Oral History of Chi-Foon Chan

Interviewed by:
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Kapoor: On behalf of the Computer History Museum I would like to welcome Mr. Chi-Foon Chan. Dr. Chi-Foon Chan, he is the Co-CEO of Synopsys. And my name is Uday Kapoor and I am the volunteer in the Computer History Museum for the Oral Histories Program. And I'd like to welcome you to this very important interview. We can start from your childhood. I believe you were born in Taipei, Taiwan, in 1956. And, so, maybe we can start with that. Tell us about your background.

Chan: Okay. Well, first of all, thank you for the honor of coming here. And this is a wonderful institution. And it's a big honor, because you've been a good colleague, good friend, and good customer. So, thank you. And it's a big honor, because I was born in 1949. So, thank you. I wish I was born in '56-- make me younger. But I was born in 1949 in Taiwan, in Taipei, as you said. And in my early life I was-- I think I did the reverse, if you know '49 is a pretty historical time in China and Taiwan. But when I was three years old I went to Hong Kong. You know? I did not go there voluntarily, because I was three. My parents were there. So, we went to Hong Kong. Most people were going the other direction. And then I stayed in Hong Kong until I was 18-19, and then came to America, and have been here since 1968.

Kapoor: I see. So, tell us about your parents-- or what did your father do? And how many siblings you have?

Chan: Thank you. I have one brother here, who's a lawyer, Chi Hung who's in Logo [ph?] City and two sister who is in Hong Kong right now where my mother is. My father passed away about two years ago at 96, had a very good life. I can tell you briefly about our family history. I don't know how much of it is true, but you grew up listening to all these stories and they become embedded in your memory. But we grew up-- I'm eighth generation Taiwanese. And because Taiwan has a lot of family history, we have the family history book at 32 generation of Xiamen [ph?]. And then 40 generation ago came from Kaifung; it's about 757 and the Tang Dynasty. But the key thing is my father was always a businessman. I'm trained as an engineer, but at home I'm always talking business. I think that's why. Eventually, I'm a reluctant managerial businessman going into business. But he-- our family history's quite-- a little bit interesting, complex. And I don't know if it's true or not. We were poor and then rich and then poor and then rich and-- mostly because my father's very ambitious in business. And, so, when he went to-- we went to Hong Kong, because we had the mining rights for seaweed in the-- you know, right now in the news is all these South China Island? One of islands is called Tungsha [ph?] Island. It's that-- it's one of the group. It's the eastern [ph?] archipelago, Pascatori [ph?] island. He had done the mining right for seaweed and some partner took the ship. So, he chased him all over Southeast Asia; 1949, you don't go sue a lot of people. You just go chase people.

<laughter>

Chan: And, well, it's 1950, ended up in Hong Kong, not having a lot of money, stayed there, make some money and then eventually get the family over. So, that's how we grew up in this era.

Kapoor: So, you don't have memories of Taipei, I assume, because you went to Hong Kong at an early age.

Chan: Not that much, but because eventually we do go back and forth, you know, like, at home with my parents, we speak Taiwanese, right? Fujianese. And then-- but in Hong Kong you speak Cantonese. And then I learned Mandarin in America. You know, so.

Kapoor: So, how was your schooling like in Hong Kong and what kind of schools did you go to? Were there any mentors? Any special teachers?

Chan: Yeah. I would think some people who influenced me a lot. Just to complete that picture, I think my father went to Hong Kong and this is what influenced some of our thinking, because eventually he did business and got rich. And the way that he did business, got rich, is because most of the fishermen were-- most of the seamen who were fishing were Okinawans. So, now, the Okinawans come back and they start trading and trading in brass and copper, which is necessary in Hong Kong. And one of the ways you get those was they were mining the beaches. If you know Okinawa, the beaches has a lot of metal after the war, right? So, that's how you get trading done. And, so, when we were going to school we had a lot fishermen and everybody around. So, why are they influential? Well, when I was early on in my age, our family life was quite good and rich. But then the fleet got too close to Vietnam and there's a lot of things that got confiscated. So, we were mostly bankrupt during young ages, from I guess it was fourth grade to college. So, school was very important, you know? So, I went to mostly subsidized school. Good school in grade school in Tuxian [ph?] and partially my high school was very-- I found very strict, but very good. They were run by Jesuits. So, between Okinawan seamen, drinking at home, coming back every two weeks, and Jesuits, I had a very-- I think, shaped my character in many ways.

Kapoor: Good. So, what kind of mentors did you have as teachers? What subjects did you like?

Chan: Yeah, I always like to learn and a lot of other things. I think some of the teacher who influenced me are the one that actually show good character. I mean, I was interested in what they teach, but mostly I was interested in them also. So, I liked my math teacher. I think that's why I like math. I don't think I like math and therefore I like my math teacher! <laughs> So, I think you are very much influenced by a lot of the people that comes in and teaches you stuff. You know? Yeah. And then my mother is obviously the dominant influence in the family! You know, host [ph?] of disciplinary side of the business, of the family.

Kapoor: So, you mentioned one brother. Did you have other siblings or just the--

Chan: I have two sisters. Yeah. My brother become a lawyer here. I have two sister. They all came to school in U.S. and they went-- I mean, my brother's here, but my two sister graduate here. I mean, Grace and Doris, and went back to Hong Kong.

Kapoor: So, after school, how did you select or where did you go to college?

Chan: Good question. I was very much-- my family financial was not great, but I always like to come to America. My brother come first. And in '67-'68 Hong Kong was actually in a very tumultuous [ph?] time. I actually went to school-- you know, in Hong Kong the university is three years and the high school goes to 13th grade. So, I almost went through 13th grade, which is 12, and 13 is the college system, right? And

then apply, my mother said, “Well, we’ll lend-- we’ll borrow money, lend you money, just go to U.S.” So, I apply and I ended up at Rutgers State University of New Jersey. I didn’t quite know where New Jersey is. I just know it’s in America. I was very excited. And it happened to be a good choice for me.

Kapoor: So, you had good undergraduate education, like you mentioned, the 13-year schooling.

Chan: Yes.

Kapoor: So, you had good engineering or technical schooling?

Chan: I think I ended up with the best of both. I think in the interviews-- see, I considered myself a very lucky person, just a lot of people helping me. Lot of decisions that come are just luck, in my mind. And I came and I got to Rutgers. They gave me a scholarship. I can’t-- that's the only way I can afford it. I was great. But I started in the freshman class and it’s very clear after one semester, it’s very-- the teacher said, “You need to place out of the class,” because in Hong Kong, they’re very focused on one thing, but not on the other. And math was very focused, like, you know, you’re in partial differential equation and you started with X-Y graph. So, actually, I tried to place out of the course, but they take $25 per course to place out and you place out physics, chemistry, and there’s-- I don’t have money to place out of the courses. So, I ended up taking other courses-- psychology, economics-- second semester to get to the-- because you cannot take EE course without going through. So, I think luckily that provided later on actually a much more-- a very useful platform, which I was not planning. And then I think the other good thing was I met a professor named Tom Marshall, who eventually became the dean. And he was just brand new coming in from-- I remember from Stockholm. Chalmers University? I don’t know all the-- I was a young student. I was fascinated every day when I wake up by everything. And he need a-- he wanted to have-- he was brand new, so he wanted to do some research. And I was a junior and there wasn’t that many-- you know, because he just got there, not many grad students. So, I did an honors thesis with him my junior and senior-- I learned a lot, because probably one of the most complex thesis I’ve done. And one day I think I’ll go back and read it and maybe understand it.

Kapoor: Right. So, you did you masters there, first.

