Oral History of A. Thampy Thomas

Interviewed by:
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Kapoor: On behalf of the Computer History Museum, I would like to welcome Dr. Alumkal Thampy Thomas for his oral history interview. My name is Uday Kapoor and I am a volunteer at the museum. I have the added privilege of being a long-term, since 1975, acquaintance of Dr. Thomas. He has a PhD and an MS in electrical engineering from Stanford University and is a well-known entrepreneur in Silicon Valley. He is most known for his contribution to microprocessor pipeline architecture specifically, as the founder of Nexgen Microsystems. Of course, there are many more things to talk about, but this is just a brief introduction. With that, we can start with your early life, and tell us-- I read that you were born in Cochin in Kerala, in India in 1946 on April 11. So with that, maybe you can tell us about your childhood.

Thomas: I grew up in Cochin. My father represented area of Cochin in India's first parliament, and there was an interesting backstory on it. He was the first one in his family to go beyond high school for generations. And the backstory was his father was a-- what in America we would call a dirt farmer. He farmed enough to feed the family, but they didn't have much extra cash. So in those days, and I think even now in India, you know, going to college is not an expensive thing, except you have to go to a different town and you have to pay for the room and board and so on. So he decided that he wanted to go to law school and his father did not have any money to send him away to another town. So he went over to his mother-- his grandmother and said he wanted to go to law school and he needed some money. And the grandmother must have figured he's a smart person, a driven person and so the grandmother said, "Well, I don't have any money, but I have my wedding gold jewelry that I can give it to you and you can take it to the bank and they'll give you money for that." So that's how he went to law school. And he was a subject of the Maharaj of Cochin when he was growing up. He was a very successful lawyer. He became the lawyer to the Maharaja. Then when India became independent, he represented that area, which was really the Maharaja's kingdom, the area, the state of Cochin. And so it was a strange reversal in the sense that all of a sudden the Maharaja became his constituent and he represented the Maharaja in the parliament. And then he went on to serve in Nehru's cabinet and very, very successful person. But I always remember that, you know, how much education does to bring a family from wherever they are to the next level up. So it's something that I always believe in and then try to help people in that area.

Kapoor: Thank you.

Thomas: And then I went to engineering college in Pilani, Birla..

Kapoor: So let's come back to that.

Thomas: Yeah, Birla Institute of Technology.

Kapoor: Let's start from, you know, so you mentioned that your father served in Nehru's cabinet. What was his role there?

Thomas: Initially, he was the minister for food and agriculture, and then in 1962 Nehru replaced Krishna Menon after the Indo-Pakistan-- I mean, China Pakistan war.

Kapoor: China, yes.

Thomas: China-- Indo-China war. And so he became the minister, junior minister for Nehru, because Nehru ran the Defense Ministry at that time.

Kapoor: I see.

Thomas: He was the Minister of State for defense.

Kapoor: Okay. Okay. Very nice to know that. So let's go back to, so you were born in Cochin, so your parents had lived in Cochin, I assume.

Thomas: My parents lived in Cochin, but they moved to Delhi, and my mother decided that my brother and I should go-- grow up, should go live at my grandfather, my mother's father, who had a cashew nut estate, and he also grew lemongrass. So those were, I guess, the cash crops. And then he had rubber also there. So that was about 25 miles outside Cochin up in the hills. And so I did my high school in the local village high school. It was sort of a strange situation, because I had no idea how good I was or anything. So in the school, SSLC they call it, which is school-- secondary school living certificate, I came second in the state among 100,000 kids or something like that. So that's the first time it occurred to me that, you know, that I was reasonably bright. But I always wanted to do engineering and I went to Pilani, Birla Institute of Technology and Science in the north of Delhi. And the Pilani, I did not have the math background to do the IIT entrance exam, but Pilani was a great because they admitted you based on your grades, and so it was also a great school. They had collaboration with MIT, we had a lot of professors from MIT teaching at Pilani. And when I finished my undergraduate in electrical engineering, I got admission to Stanford, so I came here in 1968.

Kapoor: Okay. So again, going back to the school days, you said you lived near Cochin, right?

Thomas: Mm-hmm.

Kapoor: So the school was in Cochin?

Thomas: No, it was 20 miles away from..

Kapoor: Twenty miles.

Thomas: ...in a village, in a small village.

Kapoor: That's amazing.

Thomas: There were not-- so I did not have anybody in a role model sense.

Kapoor: That was my question.

Thomas: Yeah, my classmates. They were not..

Kapoor: So you actually were a loner in that sense, that you were self-made.

Thomas: Yeah, only because, you know, my first experience in an interesting way of learning from the peers was when I came to Stanford, because, you know, I always stood first or second in the class without trying very hard. You know, you just wrote your exam and, you know, when the time came, you were either first or second. And then it occurred to me that everyone at Stanford came first or second in their classes, so that was really the very first experience I had in terms of your peers, how good they are and how much you learn from them. That is a-- I think that is a uniquely American experience. The top schools here sort of prepares you for the next level better than anybody else.

Kapoor: So, in terms of your school days, were there any favorite subjects that you had? And in fact, how did you transition towards electrical engineering or engineering? Do you have any favorite teachers?

Thomas: No, my favorite teacher was really the person who taught me grammar.

Kapoor: I see.

Thomas: And I kind of liked grammar, even though I couldn't put two sentences together properly, but I knew how it was structured. And it was a sort of a math behind it. Mathematics was a favorite subject of mine and electrical engineering, I think in India when you decide to go to an engineering school or whatever, it's very different than in the states. I mean, you don't-- you kind of do what is the most popular topic at that time.

Kapoor: Yeah, you're saying exactly what I went through, but I just wanted you to say that.

Thomas: And you know, because I think in Pilani, it went through the normal progression in India, the-- all the smart ones in the early days did civil engineering, because that's all the, you know, you had all the public works department jobs.

Kapoor: Right. And it used to be mechanical engineering was also..

Thomas: Then, it became mechanical engineering after that. And then by the time it was electrical engineering, so that's what I did. But I did a very traditional electrical engineering; power generation, distribution, transmission and so on. So it was a big shock to me when I came to Stanford, because they didn't have any electrical engineering.

Kapoor: So did Pilani have electronics?

Thomas: They had electronics-- they had telecommunication at that..

Kapoor: Telecommunication, I see.

Thomas: ... not electronics, per se, and they had a course in control theory and I had taken that course. So when I came to Stanford, there was no electrical engineering that I learned in Pilani back at Stanford, but I sort of recognize the control theory, so I said, "Well, that's what I'm going to do my PhD in." Fortunately for me, or unfortunately at that time, they gave me Professor Kalman as my thesis advisor. And so I had my first meeting with him. It took about an hour, hour and a half and after I left the meeting I just realized I didn't understand a single thing he told-- talked to me about because it was so heavily mathematical. In India, when you do engineering, you tend to do a lot less of the advanced mathematics. It's more of the applied things. So I decided that I'm not going to cut it in control theory, so-- or system, at Stanford, it was called systems theory. I know you interviewed Professor Kailath and he had just joined Stanford and he was the youngest professor at Stanford at that time. He was 24 or 25, something like that. So I decided that I'd better either go back and do all the math courses, or if I wanted to continue on my path, do something that I was on the same level as everyone else, and what was interesting was all digital courses were graduate-level courses at that time. In Stanford terms, they were all 300 level courses. So I figured that I'm on the same level as anybody else, so I switched over to computer engineering and digital systems, so that's how I ended up into computing.

Kapoor: So, again, going back to your early days, I know that you were born in the Syrian Christian tradition?

Thomas: Mm-hmm.

Kapoor: How was that for you in terms of a country where that was not the dominant culture or religion, at least the way I look at it?

Thomas: You know, in Kerala, like the north of India, there was really no religious strife at all. And also, because of Cochin, which was a natural port and it was on the trading routes between the Middle East and China, and because Kerala was where all the spices were grown in India, so the trade route was people who would come from the Middle East with spices, dates and nuts and pistachios, and they would trade that for coffee and tea and spices in Kerala and then they would take it to China and then they would trade it for silk and ceramic in China, come back and trade some of the silk and ceramic for more spices and then go back to the Middle East. So-- and that trade had existed for before Christ and so Kerala was interesting in the sense that the three great religions in India entered India through Kerala; Muslims, because the people from the Middle East had come, the Jewish religion and the Christians. And even now, in Cochin, there is a synagogue which is the oldest synagogue outside the Middle East. And there's a very small Jewish population. Most of them went away to Israel. And so, when we grew up, there was no-- what do you call? No ghettos, per se. I mean, Christians, Muslims and Hindus all lived together. There were temples, mosques and churches altogether and in the morning you heard a cacophony of sounds that came from all these various institutions. The church bells and the temple..

