACM talk and was also a 1983 keynote for one of the Unix conferences, which was sort of fun. But it's the only time I've ever invented a talk in the middle of a conference. <laughs> Scribbled view graphs and given a talk.

Markoff: And for you at that point, what was the line ... what were the lines of authority? Who was your manager and what, organizationally ...

Mashey: Okay. I was still in this automated repair service bureau thing, but here's the thing. Development laboratories would often have advanced development or applied research groups, and I was running the one that we had. And the idea was new technologies, what do we want to look at? That's why we're looking at voice recognition. Our own software methodology things, we were doing that. We thought we needed small microprocessor-based systems that nobody else seemed to be doing one for a while, as I say, until 3B2s came up. So this under the table ... well, I say it's under the table project, I would go to

other areas of the labs and say, "Could you use something like this? If yes, loan me somebody." And they would. And it wasn't exactly under the table because we were going to have a review for our executive director who runs 1,500 people, and he already knew everything about it. Yes. Really under the table. <laughs>

Markoff: So I remember being fascinated by AT&T at *InfoWorld* and the question always was AT&T going to get into the personal computing world?

Mashey: Yes.

Markoff: How did it look from the other side of the interface?

Mashey: Okay. So ...

Markoff: And 3B2 was ...

Mashey: Yeah. I know. Okay. I mean, the problem was that whole thing was done out of an organization that was used to doing switching systems, and it's a different world. One of the stress points at that point ... when I said if you knew how to play the game, you could get huge leverage. Right? There were very entrepreneurial folks inside Bell Labs, but by mid-'83, the Bell System breakup was on the horizon. All these informal relationships that made things work were starting to get frayed. It was like pouring sand in the gears, because nobody knew where they were going to be and how things were going to be organized. Things were going to split up in odd ways. There was this fantasy on the part of some people that AT&T would be a big computer company and take on IBM and DEC and so forth. That ... the answer was we had great technology, but ... some of us already knew, like, look. The microprocessor is happening. Moore's Law is happening. Some of us knew this, but it was hard to get ... I mean, again, I was in a place with some of the very best management there was, period. Very forward-thinking, very aggressive, very savvy managers. You don't get to be president of Bell Labs by being dumb. And ... but it was just weird.

Markoff: In terms of that arc, what year or years would you call the peak period of Hellishness?

Mashey: Well, I mean, '73 to '83, when I was there, was pretty good. <laughs> '83 started to get a little weird, but certainly before that ... I mean, for instance, we always thought that the prime places for computing research were Bell Labs Murray Hill, Xerox PARC, and IBM TJ Watson. We thought for software engineering that we had been doing was some of the best, and some pieces of IPM. We thought our approach was better than ... IBM was into chief programmer teams. Do you remember that? Okay. Harlan Mills. This was ... you get a cheap programmer who can kind of do everything and then you support them like a surgeon, bla bla bla. We were more of the what you want to do is build really good tools and help automate stuff and you don't need a program librarian. You need a program [that] is a librarian. And we were right. For one thing, because we looked around and said how many people do we know that could be a chief programmer like IBM thinks there is? And the answer was hardly anybody. And if Bell Labs doesn't have very many people, nobody has a lot of people.

Markoff: So if you look at your contribution during that decade ...

Mashey: Okay. So it was important. So number one was shell programming and all the stuff that came around that. When I moved to Murray Hill, Steve Bourne decided he wanted to do a shell from scratch. And that was okay for me. It was okay. I mean, I was off doing other things by then. I was doing performance stuff and Unix system accounting and all that kind of stuff. But it had to be good enough that it would be useful and fast enough for all the people we already had doing shell programming. That's why there was a Bourne shell programming for Mashey shell programs. Okay. That's the point at which we invented the current environment variables, things it inherited, which, of course, are in almost every computer used now. So that was Steve and Dennis Ritchie and I. Ken was off at Berkeley for a year. That was the generalization of the stuff I had put in the shell. So that's probably number one.

Number two is the document stuff that we did that ... the MM macros became more or less the Bell Labs standard for a lot of stuff.

I would say the third one ... the whole articulation of the software engineering things that would have been called agile programming if I'd given a name to it. I mean, it was sort of funny. Kernighan and I wrote a paper for language design for reliable software. Where ... and this was all in Ada language time and we were arguing that that wasn't really the right thing. What you want to do is use software, get components, put them together, do the highest level you could, and that that was likely to produce more reliable software faster. And we got this weird set of referee reports. One of them said, yeah, this is great. Another one said we've heard it before. Another said, well, it's okay, but it doesn't fit this conference. What turned out ... people went to the conference and a whole lot of this was talked about. A bit later, somewhere from software practice and experience asked Brian if had an article. And he says, "Well, how about something like this?" We did that. And then, a bit later, they said, "Could you update that and give it to us as an article? We'd really like it." So articulating some of that methodology and approach and the tool-building stuff and not just for programmers to use, but for actually building things. That was pretty important. I think another thing is all the work we did to take Unix from being in a lab to being a general service thing for a broader community, was pretty important. And it was building the actual applications was good stuff too. Doing work to get Blit terminals and people to be more aware of bitmapped displays that ... and mice that this kind of human interface is what was going to be there.

Markoff: And that was in that ... there was an interface part of that group?

Mashey: Yes.

Markoff: Yeah.

Mashey: Yes. I had a couple cognitive psychologists. But, I mean, there was this one funny thing where Adele and I were on a panel together in 1983, in the Spring, and I did Programmer's Workbench stuff and she talked about Altos and stuff. And somebody from the audience said, "Well, Mashey, we understand what you're doing. That makes sense. But Adele, this stuff seems like science fiction." And I said, "Wait, let me defend her." I said, "Look, what you're seeing from me is stuff that's kind of like in production.

We're already down the cost curve and everything. She's doing research, but this is what everything is going to look like. Don't worry. Another turn of Moore's Law or two and you're going to see real products that are like this. Get used to it. That's how stuff is going to look."

Markoff: And from that period, sort of '77 to '83, what did Microsoft look ... did Microsoft show up on your radar at all?

Mashey: I think I had a DOS machine later in there somewhere, but I had an Apple 2.

Markoff: That's the first personal computer you had, was an Apple 2?

Mashey: Yeah.

Markoff: And it was a hobby machine, basically?

Mashey: Yeah. Just to see what it was.

Markoff: What did you think?

Mashey: Well, I mean, it was pretty crude, I mean, compared to what I was used to. But you could see potential was coming. And what I was waiting for was when are you going to get a bitmapped display and a mouse? Remember, I was used to having a bitmapped display and a mouse.

Markoff: Yeah. Why did you decide to leave?

Mashey: Well, here's what happens. I had ... so I was a fairly senior supervisor and I was sort of a special projects guy and a troubleshooter and, I mean, my director would say, hey, can you go look at this technology? So for instance, I looked at ... you mentioned Dave Ditzel, CRISP. My director said, "Can you take a look at this? Is this something that ought to be funded?" And my answer was I ... this is the right way to go. RISC [Reduced Instruction Set Computing] stuff in general is the right way to go. This turns out to be relevant later. And of course, then I left, but it got funded to do it. But with this Bell System breakup, things were just getting harder. It was like spending more time fighting with bureaucracy and we had gotten grabbed into the 3B2 stuff. I would go out to Indian Hill in Chicago and we'd spend whole hours signing forms for each other. The management style I was used to was let's set key milestones that are demonstrable things. Let's pick those carefully. I want one a month that demonstrates real functionality coming along. We can tell where, me, the department head, can tell whether or not it actually works at that point. And sometimes, the environment we were talking to in Chicago was first draft of spec reviewed would be the same as system boots. No. And anyway, it was like sand in the gears and I was just tired. So I needed a break and a couple of things came together. An old girlfriend had moved out here and she was waiting for a couple months to get into her house and she had a condo up on Nob Hill. And she was telling all of her friends, "While I'm here, come visit." So that's number one. Adele said, "Why don't you come out and visit?" Lawrence Livermore labs wanted me to give a Programmer's Workbench talk. And then, Zilog called up, and I was getting calls this time from recruiters who would say, "We hear you know

something about this U-N-I-X thing?" <laughs> Go away. I was kind of due up to be a department head. There was an obvious department head opening by the guy I'd worked for before, underneath him, and everybody knew this was where I was going to be. Sort of. Anyway. But the Zilog folks said, "Our VP had heard your talk and thinks there's a good job for you here." I went, "Well, I'm not really looking, but turns out I'm going to be out there in two weeks. So I'll come by."

Well ... so they were real interested. I said, "But look. I would have to look around for a while." And the thing was it was in June. It's June out here. I get back. I have a great week. It's a wonderful time. It's stimulating, it's fun. It's great weather. I get back to Newark airport, get off the plane, it's 90 degrees, 90 percent humidity, and I go <sighs> that's it. <laughs> I then do a quick look around at companies. I send resumes off to a couple companies, one of which was Convergent Technologies. Like a week or two later, I'm out here for interviews. Convergent makes me an offer and I think about it on the plane home. I decided I'm taking it. I come into work the next day and say, "I think I'm departing."

Markoff: Did that create waves?

Mashey: It did, but they also understood. And, I mean, it was sort of ... part of it was actually knowing the department ... a really nice fit department head job would have been in Unix development kind of stuff. It was if I took that, I'd kind of feel morally bound to stay there a while. And I somehow felt like, well, I'd always liked the idea of California and the Bell System breakup would not be fine, which it wasn't. So anyway, I looked around. When I was out here, I did some looking for houses. I wasn't that keen about a lot of places, but then, I ran across a place in Palo Alto and after gulping about the costs ... fortunately, I'd done okay on the house in New Providence right next to Murray Hill, so that was all right. And it was a stretch, but it was okay.