Chan: After that I apply and I did my master at Case Western in Cleveland, Ohio. So, I was trying-- now trying to go West. You know? Yeah.

Kapoor: And, so, that was what field? So, how did you choose your specialty?

Chan: Great question, because I got very excited about the electrical engineering and then thesis on doing tridiagonalization of matrixes on my bachelor’s thesis and, basically, on optimization. But I was always interested in the biology side. And-- which I don’t know; I was just kind of interested. So, I apply and I was in the MD-PhD program of Case. That’s why I went to the biomedical engineering. Yeah, but after one semester I did go take all the phys [ph?]-- One semester I realized that I really much more interested in the computer side, because it was kind of touch dissenting animals. It was a side I didn’t bargain for. <laughs> It was not the studying. So, I went into computer engineering. And, you know, I

believe Case is the first university in U.S. to have a degree in computer engineering, an accredited degree in computer-- because it's a combination of computer science, electrical engineering-- at that time it was system engineering, right? So, that's where I did my master.

Kapoor: And then you continued on to do your doctorate.

Chan: Right. Interestingly, my master may be the only one-- at least that I know of, that did a master degree on the light bulb, okay? Actually, it was published in the proceeding IEEE. Probably one article you can see on a light bulb! <laughs> Because General Electric, one of the main profit center is light bulbs. And the main headquarter for light bulb for GE is at Leader [ph?] Park, Cleveland, Ohio, where Case was. So, they sponsor my master, because I needed financial aid, right? And, so-- but it was the beginning of pattern recognition. Because I joined the company-- I joined Case computer engineering department in the digital signal processing. Dr. Winlen [ph?] was my master-PhD advisor. And the-- mostly in facial character recognition and speech recognition. And this was trying to examine lightbulbs filaments, because, electrically, you know that they can be-- you can test whether it's connected or not. But they're not connected mechanically, it will still fail. So, you have to do visual inspection. And I think it really was huge [ph?]. So, it was a strange topic to talk-- I know a lot about light bulbs, which may not be useful. <laughs> So, then I continued to do my PhD in signal pro-- and then Dr. Winlen was a really good professor who taught me a lot about signal processing. And the head of the computer engineering department, which is new, was also a very interesting person. His name is Ed Glaser. You know, every inspiring person, because one of the first course I took was computer graphics from him. We have an Evans and Sutherland graphical machine, right? And he tried to teach you how to envision-- you know, you have a donut and you have a sphere hitting it, so you had to look at the cross-plane. Envision the cross-plane of every one of these. And it was first mathematically challenging. And it's inspiring, because, if you know, Ed Glaser's blind from four or five years old and teaching computer graphics. A very optimistic guy. Very inspiring, very technically strong. It's just great experience. I mean, I'm always in awe of the people I work with or learn from. And, so, I did my PhD in digital signal processing, basically, on speaker-independent speech recognition, which is quite a fashion at the time. Of course, machines-- we don't have your machine yet. <laughs>

Kapoor: So, what year did you get your PhD?

Chan: I got my PhD in '77. I graduated in '72. My master in '74. So, you see, I'm a very-- exactly at the regular pace, not fast, not slow! <laughs> You know.

Kapoor: So, what happened after that in terms of your career after you got your PhD? Were you looking for further research or were you looking to work in the industry?

Chan: Yeah, we'll come back to the personal side later. But I graduate in '77- '75 got married. So, '77 I'm looking for a job, right? I need to make a living, get a job. And I didn't have permanent residency yet. So, there are not many jobs available. I'm in the process of applying; and, so, in between I work at PK X-Ray. But the year after I started looking for-- I got my permanent residence and started looking for a lot of jobs. In the first year, before my permanent residency I think I have, like-- I make eight applications; I get one

offer. And then next year, we talk about-- I make application again and get eight offers. So, life was good. But I really appreciate that one year I spend at PK X-Ray, because I was a mathematician for the CAT scanning, which is at that time, the Nobel Prize was just handed out a few years ago to the Hounsfield for the CAT scanning. And the CAT scanning is mostly a matter of-- it's actually a two-dimensional Fourier transform your brain, the back projection. And just because you are engineer, exciting to me was one thing was you have to know the difference between the skull and the brain, right? Because if you don't have enough resolution-- since it's a Fourier transform, it just pass filter. If you don't know-- if you are under them, you don't see the tumor. You over them, you think you get hemorrhage, but [ph?] just ringing. So, of course, the exact frequency is the Nyquist frequency, between the brain and the-- so. So, they need someone to calculate what is the Nyquist frequency of the crystal and the CAT scanner. It's very exciting job for at least that time. And then I apply for jobs. And then I was very lucky: I got to Intel. You know, so.

Kapoor: So, they were looking for digital signal processing expertise for that time?

Chan: Thank you for-- I'm not sure I would be considered an expertise. Very excited about it and I interview-- I really didn't know much company. I mean, I always wanted to go to Bell Lab. I got an offer at Naperville [ph?]. I think they there were doing the ESS4, got offer from different places. And then this company, Intel, I was very excited, because the people were interviewing me-- it was Ted Hoff. I didn't know Ted was the only fellow of Intel at that time. If I knew, I wouldn't know what a fellow is, actually. But I know the Widrow-Hoff algorithm, because I'm in digital signal processing, adaptive filter. So, I was very excited. He's this guy I can learn from, an engineer's engineer. I mean, computers-- you must know him. It's just an engineer's engineer. We're still good friends. So, it was a little bit-- I told my wife, "Let's go!" I said, "I have no idea what Intel does." I have some idea of what Intel does, but I don't know anything about company, because in between my PhD thesis [ph?] in the summer, we were teaching microprocessor courses. It was new, right? The 4004, the 8008 was the time. I think 1978, when I joined Intel, it was the year of 8086, I believe. Yeah, either just before or after, because I was at Intel. We made just sure just like any other microprocessor, not by the year, but by the processor time. Like, I joined when it's 86 and I left just at the 386 time. That was the timeframe, you know? So.

Kapoor: So, what was your assignment and how was your career at Intel, can you tell [ph?] me [ph?] ?

Chan: It was very exciting, because I met a lot of people, but the first assignment was Intel was doing the first signal processor, the 2920. We call it the first digital signal processor. Other people call it the analog signal processor. But it was pretty exciting. It has a 25-bit digital. No multiplier. Just shift and add, and analog in and analog out. So, my first assignment, it was a very good team of chip designer and my first assignment was how do you program this thing. So, in fact, the only machine there was the 80-- the MDS80, right? Because not all analog engineer have codex [ph?] machine for that [ph?]. So, it was to write, like, a signal processing compiler. How to you put pause [ph?] in zeros in the S-plane? So, hark back to almost my bachelor's thesis on the filters and the optim-- how do you put pause in zeros in the S-plane and translate them by messy [ph?] transform, they say, into the Z-plane and then translate them into the 2920 code, which is shift and add, shift and add another coefficient. And doesn't have floating point at that point. Right? So, you have to make sure you don't get into these zero oscillation [ph?] or all

these other-- it was fascinate-- and this is an nMOS[ph?] machine. Oh, on top of that, it has a E-square prompt to program [ph?]. So, it has an analog, A-to-D, D-to-A digital, e-square [ph?] prompt-- <laughs>

Kapoor: So, was that also the time when you learned about chip design or technology, process technology?