Kapoor: Actually, I experienced that a few years ago when I went to Kerala.

Thomas: Yeah.

Kapoor: You're absolutely right.

Thomas: So it is-- and those religious experiences really sort of keeps Kerala apart from rest of India in an interesting way, because the Christians really introduced education to the women. So, you have a situation in India, all the women are educated. I mean, now, you have close to 100 percent literacy rate in Kerala. And there is an interesting byproduct of that, which is Kerala is the only state in India which has the boy/girl ratio, the natural ratio, because the women being educated, they will not let their girl babies be aborted. And so I think a lot-- the Christians left a big mark in India and the tradition is that a lot of the Christians were initially converted. There were Hindus and there were Brahmans, and they were in the service of the maharajah and the maharajah really didn't feel-- he looked at the trade as a good thing. And so there was never any conquest of either the Muslims or the Jewish or the Christians of Kerala. They just came to do trade, and so there was no conflict. And so the early Christians were treated really well and they didn't have any trouble living within the Brahman community because they kind of considered themselves as equal into the Brahmans. They were educated, and like my father, who was a Christian, the maharajah had no trouble having him as his lawyer, so to speak.

Kapoor: I see. Very good. In terms of your family life, you had a brother with you that you were with grandparents in the early days.

Thomas: Mm-hmm.

Kapoor: And then how often did you folks travel to meet your parents in Delhi?

Thomas: You did that once a year, during summer vacation, and it was a four-day train journey.

Kapoor: It was very similar to what I went through, yes.

Thomas: It was a four-day train journey, so you spent three months there and then-- not three months, two months, actually. And then came back to Kerala.

Kapoor: Okay, okay. So let's now go forward. You mentioned your selection of Pilani for the reasons that you mentioned and the education you got there. How did you choose Stanford? You know, were you looking at different schools? Why did you select Stanford for your graduate school?

Thomas: So, the three schools I applied to were MIT, Stanford and Berkeley, Berkeley because at that time, people may not sort of realize that now, every department in a Berkeley was better than every department in Stanford, definitely in engineering. Well, Stanford, maybe the exception was in the system theory and in semi-conductors, but Stanford did not have any traditional electrical engineering at that time. They didn't even have traditional mechanical engineering. They had aeronautical engineering. And so I got into both Berkeley and Stanford and there is a funny story how I ended up at Stanford. This was in-- TV had just come to India, so this was 1968 and it was the free speech movement. So my mom was watching the TV and it was all over. You know, the free speech movement was a big news item all over the world at that time, and she saw, you know, the flaggers(?) in Berkeley and so on, and she became convinced that if I went to Berkeley that I would never come back to India. So then I thought about it and I said, "Okay, I'll go to Stanford." And so, she was against me going to Berkeley for no rhyme or reason other than the women that she saw on TV. And she kind of liked Stanford for two reasons. One is it was not Berkeley and the second one, which is probably equally important, it sounded like Oxford. So she thought it must be a good university. That's how I ended up at Stanford.

Kapoor: So, in those days, as you had once mentioned and as I know, we did not get much money to bring with us from India. No currency.

Thomas: No, the government-- we did not have any foreign-exchange, so there was-- I think we all came here with 40 dollars.

Kapoor: So, did you have a scholarship?

Thomas: Yes, I had, but all you had at that time was 40 bucks in your pocket, and then also I did not know where Stanford was. You know, you assume that Stanford was in San Francisco or Berkeley was in San Francisco, and all of the planes landed at two in the morning and so I had arranged for-- to stay at the YMCA in San Francisco on Golden Gate. And so I caught a Greyhound bus and came to the YMCA. It was late August and I had no idea San Francisco would be a cool place, but it wasn't cool. It was one of those nice Augusts in San Francisco, nice and warm. So, I came to the YMCA at three in the morning and the person tells me-- the person tells me that it will be seven dollars or something for the day. And so I have-- now, I have 38 bucks in my pocket, the two bucks for the Greyhound, so I'm now thinking that-- so I asked him when does the day start? And he said, "Well, six in the morning." So now I am calculating for three hours I have to spend another seven bucks. So I asked him if he would keep my suitcase and where the nearest park was. So he pointed me to Union Square and so the very first night in America, I slept on a bench in Union Square.

Kapoor: Wow.

Thomas: You know, it's a good thing I didn't know, and it wasn't cool, but if you didn't know any better, San Francisco could get pretty cold even in the summertime.

Kapoor: Yes.

Thomas: And so the next day I took the Greyhound back to Stanford. Then, you know, Stanford is such a welcoming and accommodating place. You already have a host family and, you know, you become part of the community and so it was-- it was really easy.

Kapoor: Yes, yes. Very nice. So you did have a scholarship?

Thomas: Yeah.

Kapoor: Very good, that's excellent. So in terms of-- what are your memorable experiences at Stanford? I mean, of course you mentioned how you selected the subject. Any other thoughts?

Thomas: My memorable experiences were, first I sort of mentioned earlier dealing, you know, just interacting with my peers. You know, how bright they are and how much interest they had in studying. You know, in India it sounds bad when you say we had really no interest-- that much interest in knowledge, per se. I mean, you just want to study the subject material so you can do well in the exam. So that was the driving force, but after you come to Stanford, you know, the driving force was really knowledge and interacting with the professors and so on. My most memorable professor, even though I did not know him that well, was Professor Knuth, who taught algorithms, and he was this amazing teacher. And he had the system where at the very first lecture he would tell you that if you can find a mistake in his textbook, you get an A and you didn't have to attend classes again after that. So that was a driving force for everyone. At least two or three classmates of mine sort of got out of doing the entire course because they found a mistake in the textbook. So that was, you know, for me, that whole experience that A, a professor can do that, he had the flexibility to-- in India, you know, you never have that flexibility.

Kapoor: Right.

Thomas: You know, you have a fixed way of doing things. So this whole experience of driving for knowledge or striving for knowledge, the professors having the freedom, you know, the whole concept of freedom. I mean, in this case, there was also, you know, there was a physical concept of freedom because this is the first time I was on my own. You know, my parents were not around and I was making an assistantship, so I was financially independent, so to speak. So there was that sense of freedom, but the sense of freedom in a learning environment, what you can do, that was an amazing experience.

Kapoor: Right, right. So, you did your masters first and then you decided to go for the PhD. Was there a different decision in that?

Thomas: Yeah, it was a very different decision. When I finished my masters, or was halfway through my masters, I was fortunate enough to be a student of Ed Davidson, and-- who had just got his PhD from Illinois and he was in the digital systems lab. And I was his second student at Stanford. Len Shire was my-- his first student, and then Len and I then ended up founding a company together. And it was also an interesting experience because somehow you have a student/teacher relationship, and he was only four years older than me. I was 21, he was 25. And so you had a student teacher, and then the fact that you could be friends with him. You know, that's also a very different experience.

Kapoor: Unique experience in the US, yes.

Thomas: And so I got my masters at the end of the first year, and you know you're making 300 bucks a month. I sort of recalculated the 300 bucks the other day, because it sounds so low, but my sort of yardstick is when I first came to America, Motel 6 was six dollars. That's how the name Motel 6 came

about, and now the other day I was driving by the freeway and I noticed that it was 69.99 or something, so 70 bucks, 11 times. So the 300 bucks was really like 3500 bucks, so it's not that bad, but still.

Kapoor: I actually saved money with my teaching assistantship.

Thomas: Yeah. So-- but I really wanted to make some money and get some experience. And then something also, a sheer accident of timing that both National and Intel had gotten contracts from Japanese calculator companies to design calculator chips on contract to them. And National had a contract from Sony to do a calculator chip and Intel had one from Busicom, and they both decided that they may be better off hiring a bunch of people who had computer backgrounds and teaching them chip design than the other way around, because the-- I think the number of transistors involved on those calculator chips were 2000 or 3000 and the state of the art in terms of logic was Dual-D flip-flops, maybe 20 transistors.

Kapoor: Right.

Thomas: And so they figured that they would be better off hiring some computer people and put them together with the chip designers and then do the calculator chip. So I ended up on the Sony calculator project at National.

Kapoor: So, you left the MS..

Thomas: I left Stanford.