Markoff: What neighborhood in Palo Alto did you ...

Mashey: It was a Eichler house down in ... not far from Middlefield, the town in that corner, south. It's right there. I've always been a big Frank Lloyd Wright fan, so Eichlers were cool. Okay. So I got out here having actually taken a step down to be a member of technical staff at Convergent, but quickly became a supervisor and then, shortly after, a director that ran the whole software department for one of the divisions.

Markoff: So more than the CTOS operating system?

Mashey: Yeah. Well, it was in the data server side, which was a Unix-CTOS combination. It was Ben Wegbreit's division there. Where I ran into a fellow I'm sure you know, Steve Blank.

<laughter>

Markoff: I do know Steve Blank.

Mashey: You know Steve?

Markoff: Yes. I'd forgotten he was at Convergent. Yes.

Mashey: Yes, he was at Convergent. He was the VP of marketing in that or director of marketing or whatever. And of course, he discovered I was an engineer who could talk to people. So he used to drag me around to customers a lot and again, I ended up running the department, the software department. Okay. So Steve went off to a ... to help start another division and turned out not to make it. So he ended up leaving Convergent. But then, in a couple months, he was back and he was with the founders of MIPS. And basically, in typical Steve fashion, he wanted to see if what sounded like some good ideas would actually be of interest to people he trusted to be building systems. So that was fun. So remember I said a lot of my luck is ... I've been so lucky so many times to work with good people. So this is where I first ran into this folk, John Hennessey.

Markoff: So he would have ... was he still just a faculty member?

Mashey: He was still just a faculty member. He was now off on his sabbatical for a year to start MIPS with Skip Stritter and John Moussouris and Steve was just kind of helping them out. And so, they came in and they did a presentation basically of the Stanford MIPS stuff.

Then, they wanted to know what we thought and I said, well, I love RISC. I blessed it back with CRISP stuff with Ditzel. But I got to ask you a question. You had compiler people and chip people. Yes? Yes, yes. Okay, they did. You didn't have any operating system people, did you? And I said, well, no, but how did you know? I said because no OS person is ever asked for some of these things here. <laughs> Huh. I went through a list of things that really weren't there. When they said, oh, well, this is just like ... this isn't exactly what we're doing. We're doing a more commercial version. Why don't you come by and look at the real specs? Okay. So I ended up sort of being over there every Saturday looking at specs and commenting on them. And then, they were saying you're here a lot. Why don't you work here? No, no, no. I'm a director at Convergent. Well ... but meanwhile, there was a re-arrangement of management and everything and what was clear was this was the one chance you might get as a general systems software person to get hardware that's actually what you might want. That was the first thing. And the second thing, it was clear that they were putting together an absolutely terrific team of folks. And so, I ended up moving over there in January '85.

Markoff: So you were only at Convergent ...

Mashey: A year and a half.

Markoff: ...a year and a half. And what was ... where was Convergent in their trajectory? They ... were they still doing well?

Mashey: They were doing okay. They were doing okay. They didn't have the fantastic growth that they'd had earlier and the wheels were starting to come off a little bit. I mean, they were trying to do too many things, I think. But they were still doing okay. But ... I mean, it was sort of funny. The director of hardware and I ... a fellow named Grant Pierce was our controller at Convergent in that division and he was getting

recruited by MIPS to come over as the CFO. And so, Greg Hanson and I tried to scare him to death. I don't know. You want to go to a startup? Hey, they don't have any operating system people. I mean, look out. Well, when I showed up at <laughs> MIPS, he's there, Wait a minute, did you say ... you said there was no OS people. I would say, well, I'm here.

<laughter>

Mashey: But in that period, somewhere in there, I ... a fairly rare thing, which is actually very instructive, and this comes back to the being lucky to work with really good people. A lot of good people with Convergent. But of course, Hennessy is terrific. You know Hennessy. But here was the thing. I actually won an architecture argument with John. That's not easy. Because the whole point of what they were doing was very good quantitative analysis and design. All right. But the Stanford MIPS and the MIPS that they were working on were word-addressed machines, not byte-addressed machines, they had funky sort of byte manipulation things. And I said to John, "Why?" He says, "Saves a gate delay." "John, would you like to have software?" "Well, yeah." "Okay. Good. It's going to be byte-addressed." "Well ..." I said, "So John, here are a couple options. First off, we don't have half-word 16-bit things." "Oh, yeah. But we've done all these statistics." I say, "So did you look at the Unix kernel?" "Well, no." So then, what I did is I grabbed the Unix kernel for short, the 16-bit things, and there's, like, thousands of references." I said, "So why do you think that is, John? It's because the kernel packs stuff in a lot and there's a whole lot of these short integers around." "Okay." "And networking code has this everything." "Oh, yeah." "You won't see that in a user level typical code."

Markoff: So when they made that shift, what did that cost them, to do that?

Mashey: Very little, it turns out. But anyway. There were a couple other arguments and the usefulness of this is that there are sometimes real differences between what you see in academe and what you see in the real world. And the crucial thing is to combine the best of both. So I had a couple other things for him. I said, "So you wouldn't ever have seen this, because it was never published, but back at Bell Labs, our folks did C compilers for the UNIVAC 1100 series, which is 36-bit words with really weird byte pointers that cause string copy to be 200 instructions. That's bad. And they did it for the Xerox Sigma 5, which also has weird kind of pointers. And I know the people who did it and their lives were Hell." So that's the first thing.

The second thing is that when it comes to porting software, we're not a big company. Our ports to us have got to be easy. If something ports easily to a Sun and it breaks on us, they're just going to say go away. You can't afford that. And finally, devices that we have to run from the operating system often have packed data in device registers. There may be something with two bytes and a 16-bit thing and you have to be able to issue an instruction that writes to just one byte. It can't write to the word because it will have weird side effects. You can't even read from the word. There are things where reading causes side effects. And all I can say is there's ways around this. But if we have to rewrite every device handler the pain level is just very high. So it's like, you know, yes it may save a gate to delay somewhere but you don't want to do this. And he listens. John always listens. So it was a byte-addressed machine. Now, amazingly, the Digital [Equipment Corporation] Alpha [microprocessor] people made the mistake which

given the smart folks they had doing it I don't understand why they did it. They made the exact mistake later in a second version. They fixed it but it cost them no end of hassle. But, again, the message is it's really good to work with smart people who actually listen.

Markoff: What did you think of Moose, John Mousourris?

Mashey: Yes, Moose is an interesting guy. A little high strung here and there but very smart. And we certainly couldn't have done it without him. So...

Markoff: I forgot who were your first customers? Where did MIPS take off?

Mashey: Okay. Let's see. We were working with Prime Computers some. But the really key first customer was Silicon Graphics. So this is pretty incestuous because who was the CTO at Silicon Graphics? Forrest Basket. Now, did Forrest know John? Yes. Who was the lead venture capitalist for both companies? Mayfield. If Mayfield needed to know whether we were a good idea they would call Forrest. Okay. There were people at SGI who had worked for me. So they were an early customer and it was a sort of three-way OEM deal between them providing workstations to Prime and stuff like that. The regional IRIX port to MIPS was something where SGI lent me a couple of operating system people and we did a joint port between MIPS and SGI and then we split it because they had their own weird stuff that was in there.

Markoff: Did SGI start with another microprocessor before that?

Mashey: The 68000.

Markoff: Oh, they started with the 68000, too. So it was a very similar track.

Mashey: Well, you know, MIPS started on Charleston right near...

Markoff: Oh, I didn't know that.

Mashey: We were, yeah. So it was pretty easy.

Markoff: At some point you moved to Sunnyvale, right?

Mashey: Yeah, we moved to Sunnyvale. But we started it Charleston so we were right there. And, you know, the number of connections and everything was pretty easy.

Markoff: So when you came in did you build the OS?

Mashey: Yeah, and I put together the operating. Basically, Larry Weber ran compilers in the computer center. I ran operating systems networking and software QA and release control.

Markoff: This is MIPS now still?

Mashey: MIPS. And I got a really excellent collection of systems programmers and good QA folks and it was a really good team. But it was completely insane, of course, what we were trying to do is we were trying, in the space of the year, to do a new architecture, hyper optimizing compilers that had come from Fred Chow at Stanford who worked for Hennessy. And UNIX wasn't necessarily used to really good optimizing compilers. There was one point where if you optimized the UNIX kernel it crashed. And if you didn't turn the aggressive optimization on, it worked. So we had to do binary search where you optimized half the kernel. That was pretty exciting. And we were trying to do a new chip and a new system in a year and that's completely insane. But we did it. So what I ended up doing is I got there. I started hiring folks up. I got some very good systems programmers, one of whom Steve Jobs stole from me. Mike Damone . He did a lot of work on NeXTSTEP.

Markoff: So this is before Apple.

Mashey: This is at NeXT. So I did a lot of the work designing the memory management unit, the exception handling, all the stuff that the operating system folks worry about. A lot of the user level instruction set was already pretty well there in the fall of '84.

Markoff: And besides the workstation world MIPS made some inroads into consumer electronics didn't they fairly early?