Chan: Yes, because it was-NMOS- and while I was learning about processing, Intel was still very much a memory company. Right? And a microprocessor company. And, of course, Ted Hoff was one of the inventor of the microprocessor [ph?] 4004. And another name there was Stan Mazur, who at that time was already start to run-- eventually run the Intel University program. I mention it, because he's another good friend, but eventually he is at Synopsys. You know, so, there are a lot of connections that is very kind of connected there. And, of course, we're going to nMOS was, like, fantastic, coming from pMOS[ph?]. We're not into cMOS [ph?] yet. And Japan Semiconductor hasn't come out yet. And it was time when you can still go next door and go into the-- go into the fab [ph?]. Pretty amazing time, thinking now.

Kapoor: So, that was the first time you encountered the semiconductor world in terms of processor technology and--

Chan: Yes.

Kapoor: --design of chips and so on.

Chan: Yes, because, of course, you learn semiconductor in undergraduate and take some graduate course, but I was always going to the system side and the signal processing-- fascinated with that side. And I was always fascinating with application. And, interestingly, the one thing that was-- I always thought now looking back-- right, at that time don't understand the organization, because you see the whole history of microprocessor with Ted Hoff and it looks like a lot of good thing happen at same time, and-- but if you look at it, he was 12th employee of Intel. And the department is called "Application Research". So, I was very curious-- I mean, I would have joined regardless of what it's called, but I have never heard of application research group. And, so, I've become a member of that group in research. So, I was always curious about application. And, of course, we take it so seriously that regardless of how-- you know, Intel's operation Crush [ph?] I was way-- I was an engineer way at the backend. I'm not leading any-- I'm always in the lab, but I understand the power of application. Right?

Kapoor: So, any of the chips that you worked on, did they go into manufacturing or--?

Chan: Not much of-- <laughs> remember, I was more on the application research side. The 2920, looking back, great machine, but two problem: One is took us a long time to debug-- all the problem we have then exist today, right? Analog with digital? The other one is the program was location sensitive. The software was location sensitive in [ph?] its [ph?] location, because it has a divide-by-four clock. So, if you place it right where the clock is, depending on the A-to-D, D-to-A, which is sensitive to clock [ph?], you have a problem! How do you debug a software-hardware problem? So, you think about all the D-to-A, A-to-D to

problem, hardware-software problem where the hardware's dependent, where the software's located in memory? Right? So, by that time, I think it was obviously where that next architecture be: Take the A-to-D, D-to-A out of the chip. We proposed to a 9030. I don't know why it didn't get funded. I was not in the management decision. I was told we're not funded. So, we move on. And, of course, I always hear back from TI-- TI-320 started because they looked at the Intel signal processor and it-- their major market at that time-- now, I remember, some of it was in the military domain. This was a very useful chip, right? And we didn't pursue that direction, but we start to pursue speech recognition at Intel at that time.

Kapoor: So, what was the next thing that happened?

Chan: Well, the next thing was Intel decided-- our group-- because our group was research, right? Ted said, "Let's do speech recognition." Music to my ear. I did not go there to do-- and the reason is because we had 2920 and to demonstrate we can program it in digital filters. So, now we have a real good narrow-band digital filter that is programmable and you can track format, you can track a lot. And we actually produce a speech recognition board [ph?]. I'm talking about 1980-81. So, it's relatively early. It's not like the first one, but with a switch transaction board, which is important in the history of why eventually I also left Intel and the group. But the speech transaction board eventually was able to recognize 100-150 character plugged into thing. We call it transaction, because we know-- we thought the human factors was important. And, eventually, we did sell a few of these and mostly into General Motors. So, I'm probably one of the few people who has spent a bit of time in a semiconductor fab and in an automotive fab at that time. I was going to Willow Run probably once a month, every-- for the whole year and a half before I left Intel. So, this was-- we went into speech recognition-- besides I was taking on multiple jobs. I mean, at-- I think by 1984 or '[8]3 Ted left to Atari, right? And, so, I mean, at one point I had three direct line reporting to the memory-side [ph?]-- no. Because we were-- once you used these application, you were using bubble memory. I don't know if you remember bubble memory.

Kapoor: Yes [ph?].

Chan: It was a good demo for everything! Talk about demo, I remember one time Andy Grove demo'ing the speech transaction real-life in a-- either in a customer or shareholders' meeting. And it's got to be one of the first exact [ph?] demo'ing of speech recognition. You know, I'm talking about 1984-85. As an engineer, we all kind of really scared to death, worried that "I hope this thing works!" When you say, "Red," it better say, "red." <laughs> You know! You don't want to type it in, right? You just want it to work. Intel's a great training ground for me. It shapes a lot of my understanding of business and technology.

Kapoor: Yeah, you got to work with very diverse areas.

Chan: Yeah, I think I was lucky. Of course, after he left Intel, we become good friends with Albert Yu. You know, he was like a mentor all the time. I think when I joined he was not there. I believe he left to China to form some company. He was always very entrepreneurial [ph?]. And then he came back And, so.

Kapoor: I think his emphasis was also on quality.

Chan: Yes, on quality, on system, but he is-- several thing that help, he-- at that time, he say many of the engineers, senior engineers were foreign born. And Intel has a very strong constructive confrontation. It's not my culture or my character. So, he said, "You guys better learn this culture and the best way," like everything, "the best way is you go teach it." So, he formed a group of six or seven of us and said, "You go teach multicultural integration, go teach how to fit this constructive confrontation with whatever character you have." And it turned out to be a great learning exercise, because, you know, I think it shapes a lot of my future management thinking and everything else. So, Albert was-- I mean, I remember-- I mean, I didn't work directly with them, but looking at them, you're very impressed, right? I worked directly with Ted all the time, day to day. I think he reported at that time to Vadaz [ph?] and then to Andy Grove. And then to Gordon Moore and to Bob Noyes [ph?]. I mean, I-- actually, at that time, as an engineer you don't know what reporting is or not. They just-- you look-- you just in awe every day. Like, "These are pretty smart guys," right, <laughs> "that do things." And then Craig Barrett joined our company-- our company at Intel-- guess he always was there. And then he moved the group to Phoenix. There was nobody there yet. So, our group was called Telecom Automotive Military Operation, right? Because signal processing-- the group, when I joined, was the first codex [ph?] filter. Again, because of switch capacitor, that's how you can do the A-to-D, D-to-A, right? The switch capacitor and the mu-law [ph?], a-law [ph?], codex [ph?] and I think it's called a 2912. It will come to me. So, that group move to Phoenix. So, a lot of people move, which eventually is important in the story, because-- but later on. Ted didn't want to move. Ted says he's not moving. So, I wasn't asked to move. So, that's how I knew a lot of people in Phoenix and Intel's great doing that, right? So, I ended up with as they move and as Ted move; one of the group that didn't move was also the datacom group. And I was involved with that, because they were very good engineers, like Bob Beach [ph?] and David Yey [ph?] and I mean they're DataComm. Of course, Intel is, I believe, one of the three, you can correct me if I'm wrong, but historically I think the three company that defined the Ethernet, Digital Equipment, Xerox and Intel. And so Intel had the 82586, the first Ethernet chip out there which eventually spawned a lot of Internet people you can see there. Right? It's important because eventually as I left Intel I was always with that group and the Ethernet was 802.3. And, of course, at that time it was 802.5 was IBM with a token ring was another standard. And one standard that people were pushing was 802.4 which is the MAP protocol, the manufacturing automation proto-- I don't know what A stands for. But because in the automotive fab the key thing with Ethernet it's nondeterministic, in theory. Right? But if a robot want to hit it in one microsecond stop you have to stop it. So the theory, at that time, was you have to have something like MAP. And I just explained, maybe not, that I was doing speech recognition and we were installing speech recognition, pin inspection system at General Motors. So we were now connecting MAP cables and Ethernet cables. So it become a little bit convoluted. It's a straight-- life takes many turns how it gets into that stage.