Kapoor: ...at Stanford and joined..

Thomas: And then Ted Hoff, that that time was one year senior to me at Stanford, and he ended up at Intel on this Busicom calculator chip, so we had these two parallel calculator chip projects going on and we had-- it was an enormously complicated project. Intel was doing 1K memory chips at that time, which was the most complicated memory chips. And a 3000 transistor in terms of complexity is even 10 times more compensated (complicated ?) than a 1000-bit memory chip.

Kapoor: Yes.

Thomas: And so we had-- we sort of struggled with the chip design, both at National and, later on I found out, at Intel also. And so we were two or three years behind the project in terms of delivering it to Sony, and Sony, they cared, but they didn’t care that much because they had a broad product line.

Busicom, later on, I found out about it 20 years later, when I met Masatoshi Shima who was one of the-- he was the designer that Busicom sent from Japan to work in Ted Hoff's group along with Faggin and Hoff. And the-- and he said Busicom ended up going bankrupt because they had bet their entire new product line based on the electronic calculator from Intel and it was three years behind. They didn't have new product. They just went belly-up. And the story I heard from Shima is that they then went to Intel and told them that, "We cannot afford to pay you the $250,000 in NRE," which is probably 2-1/2 million or 3 million dollars now. "So if you forgive us that what we owe you, then we'll let you have the design," because it was really a Busicom design. And so that's how Intel ended up with the 4000, what later on turned out to be the 4004.

Kapoor: Four, yes, very interesting. So, after you-- for National, when the chip was late, but did you stay at National or did you decide to then pursue your..

Thomas: But then I-- at National, one of the driving constraints for us was the participation (power ?) on the chip, even 2000 transistors.

Kapoor: This is nMOS?

Thomas: NMOS design. Actually, National, it was pMOS.

Kapoor: PMOS.

Thomas: Intel was on nMOS. And so-- and then I got introduced to a company called Intersil and they had a technology called cMOS and they had a cMOS memory chip and also they had a very clever bunch of engineers who did some of the first analog cMOS designs. Watch circuits, the fluke digital voltmeter.

Kapoor: Yes.

Thomas: Amazing design.

Kapoor: This is about what time?

Thomas: This would be 71/72. So as I learned more about cMOS and more about Intersil, I got interested that this may be an interesting technology for doing microprocessors because power was becoming a big constraint, and Intersil had the best cMOS technology at the time. And they were interested in doing-- expanding their memory product lines to logic design, logic products.

Kapoor: I think they were even ahead of RCA.

Thomas: Yeah.

Kapoor: Yeah.

Thomas: Yeah, and definitely the 1K cMOS memory they had was by far the densest cMOS memory chip at that time. Then they had all this-- what do you call analogue cMOS circuits. And so I was started with another person called Shep Hume, the digital products line, and so we ended up designing a single chip, cMOS microprocessor. And we picked the PDP-8 instruction set, because we figured that that way there would be a lot of software available so we don't have to do the software for the thing. So we designed the 12-bit PDP-8 at Intersil in 1971/72. It was-- and DEC used it for a product line that they had. They had a terminal built with that.

Kapoor: I see. So you actually shipped product?

Thomas: We shipped product. It's a very successful product because that was the only low-power processor available at that time.

Kapoor: Right. So what was the complexity of the chip at that time?

Thomas: It was like, if I remember right, 10,000 transistors, and it sort of makes sense because I didn't know 4004 was 3000 transistors, or 4-bit, this is 12-bits, so about three times.

Kapoor: Right.

Thomas: And also, as you know, cMOS always took a little more area, so that the density did not scale as much as the nMOS did. And around that time, my training visa had run out and the-- so the choice was to apply for a green card, but in those days you had to get a labor certification to get a green card. And this was 1971/72, big unemployment in the aerospace business, a lot of unemployed engineers, and the labor department was in..

Kapoor: Yes, I remember exactly what you're talking about.

Thomas: Yeah. The Labor Department, that's another difference between aerospace engineer and the chip design, and so they were concerned there were a lot of unemployed engineers. So it was-- I figured it was almost impossible to get that.

Kapoor: And then there was also the Vietnam War, you know, the draft and all that.

Thomas: So I decided that it was almost impossible to get the labor certification and a green card. But I want to stay back in the States, so my only choice was to go back to Stanford for-- continue my PhD program. So I went back to Stanford in 72, right after the microprocessor design, and started working for Ed Davidson.

Kapoor: Okay.

Thomas: And then in 72, early 72 and in late 72, Deepa and I got married.

Kapoor: Yeah, I was going to ask about family.

Thomas: So she arrives and we came back to India. We got married in India and we came back in January of 73.

Kapoor: So you used to go to India?

Thomas: I had made one trip between 68 and 72, one trip in between, and that trip was really to-- for a personal reason. My sister decided to marry somebody who was 25 years older than she was, and so it created a lot of tension in the family, so I thought I'll go to be, you know, supportive to my sister and my parents. So I went there in 1970 and then I met Deepa accidentally during that trip.

Kapoor: Okay. Yeah, I was going to ask whether it was an arranged marriage.

Thomas: It was arranged-- it was sort of-- what shall I call? It was encouraged more than arranged. So I met Deepa in that trip in 1970 and..

Kapoor: This is in Delhi?

Thomas: In Delhi.

Kapoor: Okay.

Thomas: My parents-- my dad was, at that time, the Indian High Commissioner to Zambia. He had just finished his term in Australia and he was being posted to Zambia, so he was in Delhi and Deepa's parents and my parents are really good friends, so they were transiting through, and so Deepa's parents came over to see him, see them, and they dragged Deepa along. So I see Deepa for the first time in 1970 and..

Kapoor: During your trip to Delhi?

Thomas: During that trip to-- for my sister's wedding.

Kapoor: Yeah.

Thomas: And I sort of "mistake"-- I made the mistake of asking my mother who she was. I didn't talk to Deepa. I just asked my mother, "Who is she?" And so my mother decided at that time that..

Kapoor: You were interested.

Thomas: Yeah, I'd fallen in love or whatever it may be. And so my mother and Deepa's mother sort of conspired and her mother, who-- I knew Deepa's mother, too, but Deepa and I had never met before, and mainly because I was away in college and Deepa was heavy in school and..

Kapoor: In Nainital.

Thomas: And I came home only during summer time and Deepa was up in the hills in a boarding school and her long vacation was during winter, so we never..

Kapoor: This is in Nainital, yes?

Thomas: Yes, Nainital, so we never crossed paths. And so-- but I knew her mother, Deepa's mother, so she invited me for lunch and I went there for lunch and, you know, there was this big spread, and Deepa's mother told me that Deepa cooked everything. So now I'm thinking that, "Well, man, she's not only good looking, she can cook, too!" Which is probably the only lie her mother ever said in her life. And then I come back, and we didn't-- I didn't spend much time. I come back to Stanford, and about that--

Kapoor: But you did talk, you got to know her.

Thampy: Yeah, but we didn't go out. I think we did go out to a dinner at a friend's house. And but we didn't spend much time together. And then I come back to the L.A., I mean, to Stanford, and my mother calls me. She-- this is ten days later after I returned. And which is a big occasion, because my mother had never called me before in the States. At least from States to India at that time was $12. So I'm sure from India to States was probably the same. The money was just really a lot of money. And so it was-- we wrote to each other, but never had a phone conversation. So I pick up the phone and my mother asked me what are my intentions with Deepa, which sort of threw me for a surprise. So I said, "Mom, I have-- I think she's terrific, but I had no really intentions in the sense that I can't afford to have any intentions living on 300 bucks and working on my thesis. So my mother tells me that, "You better have some intentions real quick, because Deepa's going to be engaged in another week," because I was sort of in background there was a Proposal and so on. And I think that's probably my first business instincts came to me. This is sort of lost business opportunity and I'm thinking that, "Here is Deepa, she can-- she's terrific, she's good-looking, great looking. She can cook, and if I don't make the move now, then that opportunity is gone!" So I called Deepa up, a big expenditure, again, 12 bucks, person-to-person call. And we had this conversation, and first I asked Deepa whether she remembered me or not. And that got a laugh out of her. And then I asked her if she would marry me. And she didn't say "No," for sure, but she didn't say "Yes," either! You know, she said, she asked me when I was coming back, and then I was going through my green card process, so I said it could be another two years, maybe slightly longer. And Deepa said, "Oh, then, you know, when you come back, maybe we should talk." And so then my mother calls again the next day. So that is a second call she made, big expenditure. And so she asked me, "Did you talk to Deepa?" I said, "I did." And she said, "What she say?" I said, "We had a nice conversation. She didn't say anything. We decided maybe we'll write to each other and in two years, or whenever I come back to India, we'll take it up again." And that was the conversation I had with my mom. And then next morning, she ends up at Deepa's house with an engagement ring, and she puts it on Deepa's finger. And so she's sort of engaged to my mother, and my mother is no more, but she also claims that I haven't paid her for the ring, and this is also true, I think. So then we got engaged, we wrote to each other, and two years later, I got the green card, and then I went back to India and got married. So that was '72.