Mashey: That's later. There were things about what we did that I insisted on explicitly to allow for embedded control stuff, laser printers and other stuff. I knew over the long-term that's where a lot of volume would be. Anyway, now we're in 1985. We're crunching along like maniacs. We're getting together the tools to be able to do UNIX ports to this thing, getting the memory management, exception handling, and so forth designed. Very technical sell so I'd be involved in talking to potential customers. We were trying to get them to but on a startup. So there we are crunching along in '85 and at the end of that year we actually tape out the chip. And the very first chips exist by Christmas of '85. Okay. So now we get to debug this stuff. And that was really exciting. There's nothing more exciting than debugging new compilers and new chips and new chip architecture and new systems all at the same time. And a lot of that falls on the operating system people. The whole thing was planned, project planned because I was the last guy on the chain trying to whip everybody else into shape was hard work. I brought in my 128K Mac with Mac Project and hassled everybody into using it. That's how you got project planned. Okay. Well, we finally had systems kind of working like in the early summer of '86. We had a sort of demo day and I was somewhat terrified to see we had a sort of rotating thing just up on the screen. And Bill Joy comes up does control-z the type, type, type. Oh, no. but it was okay. Okay. Anyway, come the fall we're now starting to ship systems M500s, five MIPS machines.

Markoff: So Sun hadn't built SPARC yet?

Mashey: No.

Markoff: Were they still a potential customer?

Mashey: Not really. We knew they were building SPARC. That was coming. Let's see. Okay. Our CEO...

Markoff: Who was your CEO? I should know this.

Mashey: I keep forgetting his name. Anyway, he decided that when he could see that we were starting to ship some stuff boy, you know, things are really going okay. And he ended up taking a lease on our second building. We were down in Sunnyvale by that time. And staffing up more. Some of us are really nervous. Like, wait a minute, these are development systems for people to see. We don't know what they're going to do. MIPS had a complicated model. There weren't foundries at that point. We had to do partnerships with people, a couple of small semi[conductor] companies. So it was complicated. And some of us were like, wait a minute, wait a minute, slow down. Well, okay. So we quickly ran into financial trouble. Actually, Hennessey led the effort to get rid of that CEO and find another one. And the reason why is, I think, the bottom line was that after talking to a bunch of people he basically told the VCs, "You know one of the best technical teams in the valley is about to explode if we don't replace this guy." He was right. So let's see. They looked around and they got Bob Miller in.

Markoff: Bob Miller. That's right.

Mashey: He was good.

Markoff: Had he already been a supercomputer guy or did he become a supercomputer guy?

Mashey: No, he was an IBM workstation kind of guy. All right. So MIPS kept cranking along and we were often bigger than life. For a tiny company we actually got more press and visibility than you would expect. But we had lots of good stuff. We did a whole series of chips. Here were chips, a series of chips. We did the first 64-bit microprocessors. I ended up shifting out of line management into a ... I was VP of systems technology, which was a troubleshooter kind of stuff. I was an evangelist. I was heavily involved in the performance marketing.

Markoff: Which took you into the RISC/CISC [Complex Instruction Set Computer] course.

Mashey: Well, I was heavily in that. I was really in there a whole bunch. I kind of got it started, the deal that made our IPO, and here was the thing from the IPO. You've got have lots of these around. Okay. I ran around with the things to show the customers this is what's in these things. Here's what's in these things. I helped get the spec benchmarking group started because I had this hatred of Dhrystone MIPS. Do you happen to know Stan Baker? He used to run ... he was the editor of EE Times.

Markoff: Yeah, I would run into him.

Mashey: Okay. Well, I was involved in a lot of performance analysis and competitive analysis stuff. And the people who did that kind of all knew each other across companies. And we would trade our performance documents or sometimes we'd say, "These are the best numbers I've got for you. I don't want to quote worse than you've got. If you've got better tell me." It was competitive but cooperative. Well,

Stan wrote this editorial where he used Dhrystone MIPS and I dumped on him and I think somebody else did, too. And his answer was, "Well, give me something better. I'll offer my bar in Campbell as a neutral ground."

So we got HP, Apollo, Sun, and MIPS. And we went over there and then we all agreed we hated Dhrystone. We hated VAX MIPS, all the junk. And we all used often some of the same programs as real benchmarks but we used different inputs so you couldn't compare them. And we all did a lot of wasted work. So we started SPEC. I was heavily involved in that and that was SPEC. That led to weird things like at one point ... let's see, I wrote this document called a "SPEC Data Helps Normalize Vendor MIPS Ratings for Sensible Comparisons" or "Your Mileage May Vary But If Your Car Were A Computer It Would Vary More." Because the idea of a MIPS rating varied by a factor of two. Well, this fell into the hands of ... because it got published in put around Bill Bulkeley at the Wall Street Journal. Did you know Bill?

Markoff: One of my competitors.

Mashey: Yeah, okay. But he called me up and did an interview and he wrote a great article. So it's me as the VP of MIPS but talking about SPEC and why we were doing this. How we were trying to get realistic benchmarks so we could compete on that, not on junk because that would be better for our customers. And he did a great article and it came out and it was on the top left corner of the second section. I was ecstatic. He had gotten it right because I don't want to be bad on journalists but they don't always get it right, with all due respect to the good journalist sitting here. Okay. So I'm happy until I called up and got my voicemail. First message on my phone is from the CEO saying, "Mashey, what are you doing? Our stock is down 15 percent and all of the analysts are calling me asking what's wrong." I'm like what? What? Okay. And the next voicemail is from the CFO, "Mashey, what are you doing? We're down 50 percent. The analysts are all over us." What? What? What? Well, the problem is that this is getting rid of MIPS rating in favor a SPEC ratings.

Whoever puts the headline on says "MIPS Down in Benchmark Rankings." They see in bold the John Mashey MIPS, VP of MIPS. They see "MIPS Down in Benchmark Rankings." Sell. Then they call up and ask what's wrong. <laughs> Well, it was a little weird. And after a few days it all came back up but it was pretty exciting. If I hadn't already believed the stock market is crazy I would've believed it by then. But getting to the IPO was one of these weird things, again. It was this thing about just being lucky where your contributions actually depend on happening to be lucky and who you work with. Okay. The deal that made the MIPS IPO was the deal with Digital Equipment [Corporation]. How did the deal happen? Well, I was over at a UNIX tradeshow in early 1988 and I ran into an old buddy from Bell Labs who happened to work at Digital Equipment, New Hampshire. And I gave them one of the performance documents like that. We were talking he said, "Oh, this looks pretty fast." And then he went off and read it okay. And then when I saw him at the beer bust that night. He says, "Yeah, this machine looks pretty fast," because it was actually faster than anything DEC had at that point.

Mashey: Was the Alpha underway at that point?

Markoff: No, no. This is years before that. So he says, "You know, what do you think it would take to put ULTRIX on this?". I go well, our compilers are big-endian. We do both big ... little and big-endian. And we have all of the boot prompt coded and everything else. I don't think it'd be that hard. He says, "I want to do it. I want to do it and show Ken Olsen it doesn't take 300 people in 3 years." I said, give me your card. And I then go to our Boston sales guy and say well, you know, the chances of getting DEC to use an outside CPU are low. But it's a huge win if we can get it to happen. So it took a couple of months to get the lawyers to do the right thing at DEC. And we lent them two machines, one is the development support machine and one is a target machine. And he and two other guys in about two-and-a-half weeks got ULTRIX.

Well, out here, you probably know Joe DiNucci, yes, of course. So Joe was running the work system stuff from Palo Alto DEC workshop. And they were getting killed by Sun any time people didn't require VMS. If it was UNIX they lost. Because they had MicroVAX's versus by this time SPARC stuff. Well, folks out here got wind of this port that had gone on because they had a full ULTRIX up and everything. And they were running benchmarks. And they were looking good. So they went in a mad frenzy out here. Look, give us a good CPU. We can do this. We can make great workstations. We can beat Sun. So at one point this just stirred up a lot of action. And Joe describes a meeting where he went in to talk to Olsen and the high level team, where Olsen said, "You know, sometimes we at DEC don't recognize jewels from the outside but we probably should." Joe took that as good.

So after hearing this stuff Olsen gathered together a bunch of the DEC fellows and said, "You'll go out to MIPS, go out there Thursday and do due diligence on these guys and see whether this makes any sense." And I have to give them credit, they did a good job. Here was the funny thing, what they did is they sent chip guys, compiler guys, operating system guys and hardware systems folks. The chip folks had all kinds of questions. And the answers were, gee, we had folks who had done this a lot of times from Intel and other places. And, you know, sometimes the DEC guys couldn't believe how fast we moved on this stuff. These designers are like animals. They just go at it. Okay.

Well, the compiler folks knew the MIPS compilers and had a lot of respect for them because they were very good. The hardware system guys had lots of questions but we were used to making chips that could go into different kinds of systems. Sometimes the DEC chips were geared for like a couple of kinds of systems. So they had no problem. And the operating system folks who would've been like it's going to take us years to do it, well, ULTRIX was already running. It was already there. It was already being benchmarked. All libraries worked, all that stuff. I think it was only one OS guy. Now, I knew something was going to happen, though, because we took them to lunchtime or afterwards we took them around to show them our server farm that we used for simulations and I heard one of their engineers talk to Bob Supnik Do you know Bob? He ran a bunch of the Alpha stuff. He said to Bob, he says, "I can't believe it. This little startup has more compute power than we do in the VAX group for doing our simulations. How could this be." And Supnik says in a voice like frozen air, "Yeah, that's why we've got a problem. We're going to have to do something about it." Okay. And, of course, Alpha, I said sooner or later, something bad is going to happen. But it ended up they wrote a perfectly honest report that said, "Look, we can build chips as good as these guys. But it would take us years to do our own thing in software and this stuff

already works. So go ahead.” And so we did the deal with them. And that included – course, that's what brought in NEC and Toshiba as semiconductor partners. And it's what made us get public.