Kapoor: So now you're at Intel and you mentioned that eventually you moved from Intel. So how was that transition? What made you move from Intel?

Chan: What made me move? It's a difficult story because I really don't want to leave Intel. If life didn't take a change I think I would still-- I hope I would not have been fired but I would be working still at Intel as a researcher. But we did a lot at Intel and there was a General Motors task force. I mean the engineering under the lab I don't actually know all of the different structures but I know there was a GM task force in Oregon and Intel trying to sell a lot more processors there. And we were the speech team.

We were very proud of ourselves, 15 people or so. We sold $1 million or so. And then actually much more than that on pin inspection to General Motors. And the reason at that time was because I believe Ross Perot and EDS just joined GM. They bought-- somehow they were-- and they wanted to modernize their quality control. And I can tell a story why it won't have data into it like what is the pin? What is the pealing [ph?]? All of these and other thing because there are no easy way to capture it. But with EDS coming into control IT. So we sold these systems. It was complex. You need a system. You need a wireless. You need all of this. And so Intel said this team has to move to Oregon. And early on remember I said we moved from Cleveland to Intel. I told my wife it's a good place. You make the next call. You know, my wife Rebecca, is a great pianist but has very good recall. She said, “You told me I get the next choice.” <laughs> We did go to Oregon and she decided not to go. I was devastated because I love my job. I love Intel. I love the speech group. So, actually, I start commuting up and down. And, eventually, after a while I broke my eardrum. I'm a workaholic. I love my job. I couldn’t fly anymore, so I took the train. It's a 19-hour train to Oregon. And after I think two times, three times I thought this can’t continue. So then I always thought-- interestingly it's one of the few times Andy Grove [ph?] talked to me. He said, "You moved thousands of miles here. You want to move a few hundred miles?", in more colorful languages. He's a great guy. Every time he see me, even last year he said, "Are you still working with speech recognition?" <laughs> But I said this is-- I can’t do this. So I went consulting. I thought maybe you guys will change your mind. That's very naïve. Companies should not change their mind. So I went in consulting by myself in, actually, I was installing some systems for American Express and speech recognition. Yeah, but that doesn't last long because consulting is not my ideal job. It's a very lonely job. You don't have colleagues. You know? And surprisingly NEC called. And the salespeople there called me and said, “Why don't you come in and run application?” And, you know, I said, I was very lucky because at Intel I met a lot of salespeople who were my friends. I always have no relationship with the customer. But because I was not on a-- looking back because I was on a clock/clock at any time a salesperson from Asia or from East Coast come and say, “Could you talk to one of the customers?” If I could, I always say yes. So I ended up at that time the person running NEC in US year was Hank Jusefic [ph?] which is the East Coast sales head for Intel who went to NEC and after Ed Gelbach and Frank Gills had the sales. And then the head of Asia Pac sales was Chris Lincoln [ph?] who had become a very good friend. He’s one of my best friend’s there. He said, “Why don’t you come over?” Because before I left they offered me several jobs. I always thought it was very strange. Chris said, “Why don’t you go over and run Intel China for the sales portion.” I said me? <laughs> I had no skills but I ended up taking my wife to Beijing and look at apartments and everything. And she said, “No. We’re staying here.” But I was surprised. At that point in my career I was very much NMOS, now CMOS, a few micron architect, microprocessor type of guy. But they say, "What don’t you take over this?” It was new, right. Because I went to China few times to help fix some of the PC board assembly lines and things like that. So it was a very strange path to NEC. And at NEC I was heading the application group. And within probably six months I was the general manager of the microprocessor for North America.

Kapoor: So how did that happen? You were starting from applications to heading the…

Chan: Well, I credit Intel culture being constructive confrontation, so you speak your mind. I went from there to NEC which has a very good culture but a very different culture, a very consensus culture which I didn't know until later that well, maybe you should approach it in a different way. But you learn, right?

<laughs> So I always pointed out what's wrong with the microprocessor and what's good. It doesn't mean you're pointing out something not right. It doesn't mean it's not good. But so you look at it and if you back up a bit when I joined Intel we're very good friends with NEC. On the first proc-- one of the first signal processors was 7720 from NEC and speech recognition set. And there were a lot of cooperation back and forth. In the middle period of my Intel career there were a lot of problems because of patent disputes v20, v30, 8080, 8086. There's the whole history in here. Right? So interestingly, of course, Ted [ph?] was very involved. I was not. I was a worker somewhere in the chain. Now, I'm the general manager of micro processing at NEC and the lawsuit was going on. And later on, it was actually settlement while I was still the general manager, the litigation and the verdict came down, et cetera. But meanwhile, the V20, v30, there was another product for the v60, 70; it was a 32-bit, 64-bit microprocessor going up there. And I didn't think it was the right process. I questioned, as the general manager, why going that direction. I probably questioned too directly, so then I was hauled over to Tokyo saying, "What do you mean?" And then there was the v100. NEC has fantastic technology people and management team.

Kapoor: So the development was all in Japan? There was no development here in the US?

Chan: Yes, which I didn't realize because when I was at Intel all my NEC friends was very technical and they were all in Japan. When my team recruited me to NEC I thought this is fantastic. I didn't realize really that all the development was elsewhere and this is more a distributor/sales. Right? And luckily I was able to get a lot of people talking on the technical level. And so very soon they said, "Why don't you be the general manager? What do you suggest?" <laughs>

Kapoor: So that's how it happened?

Chan: That's how it happens because we've got fantastic people at NEC on the application team but was treated too much like a distributor, so there were not resources nor equipment. And very importantly, if we have time we should talk about this too, very importantly no documentation. So you go to a customer and you give the documents in a rough-- I mean it was in Chinese. You just can't-- it came from the Intel application team. Right? You need to have board. You need have system. You need to have all of this and the documentation was not there. And we had a great sales team from Intel coming in, right, really good customers, good products but not enough documentation. So in the application part I basically strong-armed myself into a lot of documentation.

Kapoor: Yeah, interesting enough, as a sideline, I was at Intel around that time. And Tom Dunlap, who was the Intel attorney, he was not familiar with microcode. So he asked me to help him with microcode because they were going to analyze the NEC microcode to see if there was any theft of IP.

Chan: Right. So, actually, it's interesting, we can go back to documentation later but, eventually-- well, it's why I always admired Sun and SPARC. I said, okay, we should look for a different architect-- we should look for different, at least argue I'm not a-- I mean we got fantastic technical people. So I think I remember looking at the SPARC, looking at the MIPS processor and looking at the Precision. But then you need two people to agree. Right? You need a licensee and licensor. Right? And the deal we eventually struck was with Bob Miller and MIPS. And the nice at that time MIPS also have a few Intel

people. I think Othello [ph?] and Tom Reud [ph?] because the RISC processor is like a signal-- it's not, like I said, but it's reduced instructions. There's no mirror dedicated. So I know some of the people there. And we ended up with the MIPS processor. And I was mainly the one driving it with Sasaki-san [ph?] who was assigned to help me. He was one of the three board members semiconductor. So this was important because eventually Sasaki-san become head of the semiconductor and then become had of NEC operations. And, basically, we came here to negotiate. One reason it was difficult was because like any fabless company you have fab, and their fab partner was Toshiba. And they very clearly said they only want one Japanese semiconductor and one European. I think we ended up with Siemens. And the strong sentiments was with Toshiba because of familiarity. Right? You know what the curve is. You know the chip. You look at the early MIPS was all Toshiba fab. You know? So at the US site I spent a lot of time trying…

Kapoor: Right. So you were still living in the US?

Chan: Oh, I was always living in the US.

Kapoor: So that was very interesting how you were head of the processors but the development was there but you were living here.