Kapoor: That's amazing. That's an amazing story! So then after you got married then Deepa came back with you?

Thampy: Right. So then I had started at Stanford in '73, and so I was-- then I went back to work at Intersil. And it was sort of an interesting arrangement where I was not supposed to work during the school year. So but I worked, and then Joe Rizzi, my boss at that time, will pay me in the summertime, because I can work during the summertime. So I didn't have any money for the first nine months, but then I got this-- but I had an assistantship at Stanford. And so I was really interested in the microprocessor design, and very little interest in my thesis, per se. And the only reason I was at Stanford was because of immigration. And then Ed Davidson [ph?] was my advisor. He went back to Illinois. He was an Assistant Professor at Stanford. He went back to Illinois as a tenured professor. And so he told-- he called Deepa and told her that, "If Thampy doesn't come with me to Illinois, he'll never finish his PhD, which is probably true. And so maybe you should work on him in coming to Champagne, the campus." And so Ed and Deepa worked on-- so we ended up going to Champagne. I was still a Stanford student. But Ed Davidson was my

advisor. And Stanford was very nice. You know, this is, again, the flexibility that we have in America. He is a Professor at Illinois managing the thesis for--

Kapoor: Yeah, I discovered that in my interview with Tom Kailath, where how MIT and the Lincoln Lab and all the arrangements they had. It was amazing. You know, because he was not a citizen, but doing some design work in the area where he needed to be a citizen.

Thampy: Yeah, and there is an interesting side story to that, because then when I finished my-- Illinois, I mean, the thing about Stanford is that you are here, it's a great place to be, and then you can work, and you're challenged by that. So the thesis was sort of, you know, secondary to everything else. And whereas at Illinois, that's the only thing you can do. There's nothing else going on in Champagne Urbana. So and then I discovered at that time that an average Stanford PhD was four years or five years. And average Illinois PhD is three years, because they just wanted to get the hell out of there.

Kapoor: Out of there, right.

Thampy: And so in six months, I finished my work at Illinois, and came back to Stanford, because I had finished my work, but I had not returned my thesis yet. And so this was in '74, and I had done my PhD qualifying in 1970. And so in-between, so I would have probably never turned in my thesis either, because I had been back to work and I was enjoying that. And then Stanford put in a rule at that time that if you didn't finish your PhD, in seven years after your PhD qualified, then you had to qualify again. And the reason they did that was the Physics Department, the PhDs were taking 14 years, 15 years. Because they were using them as slave labor at Slack and so on and so forth. So they put this, you know, requirement. And I decided that it's been now six or seven years after I finished my undergraduate, and all the PhD qualifying is all undergraduate stuff. Nothing to do with the graduate work. And I asked him if there was no way I would requalify again. And so I had to-- so that was a forcing function to turn my thesis in. So I didn't-- even though I left Stanford in '74, I did not graduate till '77 or something like that. That's when I turned my thesis in. And as part of that, there's a funny story, which is, you know, then you had to defend your thesis. You write to your paper, you know, the committee of three or whatever, review, stuff that you put in that proves it, but it's allowed to go through a presentation and interview. And so I was convinced that Ed did not have any clout at Stanford, because he's now at Illinois. So I'm the last graduate student left at Stanford. So I told Ed that, you know, "Ed, you know, I'm really worried, because he had no clout here. You know, so what would the other two members think?" And Ed, I'm sure to make me feel at ease, he said, "Tell me that it's nothing for you to worry about, because Stanford has to pay my plane fare to come to Stanford to sit through your exam, and there's no way Stanford will pay twice in a year. Second. So you're guaranteed to pass." So that just is a comfortable thing. But you asked me if all the-- early on, and were the professors-- you know, Ed Davidson is probably the person who influenced me most in my life, in my career, in my other life, as a friend, as a professor, and as a thesis supervisor. And the sweet thing is for me is that both companies that I was a co-founder of, Ed was a consultant or advisor to both those companies. And one of my most striking experiences was Ed then went from Illinois

to Michigan, and he was the head of electrical engineering and computer engineering at Michigan, University of Michigan, and he retired there. And this must happen about 15 years ago, and he's-- by that time, Ed had produced 42 PhDs. And his secretary called every one of us, and said they were going-- they want to do a surprise party, farewell party for Ed, and they were calling all his PhD students. And 41 of the 42 of us showed up for that, and the only reason the other one was missing was he was no more. He had passed away. And so, you know, that says something about the professor, the guide, the mentor that he was to his graduate students. And three of us, his students, or four of us ended up in the same computer company that I co-founded in 1979.

Kapoor: Right, that's very nice. So going back to, a little bit back to the family side, in terms of your interactions with your parents and brother and Deepa's family, you kept in touch with them and did lot of things together?

Thampy: Yeah, all of it happened after we got married. First of all, I had the money and then we could go-- so we used to make trips every year to India. Maybe sometimes twice a year. So that was-- so we-- so there was a gap of about four years, '68 to '72 when I didn't see them except for this one short trip to India. And then we saw them, we saw my parents and Deepa's parents once a year for sure. And--

Kapoor: And where did your father retire after Zambia?

Thampy: Yeah, he did. And then he had worked for, let me see the first three prime ministers of India, Nehru, Shastri and Mrs. Gandhi. And Mrs. Gandhi appointed him-- he worked for her in the cabinet, but also then appointed him as the High Commissioner to Australia, and then later on as High Commissioner to Zambia.

Kapoor: Okay.

Thampy: And Zambia, the High Commissioner tend to be a senior person, because first encounter was one of Nehru's colleagues in the non-alignment movement. So they always send a senior person from India to there. Unfortunately, I did not have a chance to go to Zambia at that time. I was here, but that's an experience that I miss. But I made trips to Africa, but not Zambia. You know, we've been to Kenya and to South Africa. We made two trips to--

Kapoor: Right. So the other aspect that I like to bring up is I read about the connection with the Tata family. So I assume that it was through your father that he knew--

Thampy: Well, you know, like we sort of touched on it my mom didn't want me to go to Berkeley because I would not come back, marry one of those girls and never come back. And my father, you know, Tata's had the reputation in India as a very straightforward company to work for.

Kapoor: Very ethical.

Thampy: Very ethical, not corrupt, they were not involved in the politics. They cared for the country. Even at that time, you know, 60 or 70 percent of the Tata Group was owned by the Foundation, Tata Trust. So my father always wanted me to work for the Tatas. And so he, I think, talked to J.R.D. Tata once. And Ratan was-- Ratan had gone back to India. He had got his architecture degree at Cornell. And so on one of his trips back to the West Coast, I guess, J.R.D. told him to go look up Thampy Thomas at Stanford. That's when we met, actually we met him--

Kapoor: So that was the first time you met him.

Thampy: First time we met. Soon after we got married. No, maybe not, because after we got married, we went to Illinois, '73. So '74, 1974 was the first time I met him. And I think he went back to India because of--

Kapoor: His grandmother.

Thampy: Family reasons. I mean, his commitment to the family, and the Tata Group. And I think if he had been a completely free person, he would have probably stayed on, being an architect. I think that's his real love, so to speak. And so he tried to convince me to come back to India. And I told him that there was really nothing that I could do in India, other than be a manager, so to speak, because I had a very comfortable life. But not technically challenging thing.

Kapoor: Challenging.

Thampy: And by that time, I got the startup bug, and I wanted to do something here.

Kapoor: Being in Silicon Valley.