Markoff: So it drove the IPO ... which happened when?

Mashey: Yes. That was 1989.

Markoff: What was the personal impact of an IPO on you? It was your first IPO. Was it a big deal?

Mashey: Yes. Well, yes, that's why we live in Portola Valley. <laughs> Let's see. Yeah, it was the first one and I was an officer of the company at that point. And I actually was one of the few people they let talk to financial analysts. So, you know, it was interesting. So there were later things. This was funny because I was involved in a bunch of deals. I helped start the ACE initiative with Microsoft.

Markoff: Oh yeah, now ACE was ... what was the ACE Consortium?

Mashey: It was the ACE consortium. Well, it was us and actually DEC but Microsoft, Compaq was the crucial thing. The Microsoft guys approached me at one of the conferences. And they wanted to understand our model with semiconductors and stuff because, of course, both Microsoft and Intel always wanted to be the only link in the chain. So they wanted every other step to have multiple sources or customers.

Markoff: Right. So ACE was their attack on the Intel ecosystem. But it involved bringing NT to MIPS.

Mashey: Yes. And part of that was it was this odd thing Dave Cutler ..., Do you know Dave?

Markoff: Well, yeah. And my friend Greg Zachary wrote the book on NT, which is largely about Cutler.

Mashey: Yes, okay. Well, here was the funny thing. I don't know if you know this one ... Cutler, of course, had been messing around with RISC for awhile, as had other parts of DEC. Okay. And Cutler thought that going with MIPS, of course, until it happened. And then he actually was going to leave DEC and do his own startup that would have used MIPS. But Microsoft got them over and they were doing i860s for a while. Right? And there were issues in doing i860s for a general-purpose thing. Okay. So Cutler was quite happy to do a MIPS thing instead. And I'm still on some videos for Microsoft. And I have to give Microsoft credit they stick with it a lot longer than I expected because the thing they said is we need to have somebody like Compaq ... like we need Compaq. Compaq was in this all the way except then they had a management change and they killed it. And then I knew it was doomed. So in 1990 ... let me back up a little bit because we have to pick up a couple of the other goodies here. So I was certainly a UNIX guy for a long time and I did things like I was on the editorial board of this magazine for a long time with a lot of interesting folks.

Markoff: It's called UNIX Review.

Mashey: Yeah, UNIX Review. Let me see. Well, Bill Joy was in there for a while. Ted Dolotta who had been my boss. A big later Greg Chesson. Did you ever know Greg? And who is this guy? He was a software developer guy named you Reed Hastings. We used to have a meeting once a month at Chantilly's in Palo Alto, which was a very pleasant thing to do. And it was a great crew. But I was program chair of Usenix. I did that. I got involved in the Hot Chips conferences. Forrest Basket got me over into that while I was still at MIPS. And I was involved with them for like 25 years. Actually, one of the first ones I program co-chaired, that's where I first got hooked up with Dave Patterson. So that was going on.

And I sometimes would give talks. And one of the talks I developed was the one to talk about the ages of UNIX. I think I did it first around '86. But in '87 I gave it down in New Zealand. And here was the idea of this talk. There were five ages in UNIX. I've got four of them here. First, is it was the age of wizards. Back at Bell Labs it was wizards. And you didn't really want ... it was a dangerous thing for a random user. But then we knocked off the rough edges and we got it all over the place in the Bell System. So Bell System ... lots of operations support systems got UNIX in them. This is the one I missing was a mortar board. We spread it around the universities. And after that starting in the early eighties it got into business. So that's the early eighties. Now, whereto from here? Well, hard to say. But I think it's got a long future ahead of it. So, anyway, that was the talk. I did that one a couple of times. It turned out these were useful.

Markoff: That's "layers of longevity" or is that a different talk?

Mashey: No, that's a different talk. This was like the five ages of UNIX. Just with the observation that from something that was like a wacko, little research toy kind of thing. It's already gotten pretty substantial. It's in the workstation business. It's servers. It's getting more commercial and yes. I had no idea of that but it's okay. Now, we made a big bet on ACE but things didn't really pan out as well as they could. It worked but not having the big PC company doing it made it hard. And then it was a struggle getting the R4000 chip out which was the first 64-bit thing. It took a little longer. We had a bad sideshow into bipolar logic chips, which were just too expensive. R6000s they worked. They were at one point the fastest thing there was. But it was exciting. I mean we were using an unusual fabrication technology where sometimes it would be zero yield some months. You have \$100,000 machine waiting for one chip and none of them come.

Markoff: Did the supercomputer industry take some of that?

Mashey: Not yet. This was still big server stuff. All right. Now, we worked closely with Silicon Graphics. They were starting to build ... in the eighties they were building multi-processers out of them. I worked with them on getting the right features in for that stuff. So in 1992 they bought us, which was okay. That was a good merger.

Markoff: Clark and McChesson or whatever. I'm trying to think of who was management at that point when they ... Clark was still there, wasn't he?.

Mashey: Clark was still there. Yeah. How can I forget his name? It will come back. Let's see, Clark left shortly thereafter. Anyway, that was a pretty easy one. And it was an easy move. I'll tell you my interview

to go to SGI. Forrest calls me up and says, "Hey, Mash, we're trying to decide where you should be here. Why don't you come here, do what you do now, report to me and we'll pay you more." Okay. <laughs> So I was in Forrest's little brain trust group which basically meant doing what you wanted to do. And it meant troubleshooting something, you would get asked to do something. A lot of it you run around ... I would have my fingers in chip designs, supercomputer design, the software strategy, and spent a lot of time with customers. I spent probably 50 percent of my time with customers.

Markoff: And what year did you go to... [SGI]

Mashey: Ninety-two. Now, you know, there were odd little side things about that time, like I used to work with some of the chip companies, our chip partners. So Silicon Graphics shipped the first system with the 64-bit R4000 in 1992. I'd been very heavily involved in the 64-bit stuff, actually writing the justification for the C language specification for how you did it. I wrote most of that. I had been pushing hard that we do this in time when you could actually ... when you needed more than 32 bits to address the memory could easily buy. And that was the most predictable thing ... the most predictable trend in computing was when DRAMs would get there. Anyway, one of the chip companies grabbed me to come talk to some networking company and I sort of convinced them that using MIPS chips, particularly 64-bit, would give them a lot of runway. And then I came away from the meeting saying well, I'm not sure it's going to win then networking wars but this Cisco company seems to have smart guys. And, of course, for a decade or so they used essentially MIPS chips. So that was pretty cool. Okay. Now I'm at SGI. Well, Joe DiNucci and I went over there. And Joe was asked to make up his own job because they already had a VP of sales. Joe is a terrific sales manager. He says, "I want to do cars." Okay. Ed McCracken is who...

Markoff: Ed McCracken.

Mashey: So Ed says, "What do you mean?" He says, "You know, SGI has all this great technology but you're not in the car business. You should be in the car business. Or you should be helping the car guys." So he was basically, "Go ahead and do it." And he ended up doing it so well that he had a whole manufacturing line business kind of stuff. But we're getting ready to come over here. And the sales team had asked us both to come and introduce ourselves to the sales meeting. Well, that was an experience. Right? And we had both prepared a couple of slides with what items to say and who we were. So we go to SGI sales meeting and it's like a different universe. So it starts by here's a big video on the screen of what looks like Arnold Schwarzenegger as "Terminator" riding his motorcycle to a hotel. And then the door opens in the back and he rides his motorcycle up to the stage. And then the screens light up with an asteroid coming at us as it turns it says, "Sun" and it blows up. And he says, "I want you to terminate Sun." And then another one comes and it's HP and it blows up. "I want you to terminate HP. And if you don't I'll be back." And then he gets on his motorcycle and he goes out. Okay. Well, Joe, loves flare and stuff. He's looking at all of this graphics technology and just drooling. And we're looking and he starts saying, "We've got slides with bullet items. Oh, good. This is going to really fly for this audience." <laughs> And then there's more stuff like that. All right. So the hats came back. I said for this kind of audience I've got to do something more than slides with bullet items. And so I said, you know, if you need somebody to talk to starry-eyed researchers I can do that. But I've been in business, too. I've done telecom stuff. So I can maybe help you out.

Anyway, we end up surviving but it was pretty scary because the whole thing was pretty crazy. Anyway, so I was over in Forrest's group. And, again, SGI had very technical customers. They may have loved their local salesperson but they wanted to see a chief scientist, chief engineer kind of person. So I started putting talks together and by '93 I was doing...

Markoff: You became part of the sales process.

Mashey: Yes. So by the mid-nineties I was flying around, which led to a heart attack partly, I was probably out of the country 30 or 40 percent of the time. That's a lot. And I would schedule the trips really well but it was a lot of flying around. And when I was at home I would be involved in the software strategy and helping out on chip designs and specs.

Markoff: Had you met Angela by this time?