Chan: Yeah. I was the general manager of microprocessor reporting to the president of NEC US but really the technical power and the decision is in Tokyo. Right? But Dr. Kani [ph?] who is the head of the very strong-minded person, very technical, very good person. I mean good technical people are strong-minded. They believe what they believe. It doesn't mean they don't like what you say but you better have something to say. So I think without Intel training I would not be so open because I don't think it was personal. I don't think I did it for myself. I said, look, this is why it's wrong. You can't sell a processor whose number one thing is Ada because the only one that use Ada is the main person that's in the US military. They're not going to use a sole-source Japanese part [ph?]. So there are many reasons that you can put down not to win a debate but just kind of maybe it doesn't make sense. Right? And then the nice thing was even as I joined the engineering force in 1978 and worked with NEC those guys are now the department heads. They're very technical the department heads. So they, at least, give me the day of time to have this argument. I didn't win every argument but we ended up by saying, okay, “So why don’t you go find a licensee?” And went to get MIPS and then finally get them responses. And, I think, the MIPS processor was important because it got NEC to the Nintendo, to the next generation of microprocessor. A quick question of documentation becoming important. On the history of floppy disk controllers NEC was very tight, right, 765. I know, Kawakami-san [ph?] which invented it. And then later on there was the next generation we lost because it went to the digital phase-locked loop. At that the phase-locked loop was analog. And it was pretty magical how you got all the-- how you get a thing to lock at that time with the right capture range and everything but we document everything. And if I recall right now somewhere 10 years after I left I got a thank you note that say, “Thank you for all of the documentation you insist on paying,” from NEC legal department. Because there was a major lawsuit on the floppy disk that was given a verdict and jury in Texas in US that sued all the floppy disk controllers for a bit that was dropping. And, if I recall, again, the legal side here that got locked on, I know for sure Toshiba paid a big fine. I think it's on the order of hundreds of millions or billions and NEC did not pay

anything because they were able to show that this error was clearly documented, very well documented. It was exactly how it behaved, exactly how it behaved. Because the bit drops and then what do you do? You had to worry about it, right? So it was interesting. It had nothing to do with the consequence. So one lesson learned was working with good people and just working good intent and just keep pushing has many effects later on that's certainly not my intention. <laughs> Right? What's interesting by that time I was already at Synopsys.

Kapoor: Okay. So tell us about that transition then from NEC?

Chan: My whole career I'd say is more of an accidental journey. <laughs> Intel I choose to go. I think Intel I didn't choose to leave but I left. At NEC I did not apply but people knew me. I did not apply for 30 jobs on got 1 of 30. I was pushing very hard to get an engineering team into NEC because it's not possible to have the-- not the whole engineering team, some engineering team. It was very difficult to fulfill my customer requirement when you have changes and you're technical. And earlier you mentioned that it's exactly my point. I got the part, I got the tests. But there are multiple issues because you cannot change the-- you cannot respond fast enough. I have a very long talk with NEC. They say, "No, we need to keep…"-- I understand now as a manager somebody asked me something there are many things I don't want to do even though it makes sense and not make sense. I would approve. I got a call from a friend from Synopsys. His name is Bob Dahlberg. But life is one accidental thing or one pre-ordained [ph?] because Bob was the first marketing guy for 2920. I was a young engineer, he was a young MBA that just came here. We haven't touched base with each other for a long time. We worked together day-in day-out. And then he went to Phoenix. And then he left. And he went to Daisy. And then at Daisy then he become one of the first marking guys at Daisy, one of the first marking guys at Synopsys. I mean we basically in different paths. He called one day and said, "Oh, we have a good company. Why don't you come and join us and run interview and why not look at application?" I wasn't looking for it. I think I don't have much interest because I'm very busy. I'm trying to win over. But he said, "At least have a lunch." I had lunch with-- at that time the CEO was Harvey Jones. And have Harvey Jones was president of the Daisy. I don't know even Harvey. Harvey is a very persuasive guy. <laughs> He's a very persuasive guy. He talked to me and he said you-- and I don't think there was any particular position. I don't know for sure, you can ask, later on, Aart was the founder, right, of course. Right? He said, "You should run the application side." Because now this is getting to-- it wasn't like a plan but between Ted [ph?] application research, application at NEC, General Motors, applications; a lot of applications. So I interviewed with Aart and then Deirdre, who was an _____ employee, who is still here. I thought well, these are very smart people; very good. So I joined Synopsys. It was a hard time leaving NEC. I still had a lot of friends. In fact, I'm probably one of the few people who left and then they still-- they actually invited me back, 10 or 15 years ago, to be on the board of directors of the NEC Electronics America. So I was still very much in good standing even though I didn't really want to leave but they didn't want to run the engineering there. Things had changed. So I went to Synopsys and at that time there were four executives. Harvey Jones was CEO. Aart was the VP and engineering. I was the VP of application. And there was a CFO, Dwight Morita who came from GE, also, because they all came from GE. This is 1990 now. I've joined NEC from '86 to 1990. And I believe MIPS was signed around '89 so. You have the whole history of SPARC and MIPS. I was really excited about it. And, also, interestingly NEC decided to take a leap also not only R2000 but R3000 but also the R6000 which is a bipolar one. And there was one other project I worked on at Intel early days

was the bit-slice microprocessor. I forget exactly what the number was. But there were two problems. It was bipolar. <laughs> As we were doing that one. The other was a two-bit slice. Of course, AMD then came out with the 2900, it was a four-bit slice; it was a right slice and it would not bipolar. So at that time there was still very much NMOS, bipolar, that's my whole introduction to bit and to the Hudson [ph?]. Digital Equipment was also doing the bipolar version of the MIPS processor which, I don't think as far as I know, had not commercial success all of us as SPARC was coming out. <laughs> HP is a precision architecture, I think. I forgot who has it. But I joined. There were four executives. And because we didn't have VPs of sales, I mean Harvey was really running sales. I was running the field. So I started a lot of, I think, at Synopsys I was responsible for the application focus and then for much of the globalization. This is when I opened up the Taiwan office, the India office. Of course, by that time, we have sales coming in. And we have two VP of sales, Alana Bard [ph?] and Brian Connor [ph?], one running US, one running international. But I was running all the applications. So, therefore, we were always very much involved in the field. So my career started-- also started to move, again, into much more of a general manager field oriented, which I love. So that's how I got to Synopsys.

Kapoor: Another sideline. Around that time, I think I was that Fujitsu. I was also approached for the same job.

Chan: At Synopsys?

Kapoor: And I interviewed at Synopsys. But I was running an engineering operation and all that. So I think it was the same applications group that they wanted to hire. So I didn’t gel.

Chan: We should compare notes. What month? I joined in May of 1990. I probably was approached in January or February…

Kapoor: Yeah well, I can't remember the exact date.

Chan:We should compare notes. Because you're right because it wasn't very clear exactly what it was because at that time there was a few-- when I finally joined the group that right away important to me was the university program, documentation, quality, application. And the CAE was not exactly what I signed up because it was changing.

Kapoor: Right. So that's what I remember, too. It was not clear what the role was going to be.

Chan: And networking. I pulled most of the original cable because it was like, well, quality should be in engineering. I was looking for it has to be this or that. You are right in reminding me because I think more of as you go and early on remember I mentioned Stan Mazor [ph?], well, he was running the university program at Synopsys. So it was wonderful. I go there. It was like you just popped over. <laughs> And you meet new people, of course. I mean I was there. I was very much running it. Harvey. So I felt very welcomed. And I felt like I was passionate about design and the methodology. And I saw-- in fact we start-- the minute we do this we start-- I wanted the university role because we started the book, design

methodology book at Synopsys. And then do a lot of applications. So build up the whole application team and everything else.