Thampy: Sili-- it's something. I think there is something in the air there. And if you're working in Silicon Valley, but if you're at Stanford, there is it there at Stanford, you know? And so I said, "You know, I would like to do something in India, but I do not-- there is really no opportunity for me there." And then 1979 when we-- when I decided-- or when we founded our first company, Elxsi, I thought there was an

opportunity there. So I went back to the Tatas and said that I'd be starting this computer company. And it would be great if they made an investment in Elxsi here. And J.R.D. Tata was really intrigued by that. And he made a decision-- I don't recall it exactly how much money they invested, maybe a million dollars or something. And but their entire foreign resource at that time was less than ten million dollars. That was the money they had before India was independent. Because after India became independent, everything came under the control. And so that was a big commitment for them. And we thought we would set up a joint venture with them in India. And so we decided to do that, and then it became clear that we couldn't do it for two reasons. One is that the government of India will not let us export that technology. And the government of India will not let you-- let Tatas be in that level of computing in India. They had reserved that for the government sector. So we ended up setting up that company in Singapore.

Kapoor: Singapore.

Thampy: Tata Elxsi is the name. And then--

Kapoor: So it was setup as Tata Elxsi?

Thampy: In Singapore. And I was the Co-Founder and the VP of Engineering at Elxsi here. And so I had-- so we got money from the Singapore government to do R&D in Singapore. So we, Tata Elxsi was the first computer company to do any kind of original computer work in Singapore.

Kapoor: Including multiprocessor, right?

Thampy: Let alone multiprocessing. Any computer work. And it's kind of interesting, because I know you know this, Intersil was the first semiconductor company.

Kapoor: Right.

Thampy: -- to set up an operation in Sing-- I think all of that helped. Because there was a reputation of Intersil, and the fact that they had an assembly operation--

Kapoor: I still remember your calling me about Juggi Tandon [ph?] who had the big operation in Singapore.

Thampy: That's right, because he was doing disk drives.

Kapoor: Disk drives, yeah.

Thampy: And so--

Kapoor: Even computers. He was making PCs.

Thampy: Right. So the government, so Singapore government gave us a lot of money. Set up a big-- gave us land for a big campus there. The building was designed by Charles Correa [ph?], it's still standing, beautiful building. And but then I learned sort of a well-kept secret, that there are no computer people in Singapore. And so you ended up hiring people from India and Australia and New Zealand, and bringing them to Singapore. And by the time you add the expert salaries and housing loans and the home leave and so on and so forth, it was more expensive to do anything in Singapore at that level.

Kapoor: In my interview with Ratan [ph?] that I did earlier, he mentioned that Elxsi initially grew rapidly and then the market collapsed.

Thampy: Yeah.

Kapoor: So there were too many competitors in that same domain.

Thampy: Right, right. We can touch on that when you talk about Elxsi. And so what I decided was that I just don't have the time to manage the engineers in Singapore, so what we decide, we brought the engineers from Singapore to California as sort of business-to-business transfer. And most of them ended up staying back here, and they were known to start other companies and very successful people. And so that then jumping ahead to 1992, the government of India let Tatas be when the liberalization happened. The Tatas could get into computers and then India and the U.S. became friendly and then we could transfer the technology to India, so then Tata Elxsi moved to Bombay, Bombay and Bangalore. And it's doing really well in India. And I got a kick out of reading of all the Tata companies, they were the best performing company in the last two years in the public market, and so that is kind of nice.

Kapoor: So who was-- you mentioned you were V.P. of Engineering at Elxsi. Who was the President?

Thampy: Joe Rizzi was the President. And it was Joe who I worked for--

Kapoor: Yeah, at Intersil.

Thampy: At Intersil. And--

Kapoor: Gonna say, this is very familiar, because I met you when I came back from Germany, and at Intersil from Eurosil and--

Thampy: And the idea for Elxsi was really interesting, in the sense that we did all our simulations during like mid-'70s on timeshare machines. And then the VAX-780 from DEC got introduced and that was the first time you could afford a computer, supermini, as people called it later on, that you could run-- you could afford to own one of them, and run your own simulations. And you know, as has happened ever since then that you get a computer, you think it is ten times more power than you thought you would use than in ten days, it's saturated.

Kapoor: That's what happened to them from Sun. You know, that the cost came down and the problems went up.

Kapoor: Yeah, right. So we got the VAX-780. We saturated it in about ten days. And at that time, the 780, they took the lead time on it was a year-and-a-half. It was 200,000 dollars, a lot of money. And even if you had the 200,000 to spend, it took another 18 months to get a second computer. So we started talking about that, wouldn't it be nice to have a computer whenever you run out of computing power, you can plug in another processor. And double the power, and three and four and five and six and so on. So that's where the idea for Elxsi came about. It was the first multiprocessor computer system in the world. And three of Ed Davidson's students were co-founders, me, V. Kumar was a Assistant Professor at Stanford. And Len Shar [ph?] was in charge of the HP-3000 operating system at Hewlett Packard. And then we decided that to build this multiprocessor system, you need to build it around a bus, and the bus needs to be a very high performance bus. And so we went looking for as a co-founder, a bus designer. And we met Mac McFarland, who did the PDP-11 when he was 18-years-old. He was a student of Gordon Bell at Carnegie-Mellon. And I was told that the PDP-11 architecture was Mac's paper that he wrote for Gordon Bell. And I think Gordon at that time was also working at DEC. And then he talked back into joining-- so Mac never graduated from Carnegie Mellon. I think he was a junior or a sophomore. And he went to DEC and he ended up building PDP-11. And the Unibus was also the first UNIFORM computer bus where there was no difference what plugged in. Before that you always had a processor and the processor generated a bus, and then you plugged in the peripherals. And then there was another bus between the processor and the memory. So there was-- if you looked at the block diagrams of computers at that time, there were three blocks, there was a processor, and the memory. There's a bus between them, and between the processor and the peripheral, there was a bus between them. So there was always a peripheral bus in those days. And so Mac was the first person who figured out "Why can't we have all of them operated on the same bus?" So that was the beginning, that was the Unibus. So Mac then invented Elxsi Central Processing, central bus was the fastest bus by a factor of ten at that time. We could plug in 16 processors. All you need is one, but you could have up to 16. A lot of memory, and all the peripherals also plugged into the same bus. And so we innovated in a lot of technologies that was the first

time computer was built where the user did not know how many processors were inside the computer. So a single job did not run any faster. But if you had ten jobs, and if you had two processors, it ran twice as fast. Or if you had eight processors, it ran eight times as fast. And so the-- and we built -- but when you have these processors, high performance processors and the memory all built into the same bus, then you couldn't afford too much traffic on that bus. So you had to have a cache on the processor. But then if you have multiple processors, then these caches have to remain coherent between the pro-- so we were the first people to build a cache-coherent bus and a lot of it-- and what is amazing is that then Next Gen, and then later on the Pentium [ph?] architecture all learned from cache call ahead and busses and multiple processors and stuff.

Kapoor: A lot of innovation.

Thampy: A lot of innovation then.

Kapoor: And I understand the business grew initially.

Thampy: Oh, so when we-- so our first processor was four times the 780. And then we could have up to 16 of them. And the very first year, we sold 20 million dollars' worth of computers. And the initial customers who had three semiconductors companies, actually Doug[ph?] the very first one for VLSI to do design rule checking. But it so happened that for design rule checking, what you needed was not computing power as much as memory capacity. Because if you can keep the entire design in memory, then you can do the checking a lot better than if you had to go get files from there.

Kapoor: Exactly. Yeah.

Thampy: So we are--

Kapoor: We're encountering that even now. You know?

Thampy: So you know, like the Elxsi machine could do a DRC in eight or ten hours that used to take ten days on a VAX-780. And so people were happy with that. A lot of VLSI Logic bought one of our machines. And then the other one was in seismic exploration. Where you get the seismic data, then you're looking for formations that would-- that may have oil in it. So a lot of exploration companies want our thing. And then there was, during the Reagan time, the Star Wars, Martin Marietta [ph?], because there were any other computer that could keep track in real time that many objects into play. So because of all of that, it grew really fast the first year. And then so this was '84. And then we built up-- we thought, you know, if you could sell 20 million dollars' worth of computers with really no application software, and we had then the beginnings of all the applications, the seismic applications, the real time, and also the semi-conductor

really design tools. So we thought if we have all of those, then we should be able to sell at least twice as much the next year. And what we did not realize was that was probably one of the biggest downturns in the Valley in '84. The semiconductor business went down, the seismic business went down. People started, because of the government did not have the tax revenues, a lot of the Star Wars funding went away. So we had ramped up to do 40 million dollars' worth of-- sell 40 million dollars' worth of computers. And remember those days everything was proprietary. We built our processors out of ECL gate arrays from Motorola. And the memory boards were proprietary. The disk drive controllers were proprietary. So when you wanted to build these things, then you had to order all those things much ahead of time. So to make a long story short, we ended up selling I think 25 million dollars or something worth of computers in the following year. But we though we'll sell 40 or 50, and we had to spend the money to do the thing. And the venture capital business went down the tubes, because the semiconductor business went down the tubes. The public markets crashed. And so we just could not raise the money, even though we had really terrific investors. We had Arthur Rock [ph?] was an investor, Tatas were. But Tatas did not have the resources outside India to help us. And help us to a significant degree. And Bill Hambrecht [ph?] was on our board, and so then we decided to merge with Trilogy, Gene Armdahl's company. And it was an interesting combination where they had raised three hundred million dollars to do wafer scale integration. And they had, I think a hundred million dollars left over. And but no product, and we had a product but no money. But what we did not realize was that was my first experience in virtual cash, in the sense that even though they had a hundred million dollars, the money was going out at the rate of five or six million dollars a month, because if they had a semiconductor fab line that they had to maintain. And so we-- Trilogy ran out of money, too. So the last surviving thing of Elxsi is a lot of technology and the Tata Elxsi. So that's--

Kapoor: Right, right.