Mashey: Okay, oh I should've gone back to that. That's a whole side path. I met Angela Hey, my wife, in January 1984 in the geekiest possible way. I was already out here. She was going back-and-forth doing a joint venture between AT&T and Digital Research. She had been at Bell Labs and then shifted to a piece of AT&T. They were doing a UNIX System V library so it was a software acquisition and publishing kind of thing. And an old girlfriend of mine who was a friend of hers introduced us at a UNIX tradeshow. And she was, as she say, "The Booth Babe." <laughs> Not really, okay, but yes, okay. And I said well, you should look me up if you're going to be out. And eventually she did. And, of course, there ends up being another weird story about that is she's very independent and flies around and has done stuff like begging a ride on the back of an Israeli army truck to go up to the Golan Heights, okay. Like leading expeditions to Nigeria to count termites. All kinds of crazy stuff. So it wasn't going to be easy to get her to marry me. I finally asked her in 1990. She then went off and did a spreadsheet of pros and cons. She did due diligence. She asked my father. She asked old girlfriends. So a pretty classic Silicon Valley geek type. Now, Nick Tredennick, did you ever Nick?

Markoff: I know Nick.

Mashey: So Nick called me up a few years afterwards saying, "You know, there's a story around the valley that you asked your wife to marry you via email." And I said Nick, no way. He says, "Yet, but it's such a good story I'm going to give you an award at Microprocessor Forum." Well, he did. Well, he also gave me an award for being the marketing department at MIPS which was unfair. I did do a lot of posting on USENET. So anyway he gave me this award and I said, Nick, you know that's not true. What I didn't say was it is true she said yes by email. The problem was after she did all of her due diligence, she had to tell me right then and I had a terminal at home and she could never get through on the phone. So she sent email.

Markoff: What a great story. Now, when you guys actually got married, who was she working for?

Mashey: Let me see. She was at General Magic shortly thereafter.

Markoff: Yes, I think that's when I met Angela.

Mashey: Yeah, but I think it was just after that she started at General Magic.

Markoff: Have you seen the movie?

Mashey: Yes. Well, we're going to see it next week. Anyway, what I would usually have is I would have a general-purpose talk and then really detailed technical talks, depending on what people wanted. I broke all of the rules of marketing of three bullet points per slide and everything. The marketing folks would always hassle me and I would say yes except that my slide sets are the ones they always ask for the most. But I have one set of talks, which ended up on a University Video [lecture, produced by] Karen Tucker. So this was a popular one. Hardware, wetware, and software. And the idea was there were hardware trends. There were no trends and use wetware we're the same. So software has got to make up the difference. And so this started ... I started using this in 1993. And as far as I know here is the first big data.

Markoff: Oh, yes. Steve Lohr gives you credit in the New York Times for being the first.

Mashey: Yes. So this was the theme that I was trying to get in there. It did actually become a standard SGI marketing theme. What do we have here? We have big compute, big visualization and big data. And the idea here was we had 64-bit everything early. We had a great 64-bit UNIX file system called XFS. We had already big multi-processors that were going to get much bigger. We had a very high I/O rates because of the graphics. But there were customers that didn't need graphics and didn't need gigaflops worth of computing. They needed to manage lots of data. And I kept telling people there's a lot of customers out there that could do data mining and data management and stuff. And I finally got that to be a theme at SGI. This is something we should do. And I gave talks. There were a bunch of big data talks and everything. So when Steve Lohr came along in 2012 he said, "Some other people think they invented it about 2001 but some people think you were there earlier." Yes, okay. So that's how that article happened.

Markoff: That's great. Did Steve Blank not pass-through SGI?

Mashey: Not exactly.

Markoff: What was the connection?

Mashey: Steve, of course, was a serial entrepreneur, multiple times. But Epiphany was connected to SGI because it actually was some software that started at SGI that was not in SGI's main direction. It was sort of internal tools that they turned into a lot of money.

Markoff: Did you keep your same hat at SGI? Or did you move around?

Mashey: I'm not sure what that means.

Markoff: Did you take other positions?

Mashey: Well, my label kept getting changed from the director of systems technology to chief scientist to VP and chief scientist. I worked for Forrest until he left to go to NEA. SGI went through management gyrations. We bought Cray Research, which was not a good idea. I had a heart attack in '95. And I had an angioplasty. And then a quad[ruple] bypass in '98. And that actually led to a funny thing, which was let's see this is my license plate. And I decided I needed a new car for that...

Markoff: By the way, for the transcript it [the license plate] says UNIX.

Mashey: Yes, it says UNIX. And the deal was my old boss Ted Dolotta had been working at Interactive Systems in Santa Monica, which was the first commercial UNIX licensee. And part of the way that he got to be there was the guy who owns the license plate said, "Ted, if you move here you can have the license plate." He was moving back to New Jersey. So he put it up for a very limited edition auction amongst old UNIX folks. And with the deal that the money would go to Usenix as a memorial scholarship for the Australian computer scientist John Lions. John had written the ... John was sort of a key person getting UNIX into Australia. He had written the Lions books, which annotated UNIX, [and] which AT&T lawyers hated but which we used inside Bell Labs anyway. I knew John. He was a scholar and a gentleman. He replaced the ... I had a set of these books that got lost somehow. He replaced them, and they actually are in the Museum here now. Okay. So I had a quad bypass. Ted figured I'd be on drugs and I'd been up enough. I finished being on the drugs. I bid 6,000 dollars [for the license plate] finally. Okay, all right. But it was at least a charity write off. So that was good.

Markoff: That's good. Great thing to have.

Mashey: So anyway ...

Markoff: And so did you stay through your heart issues? Did you ...

Mashey: Oh, yeah, yeah, I was still there. I was still there a couple years, okay, right? So I was involved, heavily involved in designing what I call the Origin 3000, or Altix machines. Origin 3000s have MIPS chips. Altix had Itaniums, okay, right? And I drove the architectural concept where these things were built of bricks, with cabled interconnects and the idea that the CPUs could change at different rates than the I/O systems, than the discs and so forth. What I didn't want to have was like the earlier Origins. A lot of that was locked together.

Markoff: So was that the architecture of modern data centers?

Mashey: Oh, yes! The NUMAflex architecture, that, persisted, in fact, it still persists, it's now merged into the HP Superdome stuff, but it's still some of the same stuff. So it's lasted 20 years, which is pretty amazing, I used to carry around in reminiscence of the little old lady with the nanosecond, I used to carry the cable around. One of the interconnect cables, okay, to explain to the sales force what was going on. Why was this stuff not looking like backplanes like they were used to? And that this was a good thing

and they should like it. Now there were also, of course, lots of chips that went in these things. And these were Origin 3000 chips.

Markoff: Those are MIPS?.

Mashey: Well, there's the MIPS chips, but then there's the ASICs that do the interconnect stuff, okay. But again, it was a lot of work, which is why a lot of advocacy on our part, which is why I'm one of the few people on the base patent for the whole architecture. All right?

Markoff: So of your ... I just noticed you have a patent library.

Mashey: Yes.

Markoff: Rank them. What are your most important ...

Mashey: Well, that was probably the most important, The other ones are nice and a lot of fun from NVidia, and later. But this is the base patent, an approach for an architecture that's lasted 20 years, and is multi-billions of dollars, okay, right? So I felt pretty good about that.

Markoff: Did you actually go into NVidia?

Mashey: No, I consulted there, later. We'll get there.

Markoff: Okay, yeah, okay.

Mashey: Okay, but now here was the thing. This was a rethink of how you do stuff. And the whole point was to have more flexibility in how systems were put together. Be able to make anything from small to big. Or small to huge, okay. And of course, I was in the middle of having bought Cray Research. And these were a constant battle. Not just with Cray, but internally. Okay. There's this thing called the Top 500 list of computing. Technical computing. Okay, salespeople or engineers would come in and say, "Well, if we only did this, we could be in the Top 10!" I'd say, "And we could sell the system to Los Alamos," and I'd go, "Okay, how many will you sell?" "Well, one or two." Okay, I'd say, "I know you're going to hate this, but I don't care if we've got any in the Top 10. I just want to have 300 of the Top 500, " And we were close to doing that. Okay, right? Okay.

Markoff: This is with Cray.

Mashey: This was coming up the ... we had bought Cray Research, but ...

Markoff: Up the food chain. You were the heart and soul helping this.

Mashey: We were coming up from below, just like the right way to do things, okay, right?

Markoff: Yeah, right.

Mashey: Okay, so people would want to organize things differently that would add cost to every system. And I'd say, "Stop! I'm not doing that, It's okay if it costs a bit more to do this really high-end thousand processor thing, but I want the four processor thing to still be something useful." I usually won those battles. But anyway, I had to explain this to everybody. I ended up doing models of these things out of Tinker Toys. Okay, all right? Okay, so this was a kit that DiNucci put together and had sent out to all the sales offices.

But what happened is that I made one set of the Tinker Toys to explain how these things hooked together, and Ed McCracken had a horizontal whiteboard outside of his office. And we'd put the Tinker Toys there, and after a while, he learned how to use them to explain to people. So that's why his picture's on the back.

Markoff: Oh, that's great!

Mashey: So DiNucci then said, "We need to send these to the systems engineers and the sales offices," and they did!

Markoff: And you must have spent a lot ... what was the big tech meeting? Supercomputing, wasn't it? You must have spent a lot of time at Supercomputing during that era?

Mashey: Oh, yeah, sure. Sure that big data thing was a supercomputing thing. Okay, but I used to go to Supercomputer meetings. And I'd talk to supercomputer guys. I used to go to NSA, you know.

Markoff: And did you go to Salishan? Do you remember the Salishan [Conferences] ... ?

Mashey: No.

Markoff: That was a traditional ...