Kapoor: And I believe they also had the IP group which they also wanted to somehow add value.

Chan: Yes. So it was 1990 and I believe we were 6 million going to 9 million. I believe Cadence [ph?] and Mentor [ph?], I was in the 200 and 400 range. They were very big. But we had good technology and we were pushing on customers. But by '92 I was advocating very much design-ware and IP. And one reason is well, you know, today we still can't really synthesize a WAS [ph?] multiplier. You still need designer. We need good tools but we really need good designers. And so we start designing-- I started design-ware group. I moved from being the VP of application to the GM of design-ware group. We did not determine what it is. And one difficulty I remember having is what I believe or what I want to do with slightly different. We want to do is MIPS processors, POP processors, I mean the super duper. What we have to do, in my mind, was a basic building block: memory, multiplexer, decoder. Right? I mean to build it up. And the first group that I recruited the difficulty was recruiting design engineers to Synopsys because you don't want bad designers designing your basic block. Right? But one of key members was a world expert at that time or a design experiment time in SCSI-2. He would say, "What do you want me to design?" How about a decoder? How about four by two decoder? How about a two by…" <laughs> But it has inference because those eventually gets into the tools to distinguish you want a two by four, or four by two? And why do you want one by eight? There are cost functions with it that had to be trade-off. So the design ware an IP group, we're now number two in the business next to ARM [ph?], gone through multiple things. I'm very proud of the work that I think we have four general managers since. I'm the first one; and then Deirdre Hanford took over; and then John Chilton; and then Joachim Kunkel. Those guys have added tremendous different views to this basic block. They actually added quality focus. They added the interface, the USB. And so that's why I say I was lucky. It seemed like that was the right move. At that time, if you remember our competitor and some of the-- it was designing TSM 320, a boat building block, microcontroller blocks and everything. It was so complex. You cannot use it. And I have design envy because I want to design those. <laughs> But it didn't seem the right strategy. It's going to take longer. Now, the part designs are very complex. So I was very happy to go from the application side to the IP side.

Kapoor: So further within Synopsys, how did your career advance?

Chan: So now we are into-- I think Synopsys is 28 plus years. Now, we're into the second year going to the design-ware side. And I'll put actually Dahlberg and Deirdre and them in charge of the field. And a few years later, I think two years, of course, Aart has already went from VP of engineering to VP of marketing to CEO. The new be VP of engineering at that time Aart was still running. He said, "You have to run engineering." I didn't want to run it. I mean I've run engineering. And, also, this is not my design engineering. So he said, "You have to run engineering." He gave no choice, so I ran engineering. I was the VP of engineering for the whole company. And pretty soon it was clear that you should have all of the marketing and things. So within year I was the general manager of the first business unit group called the design group which has all the marketing and all of this group in. And since I work very closely with a few and the AC it was very easy to move the product and design the product. So I was the general manager.

And, of course, one thing I did at Synopsys together with, of course, all the exec's is I think I've gone through all of the 90 acquisitions, all the 90 M&A and the integration. So always looking to see what else we can acquire in order to further our movement. And, you can see the M&A side, at that time we didn't have physical, for example, right? So one of our first one was EPIC, right. Which we now do have multiple integration issue. I mean, I was young and naive. I'm still young. <laughs> Less naive. But start to understand how to integrate company and so-- don't get me wrong, our motto in M&A doesn't mean we know. Our motto in M&A now is "Only make new mistakes." And it's much harder than you-- than one thinks. 'Cause we still make the same mistakes. You know. So-- so we were involved with that and so I was in the general manager position of design group because we also acquire, a few year later, Viewlogic to get into verification. So now it become more full line and need someone to understand most of it.

Kapoor: The VCS portion was there already, right?

Chan: No. It was from Viewlogic. Yeah, yeah. A little bit of history. Now remember history is all written by-- other people are different. I remember trying to acquire Sunrise in test. And Viewlogic acquired it. I remember trying to acquire Chronologic. And Viewlogic acquired it. <laughs> And we were interested in _____ and Viewlogic has-- we didn't talk. I talked to Chronologic. I talked to Sunrise. Very-- almost-- can't complete it. Lost it. So we said, you know, "Bite the bullet. Let's go acquire Viewlogic." So Viewlogic gave us VCS. What was Chronologic VCS. Gave us the test and MOTIVE. And at that time we were on PrimeTime, right? So it was-- that acquisition helped move us-- propel forward quite a bit. And one of our key staff member came from-- one of our key staff member came from Viewlogic. Manoj Gandhi, who is now running our verification group. Joachim Kunkel came from CADIS, which we acquire in '94. So Synopsys has 13,000 people today. Thirty percent of them came from the acquisition company. And-- but it's more than thirty percent on the-- over the five business group, a lot headed by people from those groups.

Kapoor: So I think the verification aspect, you had very good relations with Sun in terms of the development of the tools.

Chan: Yes.

Kapoor: From what I recall.

Chan: Yes, thank you. Thank you for all your history. And of course because Sun was leading in a lot of the verification need and-- listening to the customer. Driving, pulling it. And Sun was-- you are teaching customer. You have a very complex need, right? Interestingly though, at that time, remember we talked about the IP side and we said-- we were talking about the Simple blocks, and one of our philosophies was always that verification and the IP were two sides of the same coin. And because, as you know it well, the verification takes fifty, sixty percent of a design cycle time. Maybe not every-- whatever-- it is a big chunk. It's not ten percent. That's if you verify your own design. Right? If you are buying IP block, the theory of buying IP block is you don't want to design it so it's faster, but if you take more than sixty, seventy percent you will never buy an IP block. So verification become a critical element. Not so much-- of course the design had to be compatible. So in the early days, almost like anyone can design that block better than

you can. So then why do you won't just buy it. Because it's easier to verify, and because you didn't have to take the time. And because it is a common block, you know. So that was the philosophy that we go about building that card. It has morphed into a very different business now because USB 3.1 is pretty difficult. And eventually you know there is a USB 4.0 and eventually a 5.0 and eventually something. <laughs>

Kapoor: So you mentioned EPIC in terms of the physical. But that was more for static timing for the--

Chan: Transistor level.

Kapoor: Transistor level. But then the actual physical tool-- I mean the Avanti became a big-- so how was that decision made to get into the physical?

Chan: Yeah, we always knew we wanted to get a full line, right? As a partner, as a-- it's just our history. I think by '97-- I joined '97. By '97, I was a second VP and then the chief operating officer, and then probably by '98, for the last 20 years, I was two in a box and on the board of Synopsys. I was always the president and COO and then the last five, six years-- I don't remember exactly when-- six, seven, eight years, I was president and co-CEO. But basically we were two in a box for all this time. And we always have thinking about what else to do in the acquisition. And we try many times. We talk to Avanti many, many times when it was called something else. When it was just-- before going public. And we could never complete it. And, of course, then they went through a huge lawsuit with Cadence and all that. And the minute the criminal side was closed, we start negotiating. And then we closed the deal in 2002. But it is probably a-- I would say a-- six, seven years from the first time we talk to the time we close, and in between-- it doesn't mean we continue talking. We just drop off and they do something else. And many of the key execs in Avanti, like Paul Lowe [ph?], is still with the company in key positions. Avanti is a key-- a key for us to get into the physical world.

Kapoor: Yeah, really. And from a customer side I know. We have dealt with all of that. <laughter>

Chan: Sorry. Apologize for all the-- I know you do--

Kapoor: Including on the SPICE side. HSPICE and all that.