Thampy: I think that's what Ratan[ph?] was alluding to.

Kapoor: Right, right. So that transitioned into Tata Elxsi then.

Thampy: So then I left Elxsi in-- after the merger with Trilogy. They had an engineer in Carl Armdahl [ph?] was the V.P. of Engineering. And so I thought this was probably a good time for me to step away. And then I wanted to get back into the semiconductor business. I loved, even though Elxsi was the first computer company that I work for, and then somebody was telling me the other day that Kumar and I were the founders, very first Indian co-founded a computer company in America, and I think that is true. I should figure out a way to double-check that. I'm not aware of anybody on the West Coast who founded a computer company. And so but I wanted to get back into the microprocessor business. And the big thing those days was reduced instruction set computers. And you know what happens, like when you're in a startup, you have your blinders on, and you have no idea what else may be going on in the microprocessor business, because I was starting more in microprocessors at that time.

Kapoor: Right, and I was at Intel and this opportunity came to go to Sun, work on the Sun architecture, so same thing. Assist RISC. So.

Thampy: So I decided that I wanted to learn about reduced instruction set computers. And as luck would have it, Skip Stritter, who was one of the founders of MIPS and the architect on the 68000 at Motorola was also my senior at Sta-- no, I think we were classmates. So I called up Skip and I said to Skip, "I want to come and talk to you, you can tell me about the reduced instruction set computers." And as Skip was describing reduced instruction set and how we can build fast machines with that, and it suddenly occurred to me that it's definitely true. If he had only at that time the state of the art was 386, which is about 300,000 transistors, so what they were telling was absolutely true. If he had only 300,000 transistors to work with, reduced instruction set was the fastest way of building computers within that computer transistor budget. But I was thinking that even if you had another 200,000 transistors to work with, maybe you can translate an existing instruction set in real time. And then do reduced instruction set at the backend. And so that was idea of Next Gen. And for that--

Kapoor: Was that related to your thesis? Your PhD thesis?

Thampy: Oh, it was thesis and the architecture was related to my thesis by applying, and so on and so forth. But this was really sort of a business idea in the sense that all available software out on x86, everybody had Sun and MIPS and all had-- even Intel-- had reduced instruction set. To the extent that Intel felt that there was no future for x86. So they told Compaq and Olivetti that they had 386, 386 is what made Compaq, Compaq. And so they're-- and Olivetti, Olivetti in Europe. They were the-- they built the fastest machines in Europe and Compaq built the fastest machines, both based on 386. So Intel told Compaq and Olivetti that the next machine that they were working, 486, was going to be the last x86 machine. And Intel is going to switch over to the single i960, which was a reduced instruction set machine. And but the we came to the conclusion that we can do both. And so we went over to Compaq and Olivetti and told them about it, and they thought we were manna from heaven, because for them, they were scared of Sun.

Kapoor: So you did that under NDA? Non-disclosure agreement?

Thampy: I don't remember. I think in those days, nobody did NDA. VCs never did NDA.

Kapoor: <laughs> Okay.

Thampy: But we didn't think that it would-- well, no, it is kind of interesting that so Ward Canyon [ph?] was excited about it. Bill Gates was. And Olivetti was. And Rod then tried to put us in together with Intel. But Intel had no interest in it because they had decided that the RISC was a way to go and they put all of their thing on 960, then to follow on Itanium, the one that HP used. So Compaq and Olivetti founded us.

So we were an unusual startup in the sense that our first two investors other than the seed money was the two corporations Compaq and Olivetti. And then Mitsui invested in us. That's how I met Ashima [ph?]. And Intel-- but Microsoft really helped us. But they were not-- they sort of helped us behind the scenes. They gave us the source code for MS-DOS because you build a 360 or x86 it doesn't matter how fast it is, if it doesn't boot up MS-DOS it's no good. And in those days, the microprocessor instruction sets were not as well-defined as instruction sets were. So all of the exceptions were not properly specified. So for us we needed to-- if an exception occurred, it is easy to do the 386 instruction set but we didn't know is what happens if an exception happened. It divide by zero or something like that then what happened and what did the software-- more important what did the software depend on to happen? And so we got the-- Bill Gates gave us the source code for MS-DOS. We had the crown jewels at NexGen. And so we could run our simulations on that. I think we could do if I remember it right, maybe 100 instructions a day or something like that in terms of simulation. And they-- Intel had really no interest. But Intel never gave us any trouble in the sense that they recognized-- they knew what we were doing because we went and gave a presentation to them. And so I always tell people that we were the only company that ever competed with Intel that wasn't sued by Intel. And so David House knew what we were doing. David was running the microprocessor group at that time. And then another thing that happened to us is we didn't realize it at that time, the people who-- other than Intel, the people who had the best processing technology was IBM at that time. So we had IBM do the manufacturing for it. So one story I really don't know is why Intel didn't sue us is IBM was manufacturing these processors for us. So probably IBM had the right to manufacture using Intel patterns. They probably had cross license. I still don't know. But I think Intel also respected us because we were really bringing new technology into the marketplace. And then we went public and the name-- they bought us after we went public. But interesting side story was that AMD paid us $850 million which is a lot of money in 1994. And then they turned around and sued Intel for patent infringement on the Pentium because Pentium then followed a lot of our architectural innovations, bus following, decomposing the 386 instructions into reduced instruction sets, so on and so forth. They ended up settling with Intel for $2 billion or something. So that turned out to be a great return on investment on their part.

Kapoor: So on NexGen who was the president? You were running it?

Thampy: I was the president. And then maybe five or six years in Atiq had joined us from VLSI. Atiq was in charge of design automation. And one of the challenges laying out the Pentium chip was really design automation challenge too. So we felt that Atiq would be really helpful. So he joined as a VP of engineering. And then two years later in '92, he became the president and I became the chairman. And then in '94 we went public which in hindsight turned out to be a fortunate thing for me because I had no requirement to go to AMD. Atiq, since he was the president of NexGen he had the obligation, which turned out to be a good thing for him because he became the president of AMD and did really well.

Kapoor: Right. So I remember from a technology perspective, you mentioned IBM was the foundry. I remember Atiq coming to me at Cypress to look at the Cypress…

Thampy: Well, we tried to do that with Cypress too. I remember that.

Kapoor: Yeah. So in the end, they stayed with IBM or who was the foundry? When AMD bought it…

Thampy: Well, then AMD bought it and then they started doing it.

Kapoor: But until then it was still IBM.

Thampy: IBM. Yeah.

Kapoor: That's very interesting. So talking about your career so then after you left when AMD bought it, what was the next step that you did?