Mashey: No, but I flew around the world, you know, I was in oil and gas companies all over the place. I was with the climate modeling folks. I went to three letter agencies of various kinds. You know, all over the place, right? And you got ... I used to have huge bags of foils. Even when there were laptops. Now, and there were two reasons for this. One was that if somebody asked a question, you could grab a foil out and go, "Here," The other one is when the sales people would bug me, I'd say, "You obviously don't talk everywhere I do," and they'd go, "What do you mean?" And I'd say, "You don't take a laptop into the National Security Agency," because you didn't, right? I mean, there were a lot of weird things that happened when you'd get into that. I mean, we'd have meetings with ... we'd be told, "Well, there'll be some people here from various agencies," they may not describe." "Okay, or gotcha." Or GCHQ, which is the British NSA, well, they were in one time, we'd usually have a monitor up that said who was there. That time, it just said, "Her Majesty's Government." Okay, all right? Another time, you remember when Linux

couldn't be put on hardware and shipped out of the U.S. because it was munitions, because of crypto-code?

Markoff: Yep, yep.

Mashey: Okay, so I was down at the Defense Signals Directorate in Canberra, Australia. And they knew me from past times. And they were hassling me, because we had to ship Linux hardware ... our Linux, but I had fought very hard to get Linux in as a separate product line, Because it fit some things that our stuff didn't. Anyway, they said, "Why do you have to ship the hardware to your office here, then they mess around and put Linux on it and ship it over." I said, "Well, okay, the U.S. government thinks that we should ship crypto-code to places like you!" Okay, right, Okay, well, they had a laugh; I had a laugh. They knew that I knew they trade code with the NSA all the time. Okay, right? <laughs> I said, "You know, particularly a place like here could be really dangerous." Okay, right?

Markoff: Now, traveling in that world, one of my favorite sort of not well-told stories is the so-called Cray Instruction that was put in for some kind of string search thing. Did you get into those kind of instruction sets?

Mashey: Yeah, there was a guy with a cane at NSA that used to beat on me. You know, or I'd really want to ... the population count is to ...

Markoff: The Popcount.

Mashey: Popcount. Yeah, right, yeah. And I understand why they wanted everything. And I think, you know, there were some scenarios where we might have done it, okay. But about the time we would have done it is when we stopped doing really new processors. Okay, so to sort of finish that up. There was, let's see, you know, so SGI went through some messy management changes. Again, buying Cray Research was a bad mistake. It turned out it was some of the due diligence that needed to happen, didn't happen. We tried very hard to make it work, I flew to Egan, Minnesota, pretty often. I drove over to Chippewa Falls. Some parts just weren't digestible. And the sad this is it pulled us away from where we needed to be. Now in particular, do you remember the Nintendo N-64?

Markoff: I do!

Mashey: Yes, now that was very cool, right? Let's see, you know, the deal was they were in deep trouble, they did a deal with SGI to do a couple things. We did a cut-down version of the R4000 with a 32-bit bus for lower cost. That was the first thing. We did a single chip graphics, unit graphics and image thing. And that was interesting because it was staffed partly by volume chip kind of folks and partly by people who'd been doing the [SGI] Reality Engine stuff. Okay, so they'd just come off a project where I won't say cost is no object, but it's like, you know, lots of boards, sing and dance, run multiple displays the whole bit. And now they get, "You got one chip, do the best you can." And the best was pretty good, right? Okay, and the wonderful deal was Andy Keen and Dave Corbin, you remember them? Good MIPS chip guys. Okay, and Andy comes up later at NVidia, right?

Okay, so they negotiated a deal that went like this. We got royalty ... we got non-recurring engineering money for doing the versions of stuff. We got royalties on the chips, and we got a cut on every game cartridge shipped. <laughs> Hundred percent gross margin. Wonderful stuff! Okay, all right? Now here's the unfortunate thing. A bunch of us after that wanted to do a non-proprietary chip for the PC market. SGI had sort of tried that before, but too early. Because they'd done a board beforehand, it just didn't sell, because you had to adapt every application to it. And it was on DOS, you know, early Windows. It wasn't Windows NT. Okay, but with Windows NT coming out there, it looked like you could actually ... and OpenGL was now in pretty good shape. It looked like the time was ripe to start having a commodity graphics units. And we just couldn't get people to buy ... it was like, "Why do we want to compete with ourselves?" Have you heard that one before? Yes, okay, right? That's too bad. Okay, well, with one thing or another, gee, in fact a bunch of the people in SGI graphics people end up at Nvidia. And later, when I was consulting over there for Andy and then some other folks, okay, that's what led to the patents, the batch of patents.

Markoff: Andy?

Mashey: Andy Keen.

Markoff: Oh, yeah, I see. He went over ... yeah.

Mashey: I mean, I'd be sitting in the cafeteria working and it'd be one person up there going, "What are you doing here?" that I hadn't seen for years. You know? Okay. But it's too bad, because there could have been a division of SGI that was Nvidia. Okay, so anyway, so '98 was a quad bypass. And I had already slowed down and tried to cut back on the amount of flying around and everything, right? But, and I really wanted to get the Origin 3000 stuff done. And I wanted to see it ship. But in 2000, my cardiologist said, "Well, I don't know what you're doing, but if you keep doing it, we'll see you in here for another quad bypass in three or four years. But if you'll stop being stupid, we won't." So I told Bob Bishop, who was the CEO at that time, "I think, you know, time for me to wind down." He said, "Well, if you're not going anywhere in particular, why don't you stick around part-time, debrief people, do some stuff ... you know, we'll keep your health insurance and everything." And so I did that for about six months, and then January, 2001, I was out, okay.

Markoff: And you did a brief turn as a venture capitalist.

Mashey: Well, yeah, we tried a little thing that would be a little sort of venture startup kind of software thing. But it never got funded, and you know, it didn't really go anywhere. So mostly what I did then for the next half a dozen years, was do due diligence for venture capitalist, especially Warburg Pincus, with NEA, and a bunch of other folks. Or help startups get going. So I helped a couple wireless sensor network folks, okay, Chris Pister, you know him at Berkeley? Does networks and straight line networks was just an offshoot of that, okay, right? And then after that, I still kept my hand in it. Like I did ... I revisited the SPEC stuff. And I sort of discovered some better statistics. Okay. That was they were compatible with what we did. But we hadn't ... we'd done the right thing, but we didn't think deeper enough about it. Okay, right? And that's actually had a resurgence in the last couple of weeks, because Dave Patterson grabbed

me in for machine learning performance stuff that they're doing. So I'm trying to get them to use the right statistics, and we'll see. Okay. So anyway, so I wrote a paper on that. I would give talks, okay, right. Of course, I did the Big Data talks. You know, after *The New York Times* article, I got calls from meetup groups saying, "Oh, Big Data! Can you come talk." Okay, right? I said, "Sure, all right." <laughs> You know, I wrote a paper somewhere in there, "The Long Road to 64 Bits," which was all of the ins-and-outs of how the sort of 64-bit stuff really happened, including the way the standards got set for 64-bit C. Because there were three different ways you could do it, any of which could be right. And we had meetings where if the lawyers had caught us, it probably would have been trouble, because most of the computer industry was represented by engineers. You know, okay. But the right thing happened. The paper you mentioned ...

Markoff: On 170.

Mashey: ... on the "Languages, Levels, Libraries and Longevity," that was a request to do something about scripting languages. And I said, "Well, that's just a subset of the general problem." Both of these papers are weird in that they don't get referenced. They don't get cited very often, but get downloaded a lot, and they get used in universities all the time to teach. But at the same time, I ran around, I had done a talk about 20 years ago for Peter Mandelson, you know that name? Used to Tony Blair's right-hand man?

Markoff: Oh, yeah, yeah, yeah.

Mashey: And he had an entourage coming out here to understand how Silicon Valley worked. Okay, right? And so I was ... I helped the Briefing Center at SGI out all the time. So they called me up and said, "Can you talk to this guy when he comes?" And I went home to my British wife, and said, "Is Minister of Trade anything?" She said, "Whoa! Big Cheese! Big Cheese!" And he had been saying, "The UK has great universities," which is true, "but it's not so good at converting offshoots into business," also true, "and part of the side effect is outward brain drain," right, which is also true. So he was saying the right things. And he was coming to Silicon Valley to learn how did we work? So I put together a talk for him, which was this talk. This was about 20 years ago, but I've done it half a dozen times since. "How Silicon Valley Works."

Markoff: Is there a nugget out of that that ...

Mashey: Yeah, well, I'll get to that. But it was sort of, I said, "So you know, I come to the UK, we only sell to your advanced technology folks. We sell to Cambridge and Oxford and Glaxo, and your GCHQ and so forth. You know? The better you are at technology, the happier we are, I have to thank my wife for helping me. But of course, she's exactly what you're trying to stop." And he says, "What do you mean?" I said, "Undergraduate math at Cambridge; PhD at Imperial College in Mathematical Programming; and she moves to the Bell Labs." He says, "We'll get her back." I say, "No, you won't!" <laughs> Okay, and I said, "There's a whole lot of ingredients that you need. Everybody knows you get a research university and some office parks. But you need a lot of other things." You know, I said, "So you've been HP." "Yes." "You've been over to Stanford and talked to Hennessey?" "Yes." "Have you been to Fry's?" "Fry's? What's Fry's?" I explained what Fry's is. [A large computer and electronics retailer]. And Weird Stuff. [A

local surplus electronics store]. I say Weird Stuff, okay. These are things you need to have. I said, "You need the right kind of lawyers." And they go, "Well, we got lots of lawyers in the UK." I said, "You should go look at Wilson Sonsini, okay, all right? Do you have the kind of lawyers who know patent law? Know about start-up compensation policies. Will try to tamp down on lawsuits to keep little companies from fighting each other?" etcetera, etcetera. And they went, "Eh, maybe not, okay." All right? I said, "Well, you need that kind of stuff. You need places like the Wagon Wheel, or Bucks, Il Fornaio."