Chan: Yes. So that's what I mean by-- we have acquired 90-plus companies, but those companies, some of them has acquired many company. Like, as you said, SPICE, TMA [ph?], PERSIMMON, OPC. Like 20 company, right? I mean. And so Synopsys has about 90 companies that acquire-- and those 90 company acquire about 90 other companies. It was like 180--

Kapoor: Right. Like one person that I interviewed, Professor Tom Kailath [ph?], Stanford, Numerical Technologies. So all of the Faceshift mask technology. I know you acquired that as well.

Chan: Interestingly, right? Because we go after Numerical Technologies because of the Faceshift mask. Because all these issues of OPC, double patterning, all these things are coming up so facial mask panel

was important. The main reality we got off that was not that. Was CAS [ph?]. The GDSII polygon. Main value. In fact, we-- because it turned out this mathematically, effectively-- a very interesting problem and you can grind on it and-- that still become a good business. In fact, I said that we lead a lot of acquisition in-- and globalization. China and India, but some of the place we were in that's interesting is Armenia. And we'll talk more about it as we-- and then the other one is Chile. Okay. And Chile is one of the place where we are doing a lot of the CAS work. Because of a lot of mathematicians.

Kapoor: Right. So I think you buy Virage Logic and Zorian-- I know him very well.

Chan: Yeah. Interestingly enough, Yervant is also Armenian-American or Canadian but expert in tests, right. So all these become very important as you go into automotive. The self-test and repair memory and all these reliability-- and when we acquired Virage we were the largest employer of high tech in Armenia, in Yerevan. And the second largest was Virage, and so we become one of the largest in high tech in Armenia. So, yeah, that's right. You do know-- you know a lot of people. <laughs> Outside Synopsys, too, we know a lot of people.

Kapoor: So tell us more about anything else you'd like to talk about Synopsys.

Chan: Well, so Synopsys, we now 13,000 people really in three lines of business: EDA, the IP business, and about four or five year ago we decide to look for a third leg of a business. And about four years ago I actually start living in San Francisco to run the software cybersecurity group. We started off by buying a company called Coverity. I don't-- another Stanford startup. Because they are static code checker. And amazingly when we started our career in design, we don't all use static timing in these chip design. But now hundred percent use static timing. Nobody-- I was a very small percentage of all software engineers in the world, ten percent, twenty percent use static code checker. Question is: why wouldn't you use it? You can see buffer overflow, which is the-- one of the biggest problem, you know. You just don't follow the buffer and many of the Internet hacking is taking advantage of that. So we took Coverity, and we start to say we need to move into security business because it is the headline and this where money in. And also, if you don't have quality, you sure don't have security. If you're quality, maybe you can do other thing like security. So we have acquired seven or eight companies there. One of them is called Codenomicon. That's a fuzzing of IP. Especially USB, DDRSI [ph?]. So there's some relationship. I'm trying to point out that-- we jump into the third field, but we are not a-- like a big risk-taking type of company. We're a very deliberate-- I wouldn't say conservative, but very steady kind of approaching it. And then we bought Cigital, which is a-- one of the leading Internet cybertech consultant type of security. And recently we bought Black Duck, which is the largest open source analysis software company. So that business is now about ten percent of Synopsys. In the cybersecurity software space. And software is important, so between-- I'll draw a quick analogy why eventually these two would even meet, because I thought it was-- Synopsys is not a mathematician. Static code checker, pathfinding, reachable state, non-reachable state. Think about formal verification. Do you know well? Now instead of looking at Verilog, you need to look at C++, Java, PE, and there's no-- VCS you mentioned. We very much a compiler expert. This is a lot of compile execution type of issue. So between all those we just started-- that's where some of my concentration are today.

Kapoor: You also acquired Atrenta.

Chan: Atrenta, yes.

Kapoor: So in terms of overall growth of the company, you know, you certainly are number one. And I think Cadence faltered for some time and I guess they are doing better now but Mentor, of course, was acquired. So the three big-- of the three big, you know, you continue to grow as a company.

Chan: Right. Right now we are growing faster than they are. Right now. If you count the year that passed or the last year. And the last two year. And they are very respectable competitor. <laughs> Actually, you never want to be in a business where there is no competitor. Nobody else want to be in. They are very respected. So we have-- it is not-- and the customer base for semiconductors is shrinking as you know, right. And technology is getting tougher. Physics. So you know it well. So I think as an engineer there are no better time than to be in this business at this moment, because it's so exciting. As a businessperson, <laughs> it's always a challenge, right.

Kapoor: So on one hand, the technology, in terms of the FinFet [ph?] and so on, that's more challenging, more expensive. In terms of strategies for AI and deep learning, I mean, there's a lot of new requirements, right?

Chan: Right.

Kapoor: Would you say? So how is the overall strategy for Synopsys affected by all the changes that are happening?

Chan: So we know that there are probably three or four directions out there that we cannot miss. And then we need to play a part. And if you are very conscious of the market and customer, then you will probably be in the right quadrant. Right? And then you need to be the best in that quadrant. But first you gotta be in the right quadrant or it doesn't matter. So there are a few things that are very clear that are going on. One is the whole electrification of vehicles. Not necessarily autonomous car, but the whole electrification of vehicles. So there all the tools have to be recertified, because what is the main difference between designing a chip for automotive versus designing a chip for mobile? Of course there are many different applications. But what are the standout? One standout is documentation. You need to have much more documentation. Who did what to whom? So the tool have to provide that. How you get there. The second one is failure in time. Because you don't carry a ten-year old cellphone. You probably will-- I drive more than ten-year old car. So the failure in time become a different element, right? So as engineer we all know time is a fundamental unit. Right. So that is a-- and then there are many other difference. So that means tool have to be certified-- the EDSI [ph?]. The IP had to be recertified. Had to be documented. For example, we now-- every team has to have a safety manager. That term does not exist five years ago, right. Who certified the safety proceeding of this? And then, of course, interestingly, I say we are three business-- the EDA, the IP, and the software. The software side is very much involved because one questions to many of the automotive company how many lines of software do you have? It turn out to be a lot. But they don't necessarily have a very good count because they come in from the tire pressure,

from Harmon Kardon from windshield wiper, from-- right. How many lines of those codes are open source? How many signs of those open source are not fixed but unknown? But I mean, so the three business are somewhat tied in this bus-- in this kind of quadrant and within the automotive different quadrant. The second one is, of course, AI. Because AI is a very big-- I do believe is a very big influence and it comes about because their data and because their-- thanks to Sun and thanks to you-- a lot of computational expertise. Because if you have big data, you don't have computation. Therefore memory. So it's all good for our business, but where is AI taking? We need-- where should we be? So within-- the way I look at it with Synopsys is one, we have to make sure that our tools are using the right technology. And of course EDA tools, as you know, are very algorithm- and rule-based, and AI is very much data-driven and pattern matching. They not exclusive, but they're different. So there is a turn in thinking of all these. And then the second thing is, on the AI front, besides making sure our own tool is-- there is a whole new group of people designing AI chips. How are they designing it? We want to make sure they are our customers. There's another dimension, which is how do we use AI more effectively with customer? But they all know-- it's not like we have to spell it out for them. They all want to know. They're all doing something. And then the last one is are there other opportunity for us, and we don't know that. But we are very much involved with getting our own team educated and involved and what are the data we have, what are the data we have to have variable. Of course we have a lot of customer data. Those are not the one we want to meet-- they are our customer's data. But we have a lot of data. For example, we have several hundred million lines of code we develop. That's why when we say we go into the software business, we are actually a software company, even though we look like a hardware semiconductor company. So we are hoping that these things all-- if you in the right area where things are kind of getting together then it makes sense, you know. And of course the overarching direction of things is not a competition are now going to the cloud.