Thampy: The next step was interesting because the company went public. We, for the first time, '94 was when Deepa [ph?] and I were without debt with some spare cash in the bank. And then it was a long-- Elxsi was from 1979 to '85, that is 6 years. And NexGen was from '85 through '92. That's twelve years of startups. And so I really wanted to take some time off. And around the same time Joe Rizzi after Elxsi iced (?) out at NexGen Joe joined Matrix Partners as a partner. And he did really well. His first two investments were Veritas Software company who became then Symantec after that. And then the flash-- the name will come to me. Not Synotech. Well, the name will come to me. And so his first two investment were just great. He made a lot of money for the partnership. But he also decided he had by that time eight years of venture capital, I think, at the same time, same duration that I was at NexGen. And he was thinking of doing something on his own investments. So Joe and I started doing a sort of angel investments in the '96 timeframe. So our investment model was that we'll find something interesting, a good group of founders. And if they can do the first product, proof of concept in $3 or $4 million, then we said, okay we will put together that money. And then once the concept is proven, then we'll go to the venture capital people for the expansion money. So that was our portal. And it all worked out really well because in the '96 to 2000 timeframe the VCs were not interested in funding small startups. They all wanted to do dot-com. So if you had a clever piece of software, or a design that required 2, 3 or $4 million they had really no interest in funding that. So we funded the very first synthesizable core company Virtual Chips. They had a model of a bus interface for the PC bus, IBM PC bus, PCI bus. And so they will send that synthesizable core to people who want to do logic but they wanted something to interface to the bus directly. And they got-- it was a great exit. _____ who founded that company got bought by Phoenix Technology which is the BIOS company. And then we funded PostX which is an encrypted email company. And then a sort of reverse of Virtual Chip as a company called Real Chip [ph?] where the idea was interest in the size of a core, we'll make real cores and then put them for big designs. That didn't work out really well. But PostX got bought by Cisco. They're still using some of that technology. And then along the way the most interesting startup we did was a company Liquid Robotics which was invented by a person called Roger Hine. And the invention was doing a marine robot where the entire propulsion was

waves going up and down and which provided the forward thrust. So all of the mechanical powers generated from waves. And then they had a solar cell at the top for communicating with satellites and GPS systems and so on. And it turned out to be a very successful product. Initially, the people who bought them were all intelligence agencies, CIA.

Kapoor: So this is a nonprofit…

Thampy: So the nonprofit is-- I deleted the nonprofit part. The initial partner that research was funded by a foundation that Joe set up called Jupiter Foundation. So Jupiter Foundation funded Roger for twelve months, fifteen months to develop this technology.

Kapoor: This is purely from the love of nature?

Thampy: Well, it started in a very interesting way. Joe has a house on Puako. It's a beach in the big island. And that's on the migration path of whales. And he got interested in listening to whales. But he needed something that he could moor in the ocean not close to the beach because they had this thing called snapping shrimp which created a lot of static so he couldn't record the whale sounds properly. So he was looking for a solution that records whale sounds but in the middle of the ocean or at least far away from the snapping shrimp. And so he had first he had a moored buoy which was moored in the ocean with the chain and weight, you know, the traditional way. And every time it lasts for three or four months and every time there is a big swell then the chain breaks. And then he has to go looking for the buoy. Fortunately, he could because it had a GPS system on it. So it's amazing how these great inventions start because he was postulating wouldn't it be nice to have something stationary in the ocean that is not moored down? That can stay on the ocean floor, on the ocean surface but be stationary. So that was his thought because he got tired of chasing his buoy after it broken off. And so one of his-- Roger Hine was his friend's son and was a robotics engineer from Stanford. So I bet it was a picnic in his backyard or whatever. He talked to Roger about it will be great to invent something that can stay. And then it becomes a very challenging problem because it cannot be battery operated. It cannot be solar powered because you cannot generate enough power to sort of overcome wave thrust so that it can stay stationary. So then Roger came up with this design which was a two part design, a float, and an eight-foot chain with a submarine sort of structure at the end of that eight food chain. And it had fins, passive fins, spring loaded. And so what happens is that when the waves go up and down, the float go up and down which will drag this submarine portion up and down. And then because of water pressure or the water column, the fins go-- you know, it's sort of like an up and down motion which creates the forward thrust. So the waves going up and down created the forward thrust. That was the theory. And then they made it work. And it was just an amazing piece of invention because normally any kind of diesel powered or battery powered thing that stays in the ocean, you need enormous amount of energy to overcome the waves. In this particular case, the waves provided the thrust. And the way then they decided-- but it cannot stand still. It always went straight forward to speak. And the way they made it stand still was is they put a rudder on it and made it go around in circles. So the circle was like a 50-foot circle but in ocean terms it's a pinpoint.

Because if you have an ocean floor that is two miles down, the best you can do even if you chain something down you can keep a three-mile radius. So the fact that it can keep a 50-foot radius was pinpoint. And at that point, Joe wanted me to get involved with it because he wanted to sort of making the commotion operation. And so I joined. And then we spun off this company called Liquid Robotics from Jupiter Foundation as a standalone entity. Got it funded. And initial customers were all intelligence agencies. Well, Joe used it to listen to the whales. But intelligence agencies were interested because they can have now something that they can without-- you know, it doesn't have a motor so it doesn't make any sound prints, voice prints. So nobody can detect it. But it did like one-and-a-half or two miles an hour, two knots an hour. But what they could do is if they wanted to monitor some area they could drop it out of a plane, monitor it and then bring it back. So it can swim home, so to speak. And even though it took two months to come home it didn't matter because the mission was done. And it has gone from here to Japan and back. It has circumnavigated the earth. Now, it is commercial applications for not only intelligence agencies but for seismic exploration, offshore oil exploration. It can use it-- you can literally put a picket fence around a country. You can put these things in the ocean and decide what crosses it. People use it for…

Kapoor: So you have a lot of data gathering.

Thampy: Yeah, drug interdictions and so on and so forth. And the company did well. And then last year, which is my last startup, Boeing bought them. So I have more involved in startups. I'm involved in Deepa's [ph?] book project.

Kapoor: Yeah, that is excellent. I noticed that there's been an intersection with Joe Rizzi.

Thampy: Yeah.

Kapoor: So maybe you can say as few words about him and his role in effecting your life or whatever.

Thampy: Well, it so happened that I have spent more time with Joe than anyone else in the world, including Deepa. I've known Joe before that and we worked together. We started one company together. We invested in companies together. He's one of the cleverest people that I have-- clever in the-- I mean that in in a very high comment. A lot of us are intelligent. But some people are just clever. They can think about things that just off the charts that somebody would never think about. I know that you know this at Intersil one of the problems with programmable memories was that you-- we blew the fuse, the fuse link. And the problem was some of them grew back or settled back. And Intersil had this thing where it was what they call avalanche introduced migration, AIM, which was the problem that we were all sort of afraid of is how do you _____ electrostatic energy in a swap _____ shorts the input paths. So we used to protect it. And Joe used that as a way to program and to make that thing happen in a controlled way so that he can program a bit that will stay programmed forever. So that's one idea. Roger invented the Liquid

Robotics Wave Glider but it was Joe who asked the question, who posed the question. I would never think of it. First of all, I think of, who the hell wants to listen to whales? Or this ability to take it as a hobby and then worry about then you have all of this static in your sound recording. And the first approach was okay I'll filter it out. But the problem was you couldn't filter it out because it was so random.

Kapoor: So it's his attention to detail.

Thampy: Yeah.

Kapoor: And I remember the criticism of Shep Hume was that he had great ideas but once implementation came he was not interested.

Thampy: Yeah. But Shep was a very clever guy too.

Thampy: He was also very clever. And, you know, one of the privileges of working in the semiconductor business or the two startups that I was involved in these guys are-- see I look at myself not as an inventor. I look at myself as an editor. I can have really smart working in my group and I can sort of synthesize their ideas or pick a direction. Ideas rarely originated from me. The two ideas interestingly enough that originated from me was why can't we make Intel's instruction set intro reduced instruction set? And this whole idea of why can't we have processors that we can plug into your bus? So those two things did occur to me. But a lot of inventions needed to make it into reality and it was Len and Kumar and Mac McFarland [ph?] and Nick Trednick [ph?] at NexGen who Nick did the circuit design for the 68,000 with Skip Streeter [ph?] interestingly enough. Skip was the architect. Nick was the circuit designer. So you have-- you interact with all of these bright people and you feel so fortunate to do that. And it's a privilege to be around.

Kapoor: Yes. I feel that. I mean even the project we were doing the CMOS microprocessor, the first CMOS microprocessor. And how it affected the Intel and all of that. It's amazing.

Thampy: Yeah. So I feel it's a-- I lived a privileged life. But I always think one of the-- when Mitsui was an investor in NexGen when I was in Japan they took me to see the _____ Masushita [ph?] who started-- it's sort of like going to see JRD _____. And I mean in term but it's just it's two generations before that that Tata started. But they already made Tata into what the modern Tata and then Ratan built on that. So here I am sitting in front of this 85-year-old person and I'm trying to make a conversation. So one of the things I asked him was how do you hire people? And he thought about it for less than a second. And he said, "Oh I just hire the lucky ones." And I think luck plays a really important part, in one's life. And if I had not met Ed Davidson at Stanford or Joe at Intersil or Deepa in an accidental meeting, my life would have been very, very different. So even though I have done well in my life I always think you

could have been something different. A lot of people paved the path. Or if my dad had not talked his grandmother into giving him her jewelry our life would have been different.