Markoff: Or The O. <laughs>

Mashey: Yeah, right, "You need these things, " And they go, "What?" I said, "Yeah, these are places where competitors would sometimes gather informally." And I said, "Now you can't duplicate the risk-taking culture. But you as a government can make it easier to start and stop companies. And you can reduce the penalties for failure." So I said, "Okay, so suppose in the UK a business guys had two companies fail." And they go shudder. You know, "This guy's doomed. Right he's over. He's gone!" I said, "What do you think happens here if that person goes to a VC to get money?" "They shudder!" I go, "No! They'll say, "Well, at least he has experience." They'll want to know why he failed, how he failed. Okay, what did he learn," but they know. I said, "Look! I'm not sure around here is ... if you've never failed, you're not trying hard enough." They go, "Okay, all right." So my understanding is that actually some things have loosened up in the UK. All right? So anyway. Okay. Well, that's all the computing stuff, except for the NVidia stuff. What happened is Andy Keen was running their high performance computing there. And he wanted me to come over and look at a project they were thinking of doing. It turned out it wasn't the right thing, but there was another way to do it that I got involved in for about a year-and-a-half. And somewhat weirdly as a consultant, because they don't use consultants.

Markoff: Was Rosenthal still around? Or was that after David had left?

Mashey: I don't remember. It was a different piece than I was in. Anyway, what we were doing was a really nice hardware/software problem of how you get what amounts to a seamless sharing of memory between the GPUs and the Intel CPUs. And it's not easy and it's sort of like page migration and there was things. Anyway, it was a very complicated hardware/software problem, which is what I've dealt with for a long time. So but anyway, let me fin ... the SGI stuff, you know, sort of 64-bittedness was pretty important. The supercomputer stuff, you know, I had a big hand in that, particularly the architecture for the later Origins. A bunch of the work on the evolution of the microprocessors, including the performance management things that were in there. And just a lot of sales deals. I mean, sort of one of the things that made me proudest there was I was probably the most popular executive to be brought out on things. And these were people whose mortgages depended on deals. So I felt pretty good about that.

Markoff: Did you play a role in the Clinton/Gore day when they showed up SGI?

Mashey: Sadly, I was in Australia. But I used to go Australia and New Zealand. I would spend a couple weeks a year down there. One of the most fun groups is Weta Digital, do you know them? Lord of the Rings? Peter Jackson's outfit? So I first started going there when they were a garage shop. The last year I went was 1999, I think, or 2000, somewhere in there. They were not a garage shop. They were in a

palace. I helped plan the storage systems for Lord of the Rings. Because I told people with Big Data, I said, "You know, when I go to Disney Animation, I spend all day doing a technology review for those folks." Which is something I did a lot. And I would point out to people, "You know, we have a lot of workstations in places like Disney, but we made a lot more money by the servers in the basement that do all our asset management." The same true was true at Weta, That also led to one of the most interesting non-disclosure [agreements] I've ever had. I've signed hundreds of non-disclosures. Because we often dealt with competitors, you know, at both SGI and MIPs. And they did something the movie guys rarely do. They were willing to show me half-an-hour of footage a year early. They normally don't do that, right? So they had a ferocious non-disclosure, and then they said, "If you tell anybody, we have special half-breed ORC lawyers to send after you." ORC lawyers! Oh, my goodness! Okay, right? What are they? Okay, anyway, <laughs> but it was fun ... the NVidia thing was a lot of fun, and that features in all their chips now at this point, okay, right? And so that's where all those other patents came from, they cranked them out.

Markoff: So then let's shift and talk about your ... you had some stuff with UCSF.

Mashey: Yeah, okay, so then something really weird happened, right? Is after I had ... just when I was leaving SGI, let's see, Dennis Allison, you know Dennis?

Markoff: Good friend.

Mashey: Of course, okay. Adele and Dennis are both good friends. When they're here they stay with us. Okay, right. And Dennis I've known forever, too. So Dennis runs EE380, which is this [Stanford University electrical engineering] seminar, which is whatever he feels like having. So he and Angela and Adele and I were hiking up in the hills. And I had just read Bjorn Lomborg's, "The Skeptical Environmentalist." Because *The Economist* had recommended it. And I had just made the first pass over it, and I told Dennis, you know, "He raises some issues." I hadn't had a chance to go check the footnotes out, and of course, when I checked the footnotes, they mostly don't support what he says. But I said, "But you know, he raises some issues about global warming and other stuff." Now I had helped sell supercomputers at places like the National Center for Atmospheric Research. So I kind of like believed what the mainline science said. I said, "But yeah, he raises issues." So Dennis says, "Why don't you come to EE380 and be the skeptical discussant for the climate scientist, Steven Schneider." Of course, he's a famous climate scientist at Stanford. I went, "Sure, that sounds cool."

So what I did, of course, was I went out and I ordered a bunch of books from all different directions. And I ordered the IPCC [Intergovernmental Panel on Climate Change] documents, I thought, "Well, this looks interesting." And I'm just finally done at SGI, and I'll do this, okay. Well, by the time I got there, of course, I had looked across stuff, and I was like, "Eh, okay, all right." The mainline science is what it is. But Steve gave a very impressive talk about uncertainty, and you got to address it and uncertainty is not our friend in climate and so forth. And what I did was I brought a stack of books, and I said, "So, I'm looking at a bunch of this stuff and you probably like this one," "Yes," "You probably don't like this one, Fred Singer, bad, okay, right?" "Yes." Okay, anyway, I got to be a friend of Steve's and I got interested in the whole climate science thing, and I thought, you know, "This is an interesting topic, I'll learn about it." And then by

2007, I was really wondering, so the science is very clear. I've studied enough of it. I have a Physics background, remember, from way back? Why aren't we doing more? And I ran into Professor Naomi Oreskes, who was at UC San Diego at the time. Now at Harvard. And she was giving a talk, and she was starting to do the research that led to the book, "Merchants of Doubt." Anyway, I talked to Naomi, and I read her book about ... I thought, "Well, she seems to know what she's doing. I'll read her book about plate tectonics, okay. And how ... why it wasn't accepted for a while and everything." And then she got attacked by this crazy Viscount Christopher Monkton, over in from the UK. And I sort of helped defend her. So we got to be friends. And I got studying the information flows, the disinformation flows on the internet. And I've done information flows in social networks before, in a more positive sense. But I started looking at that.

I found that his attack base was this really dumb little think tank in Washington. And had a certain set of advisors. So I made a matrix of the advisors and what other organizations they were in. And I noticed there really weren't that many of them, but they were all, you know, it was all the same people. Okay, so I started building a spreadsheet, which by now has a thousand people in it. About 120 organizations. And about 30 events or actions. That's built up the picture over time. So I ended up, I actually reviewed the first chapter she did as a test chapter for her book before she sent it to the publisher. And I ended up reviewing the book all the way along. That's why I'm mentioned in the book. And so I got plugged into the people who study the disinformation, the industry there. Remember, "Merchants of Doubt" has connections with the tobacco industry. All right, so now I had now written a bunch of things about doing investigative reporting on think tanks and money flows and I learned how to read IRS Form 990s, and you know, I started to learn how to use the Tobacco Archives up at UCSF. 2012, in La Jolla, okay, the Union of Concerned Scientists and Naomi and a few other folks put together this little workshop. Now of course, sitting up at Scrips on La Jolla, looking out over the Pacific, and La Jolla Beach is really a hardship, but someone has to do this. So there were only about 20 or 25 of us. It's a mixture of climate related people, environmental lawyers and tobacco control folks.

So for instance, let's see, it was Stan Glance who runs the UCSF, Center for Tobacco Control Research and Education. Let's see, there were lawyers who had driven some of the tobacco legislation. There was Robert Proctor, who's probably the number one historian of the tobacco industry at Stanford. You know, he does witnessing in tobacco things. He's probably the most hated guy by the tobacco companies. Okay. And the idea was for us climate folks to trade notes with the tobacco folks and learn from them, because they've been fighting the legal battles longer. So this workshop is now sometimes called La Jolla Junta, by the think tanks. There's a secret cabal of folks, although the meeting notes were published a couple months later by UCSF. But it's probably in some sense the inspiration for some of these lawsuits against the fossil [fuel] companies.

Okay, so now when we were doing this, we each got five minutes to describe who we were. And Stan got up, and they were just doing the research that discovered that [the] Tea Party was a joint venture of the Koch Brothers and big tobacco. And Stan had these complicated graphs that showed how the tobacco industry had evolved to use think tanks as front groups and so forth. Had different people, and you know, how they moved around. About an hour later, I got up, and I'd been studying the Heartland Institute, which had a Philip Morris executive as a director for a dozen years. And I had found him in the Tobacco

Archives, he as the guy who gave out money to the think tanks, and every year he had a spreadsheet. And I went, "Oh, thank you! Thank you, you've just saved me so much time!" So I had some diagrams of Heartland and who funded it, and who they were connected to and what think tanks. And Stan says, "It's all the same people!" And it mostly was. And so he says, "You've got to come UCSF and give this talk, and give a talk." So I did, and I actually gave a sort of related talk on corporate misbehavior to a graduate nursing class. Which was interesting. Like some of these folks are oncology nurses who just can't take it anymore. Because it's pretty hard emotionally, and were getting their masters in public health with the idea of policy to help people not be ... get to there, right? And then Stan says, "Why don't you be on the Advisory Committee?" And you know, since the computer database up there is something I could sometimes advise on, and very often the same people are involved in tobacco promotion and fossil fuel promotion, or chemicals or ... anyway, part of what's going on is an extension. They now have sections on chemicals and pharmaceuticals. Hopefully, they'll get one on sugar some time, pretty soon, all right?

We've been trying to have this as a real resource on corporate disinformation and misbehavior related to health. And you know, UCSF, of course is one of the top probably four medical schools in the ... health schools in the country. It's the only one that's public, actually. And it's sort of a weird sounding connection, but I sometimes help out their postdocs in terms of researching things. I usually do a talk up there, but every couple years they want to hear an update of ... that's this talk. That's, "Machineries of Doubt and Disinformation," "Cigarettes and Fossil Fuels and Disinformation." You know, that kind of thing. So you know, money comes in; fog comes out. Anyway, that doesn't have much to do with computers, but that's kind of where ...

Markoff: It's occupying you. So I probably don't need to to ask this, but there's one backward looking question at the end, and one forward looking. Roads not taken? Are there any things that you passed up that you think about, and I mean, you talked about serendipity right at the beginning? But are there any paths you didn't go down?

Mashey: Okay, well, so I mean I didn't go the path of doing fusion research <laughs>, for which I'm very thankful! <laughs> So, I mean, you know, it'd also become clear to me by that time, that, "Boy, a lot of physics projects are really long-term things." You know, and I've got to admit I didn't mind working a couple years on something, but working ten or twenty years on something before you got something to work, you know, it was just ... I decided, I enjoyed the feedback you got from computing, too, quick, okay, all right? I certainly don't regret moving out here!

Markoff: That's a path taken. <laughs>

Mashey: I mean, you know, what can I say? Right? Let's see.

Markoff: Did you ever consider working for any ... there are lots of other threads in the Valley that you could have taken.

Mashey: Well, Bill Joy hassled me when I went to MIPS, you know? And it probably ... it could have been okay to have gone to Sun. I thought what Sun was doing was a little ... let's see, what we were

doing and what Sun was doing ... what we were doing back at Bell Labs and what Sun was doing were a little closer. Sort of like I didn't want to be too close.

Markoff: Yeah.

Mashey: Okay, and Convergent was enough different that I sort of said, "Okay."

Markoff: Did you ever have any ... given the importance of UNIX to the Apple ecosystem through Steve [Jobs] ... did you ever have any flirtations with NeXT or with Apple in their UNIX era?

Mashey: Okay, well, I flirted with NeXT in the following sense, okay, Steve [Jobs] had stolen Mike Damone from me by offering a \$50,000 hiring bonus, bulked up to be tax free. To which I said, "Bless you my son. It was more like that." Okay, let's see, I visited NeXT one time, spent an hour with Steve trying to convince him to use MIPS chips, rather than Motorola chips. And the reality distortion field didn't work. His view was that we should give him the chips, because they were very cost-conscious. Okay, and he would make us famous, and that would be worth it. <laughs>

Markoff: Yeah, that sounds like him.

Mashey: But I knew about the cubicle stuff. So but look, for a long time, after all Apple was not UNIX, right? Angela and I had Macs for a long time. But by the mid-'90s, it was frustrating, like Apple, there are these things called multitasking in virtual memory, you know, really. And with SGI actually having a Windows NT machine, and with Intuit saying they weren't going to do the next version on Macs, you know, we gritted our teeth and switched to Win NT.

Markoff: Yeah, yeah.

Mashey: But let's see, so the thing is, you know, most of what I've done has been in more enterprise, and underpinnings and plumbing and stuff, okay. Not so much in consumer products. And you know, it's certainly imaginable. Apple was the other company I interviewed out here in the first place, right? But they were going through a lot of churning around, and I ... yeah, '73, you know, and Convergent was much more aligned with what I'd been doing. So I don't know that ... you know, except for the thing of maybe going to Sun at some point in there. You know, that was a plausible thing. Let's see. The thing is, really doing startups after a heart attack is not a good idea. There's, you know ... I can almost imagine, for instance, having really pushed harder to look for a job in venture capital. You know, right? But I also ... there's this image of them sitting around sipping Chardonnay, but I know better, they work awful hard.

Markoff: I was struck, you know, your mentioning of that discovery, the Tea Party was a joint venture of Koch and ...

Mashey: Philip Morris.

Markoff: Philip Morris. If you play that forward and think of Trump as being a joint venture of the Tea Party, and now it looks like Russian mob.

Mashey: Yeah, right.

Markoff: It gets pretty interesting. I mean, in terms of money flows.

Mashey: Oh, I know! But well, particularly, right, so dark money flows are stuff that I've studied a lot. And I worked some ... I think I'm the one who discovered this thing called Donor's Trust. Which in tracking the Heartland money, I came across one mention that they got some money from Donor's Trust. And I was like, "What's that?" And I looked it up, and the instant I saw who they gave money to, I went, "Whoa!" It's a donor advised fund set up by a bunch of the Koch allies, and the idea is Charles Koch, in particular, hates the idea that he has to report where his foundations give money to. So what you do is you put money in this donor advised trust, and then all the checks are written by donors. So now you can't ... you can see where the money goes, but you can't tell who gave it.

Markoff: Right.

Mashey: Okay, right. And that actually got fed into ... so my friend, Robert Poole, from Drexel, okay, was up at where you have been. Up on the Hill. And he was out here for a year, and he was doing a very extensive analysis. More extensive than I did in terms of where the money flows where. And he found ... one of the things that we knew, and he went in detail, was how the money from the foundations like Koch's were slowly going down but the money through Donor's Trust was going way up. So it's a big anonymizer.

Markoff: Which the IRS, apparently today has helped.

Mashey: Yes, I know. I know. Well, bad, okay. Now that's something that can get fixed. Okay, so yeah, you know, I've ended up doing a few other investigative reporting, like which is related to money flows, like looking at the money from the Trumps to this lady, Pam Bondi in Florida, who is the Florida Attorney General, 2013, And this is one of these where I'm always reminded of ... you know, the old Sherlock Holmes story where the crucial clue is the dog that didn't bark in the night? I'm always reminded you have to look at the background information to know whether something's happening.

Well, here's the funny thing. Okay, about six weeks or eight weeks before the New York Attorney General lawsuit got filed versus Trump University, in one day four different people record getting money from Trump. There's two judges in New York; a New York District Attorney; and Pam Bondi down in Florida. Okay, all right. And there'd been a lot of flak in Florida, around 2013 about why wasn't ... why weren't they chasing Trump University ... because there were a lot of retirees down there. All right, over the next six weeks, more donations go to like the Iowa Governor; to the Texas, Greg Abbott, all right. And then there's the \$25,000 that David Fahrenthold found ... at *Washington Post* ... that went from the Trump Foundation to Pam Bondi, one of her groups. And that stirred up a lot of that stuff. And they claimed there was a

clerical error, because of course, they couldn't go for <inaudible 00:41:42>. You know, it wasn't a clerical error okay, right?

One of the things that I found was I looked through all of the donation records. Essentially all these donations ... there were a couple more to judges in New York, there was more to Pam ... were to people who not gotten money before. Now here was the other interesting piece. It's something like September 10th is the date, September 10th, 2013 is the date that he cut the check, the 25K check. Let's see, and the day after, Bondi records \$500 from Ivanka Trump. Now there's some coordination here. Because she had to have written it ... what it looks like is that they were sending whatever they could ... because \$500 was the limit to the one committee, and it wasn't enough so, you know, they send some more. But then it turns out there's a sequence of things where she ... Bondi didn't need the money. She outraised her opponent four-to-one. What she needed was to show she could bring more money into the Republican Party down there. And so there was an event at Mara Largo, that amazingly didn't cost very much, \$300. There's all kinds of donations in weird paths through ... anyway, you draw the thing, and it looks like a network flow diagram of what goes on. So I did one of those. Okay, all right? I will get back. I'm currently working on a tobacco one about the votes about raising the age from 18 to 21. It's one of the very few times you can pull out a simple bill, okay, that's a no-brainer, and see who voted for it, and how much money they got. And guess what? California, which passed it, of course, the simple way to put it is almost the only people that voted against raising the age were Republicans who got a lot of money.

Markoff: Yeah.

Mashey: Okay, mostly men.

Markoff: That's a good project.

Mashey: Yes. So anyway, but it's the same things where you know, you go in and you dig around, and you do detailed analysis. Again, some of these things are almost like ... funny thing was, some of the diagrams I've drawn are the same ones we were drawing at VVidia to show all the transactions back and forth between the two chips. Well, you know, you draw ... you do timelines sometimes, knowing that information never arrives before it's sent. <laughter> And then you can sometimes figure out where it came from. So, but anyway, again, the way I put it is a whole lot of this is I've been lucky to be able to make a bunch of contributions to a bunch of different things. But an awful lot of it is sort of luck and being in the right place and happening to work with a lot of good people at all these places, you know? So good, good!

Markoff: So thank you very much!

Mashey: Sure, thank you, sir!

END OF THE INTERVIEW