Kapoor: So you raised a good family. Maybe talk a little bit about your boys.

Thampy: Yeah. The boys had-- it looks like it skips a generation in terms of careers. One of my favorite experiences was when Ahin [ph?], our younger one, was seven or maybe ten years old. They had Portola Valley in middle school they had a career day. And so the thing is that so the parents come, the kids are there. And so the teacher will ask the kids what do you want to be when you grow up? And for me the most amazing thing was very-- actually nobody in that class wanted to be something because their dad was a doctor or an engineer or a mom was a doctor, or dad was a lawyer. It was always a grandfather. It was always I want to be a doctor because my grandfather is a doctor. And it just happened-- clearly happened in our case because my dad was a lawyer. There are nine siblings in my family, five sisters and four brothers. None of us became lawyers. But there are at least four grandchildren who are lawyers and doing really well. So Suneil is a lawyer, the older one. He works for Google. But he came to Google in a very roundabout way. He was-- he did law. He was very interested in environmental law. And he worked for a nonprofit called Nature Conservancy. He was their policy person for California. And then we started or when we were part of getting Liquid Robotics off the ground he joined Liquid Robotics as the lawyer. And the reason for that we thought there were interesting legal issues to be looked at because we are crossing international boundaries and you're collecting data across international boundaries. And a lot of countries have even the-- you have twelve miles worth of the boundary. But a lot of people can claim 200 miles of economic zone. So the question was can you go to somebody's economic zone and collect data? Who is-- and we also thought that the initial applications for Wave Gliders for Liquid Robotics would be ocean monitoring, monitoring of islands, monitoring of ocean life, marine life. So we thought his background in conservation and in environment would be of use, even though he had no background in robotics in the ocean. And now the question is what happens if a ship runs over it? In most cases, noting would happen but it could get intertwined in the propeller of a ship and the ship gets damaged, who is responsible for it? So not that he had any experience in that but nobody had any experience in that but he was a smart lawyer. So for me that was a really terrific experience where I worked with Sunil as we were all learning all of the complexities of maritime law, robotics. One thing that I learned is that all of the maritime law is written about around a concept called a captain. So there is a captain. So the captain is responsible for the men and the ship and the cargo. So now a Wave Glider robot does something stupid. Now, who is the captain? Is the captain the guy who is controlling the glider or in some cases the glider is controlling itself? So is it the person who wrote the software and so and so forth? So there are interesting legal questions. And so he did a great job there. And then he ended up joining Google's cloud division. And there also he is in the AI pod of Google. And there are interesting challenges in the AI. One of the-- last year one of the more interesting things that he ran into is that they put out a facial recognition software as part of their cloud offerings. And somebody showed him the face of a black guy and the software identified it as a chimpanzee or something like that, which made all of the Internet things and so on. So you get into challenges like that. And so AI is a blessing but it's also a challenge for us, especially we look at America in terms of the employment and the opportunities for the less educated people.

Kapoor: Yeah. In fact, I was going to ask you about the current challenges that you see and how to address machine learning and AI, all of that.

Thampy: Yeah. You know, for me Trump getting elected was a really wakeup call for me in the sense that I think a lot of us should take responsibility for that to have happened in the sense we all believed in trade which is good. The overall wealth of the company or the nation goes up with international trade. But what we forget is that there are a lot of people who get hurt. And the people here including me, you and me and Deepa [ph?], we get all of the benefits of the trade but none of that disadvantage. And so I think in that respect it has been a wakeup call. I think if you look at the industries that the trade helps the most are all technology, for sure, because we sell more stuff than we buy in technology and pharmaceutical, Hollywood, the financial services. So if you look at it, these are the four sectors where most of the senior people are democrat. So you would think that they would have thought through the second order effects of free trade. And we did not. And I think it has been a wakeup call. And in a funny kind of way it is happening In India now because India became a middle-class country because of technology offshoring. But a lot of the now the lower levels of that are getting automated. So a lot of Indians in that sort of coming up to the middle class are getting laid off. So you could have the same sort of reaction in India that we had in Detroit with the auto workers. And what brought them to the middle class is sort of now pushing them back.

Kapoor: So as you mentioned, certainly AI is causing a lot of discourse in the world about the future employment issues, unemployment issues. So certainly some food for thought.

Thampy: It really is. I think the fact that all of us are thinking about there are very few things that are personally speaking that we should be grateful to Trump for but I think this is one. He made us think about it. Nobody else had. Obama for sure had not. And even though I admire Obama a lot. But I think what happens is we all live in a world of our own and we don't know what people in Kentucky or Ohio are going through.

Kapoor: Right. It's interesting that my conversation with Ratan Tata, a _____ conversation, there was something that happened at the time as the computers being introduced in India, and there was a reaction. Everybody said we're going to lose employment. And his dad wrote an article because he represented ILO, India in the ILO. And he wrote an article defending why computers would be good for the country. And it turned out that it turned out okay for India at least for that because it was a growing thing. It actually helped the country. But the same kind of discourse can happen on the AI front.

Thampy: Yeah. And there are some people-- this is something I really admire about Tata's. There are certain things-- you know, automation puts people out of work but that's what happened with the steel plants. You know, they want to automate the steel plants because they couldn't compete in the international market, which then put a lot of their people in Jamshedpur out of work. But what they did is they told all of the people who they are putting out of work that their salaries are going to be paid even

though they're not working at TISCO until they retire. And it turned out to be in hindsight it turned out to be a good thing because they made more money automating the things and these people with their salaries could go do something. Hopefully, they did something on their own. I think, for me, that's an example of a more forward looking way of dealing with automation is we need to be sensitive to the people that it is negatively impacting, who in turn, that negative impact provides more wealth to us, so to speak whether it comes from the stock market or our own businesses.

Kapoor: Right. So in terms of challenges, you know, certainly we are talking about the computational world and the computer world and software. But the biology in the case of biology and the brain research and whole medical profession and how to improve the lives of people, there's a lot of interesting things happening.

Thampy: It is. And it is a problem in a sense, in the sense that as I was telling you my retrieval time is getting slower. And so I am 71. And I'm healthy. And so then you wonder in ten years I may continue to be healthy but there may be aspects of the quality of my life. It may not be that interesting a life. So I think that's going to be a big challenge. And I think it's more than medicines are going to make us age…

Kapoor: For a long life, but not necessarily a quality of life. So there's a whole discourse happening in that world as well.

Thampy: Yeah.

Kapoor: So I wanted to unless you want to talk some more about this subject, we want to transition to what your recommendation would be to the future generations in all aspects, whether what kind of careers to choose or how to help the community or the world around us.

Thampy: Yeah. I think I am jealous of the kids who grow up in America, in the sense that there are no pressures on them to become a doctor or a lawyer or whatever. I remember one of the first letters that I wrote home when I came to Stanford was, you know, smart kids take English at Stanford or graduate in history or whatever. And see that world has gone away too because my first job out of Stanford at National was making $1000 a month, not even $1,000 a month, $10,000 a year. But you could be a high school teacher and make 7000 or something which wasn't a bad deal because you got 3 months off. But now the delta is 150,000 and maybe 60,000. So the opportunities that people had in America of choosing one's own path may not be as readily available now than it was 40 years or almost 50 years ago when I came. So people need to be sort of career conscious. But within that I think you have a lot of freedom. You don't have the family pressures to follow the family business, or become a lawyer or join the Indian administrative service or anything like that. So I think they are a privileged bunch. And at least our two sons, we are really proud of who-- they are now 43 and 39. The 39-year-old he and his wife are expecting the first child in another three months, our first grandchild. They've really done us proud and we're really

proud of the men they have grown up to be. And Deepa and I talk about this in the sense that the way they deal with their partners are different than most Indians, including me, deal with their spouses, most men. There is a-- you know, you sort of assumed in the old days that women had a place and the man is the boss of the household and so on and so forth. But it's really amazing to see these kids. They treat each other equal. There are no expectations on who is going to cook the dinner, those kinds of things, minor things. But they are big things, I think. And so I enjoy watching them. And I think their kids will have even a more equal life.

Kapoor: Right. Thank you so much.

Thampy: Thank you.

END OF THE INTERVIEW