Kapoor: I was going to ask about the cloud. So what's the-- where does Synopsys stand in terms of cloud offering?

Chan: I think the-- I think a few years ago we started a business and we move away because many of the thing was too early. We think the cloud has several [ph?]-- one is security. And now that is not a big-- I mean, you and I trust our credit card, our data, you know what I mean. One is latency from a design. So there are some tools that still have issues on latency. Because, you know, you-- if you're doing interactive, you can't do it. The other-- the other one is just-- there are many-- there are many type of design that you put data in and take data out, and there is the in-and-out that cost money. Or cost energy, let's just say. Right. The one that sits there and keep regressing you should be able to use. So in my mind is enough-- we have to be-- we are working on the cloud.

Kapoor: So in terms of a business model for licensing, you know, because I know Oracle has that challenge. And so is that a challenge for EDA companies as well?

Chan: Yes. I think for EDA companies because we have a certain business model and-- but, you know, a business model is a two-way conversation. I mean, you-- if you don't like it you can stop it for a while, but you can't stop it for long. And we are not necessarily the first one to plow-- we're not pioneering in terms of the business model. As you said, Oracle-- there are many people doing business on the cloud.

Right. And what's possi-- what's not possible before is now possible and more and more possible. And its critical mass is clearly going that direction. It's not gonna-- it's not all gonna be off-pram [ph?] next year, but it's gonna be less and less percentage, right. So absolutely. So in my mind those automotive, AI, cloud-- are all there. And of course IoT is very undefined. But it's all of these. I mean, automotive is IoT in the car. <laughs> So. It's exciting time.

Kapoor: Very exciting time. Any other future things that you see, for example, 5G? How do you visualize 5G in terms of the IoT and so on?

Chan: Yeah, I think 5G obviously will come about, and for the vehicle is necessary because of the speed and-- but I'm-- now we are interested in the security. And the more data the more issue. You know, how-- when-- do you stop the security at the edge or the cloud? At the edge you don't have enough computation. At the cloud you've got too much data. So I think things will-- natural things will change a lot of this. It's all about risk management and I think Synopsys is reasonably well-placed because we have good technology. We have good customer and we continue to be listening to the right learning, teaching customer will be okay. 'Cause the thing is moving very fast and very complex, you know. I mean, and, as you know, many other people are-- the people that you don't think have chip design team ten years ago are now designing chips. And how will they go about, you know, I mean-- we better be-- we'd better be one of the main vendors. Right?

Kapoor: So how is your-- you are co-CEO with Aart, and I was wondering how is your role relative to Aart? You know, what do you guys do in terms of managing?

Chan: That's a good question. I think many of our staff ask that when they join and then they stop asking. <laughs> Because it is not, you know, a linear equation on this. I think we trust each other. We work with many things. He is running-- in different years we run different things. He is running-- more concentrate on the EDA side and the strategy. I am much-- I'm almost much more involved in the M&A, the operations, financial planning, the software, the IP, but it's not exclusive one or the other. It deemphasize--

Kapoor: So in other words there's tending to be more COO kind of in your role.

Chan: Yeah, COO and CEO in terms of the-- very much involved with the stra-- the future. Like the AI side. Like the new TAM [ph?]. Or the SIG side. This SIG-- software integrity. Which is software-- because it is not an operating role. That business need to grow, move the market. And what does that mean? Where is security going? The other is, of course, the geopolitical situation is getting way more complex. Way more complex. So as a co-CEO I enjoy our role and I don't think, you know-- I don't think we want each other's job, you know. It's been a good partnership.

Kapoor: So you mentioned geopolitical. Does it mean like a relationship with China, a relationship with European countries? Is that what you're talking about or what's--

Chan: Geopolitical meaning there are more rules and more-- more-- yeah. It's not just China. It's Europe. It's every-- it's everybody, right? So as a global company how do you operate? What are the rules of engagement? How do you put your-- you know. So all those you have to be mixture because-- obviously you stay within very-- way beyond-- you know, within the scope of where you-- what you're allowed to do, but then how do you-- what do you-- how do you look at the future? Where all this is going.

Kapoor: Right. Also, in terms of H1B visa kind of issues where you hire people.

Chan: Yeah, there are many of these things that come together that has effect, right? So good news and bad news. That's the bad news. The good news is all of us are in the same boat. <laughs> We are all of us-- all of us in Silicon Valley, or our competitors in the same boat.

Kapoor: So in terms of your personal issues, we didn't talk a lot about your family, but do you have-- in terms of philanthropy, are you interested in social causes or is your family interested in that? Are you doing something in that area?

Chan: Well, we-- I am active in the Chinese-American community, in the relationship, and not exactly but I was on the-- you talked about earlier. I was on the honorary advisory team of the AACHI [ph?]-- the Asian-American company-- the _____ as you know. Probably philanthropy, one of the main thing we're supporting, 'cause Rebecca's a musician, is the San Francisco Conservatory of Music. Which-- trying to link up with a lot of the-- I think on the West Coast there is going to be a major music institute. It already is a well-known institute but I think it will get better and better. So that's where we do a lot of philanthropy and exercise on. But generally I'm pretty low-key because I'm very low-profile. Perhaps I shouldn't say low-key. I'm very energetic, very excited, but very-- my emphasis is on basically customers and my family. Just my small group of family. Recently I have a granddaughter from my daughter and a grandson from my son who is now eleven months old and eight months old. You know. Emerson and Cameron. So it's-- it's a good life. Very exciting technology, good family, wife's-- Rebecca's still playing. Both happily married, both kids. Business is-- business has never been not tough. <laughs> You and I know. There's never been a business where you don't exercise a lot of energy and thinking, you know. Whether the economy is good or the economy is bad.

Kapoor: So in terms of recommendations or advice for future generations, people that are just starting their careers, what would be your advice to a young engineer or a young entrepreneur?

Chan: Well, I would tell them-- generally I think-- first I think-- we're both still young. <laughs> So when I think young, I think very young. So I think of them as-- number one is you have to do-- it's like a basic. You have to work hard. There is no easy job anywhere. The second is-- I think I learned this very early on from Intel-- is you surround yourself with successful people. And that is a self-fulfilling thing. Because you have to define success. Because you can define success as somebody who is very good technically, who is very well-off financially, or who is very caring about the community. I mean, it's self-fulfilling. You find yourself with successful people and you have to define-- you have to define it. And that-- that definition will define you. And then you have to have passion. And I saw a lot of word on passion here, and I always thought-- because I have seen people say, "Well, how do you get passion? Does it hit you on the head?

Do you-- what? Are you talking about marriage-type of passion?" And I always-- I will give young people advice that passion is-- be thankful. You didn't get here without someone helping you. Like I didn't get here without a lot of people helping me at Intel, NEC and Synopsys. And people took a lot of effort. If you think of those, you can get passionate very fast. You know, people help you without asking for other things. They are invested in you. So those are my simple advice.

Kapoor: Thank you. Any other thoughts you have before we--

Chan: Don't know. You ask so many different <laughs> good question, you know. I always think one of my deepest inspirations has been from my parents, you know. Seeing how my father go-- you know, our family has been poor and rich and poor and rich and pick up, you know, from fishing to-- to trading copper, to doing-- to looking for-- because we are efficient-- fishing fleet looking for treasures in the sea and all. And always being optimistic. I think really what I learn is being optimistic. And I see my mother, how we grew up. And she's-- if I knew all the-- if I understand all the situation I would be depressed. So growing up in a happy-- I have a happy childhood, and I think I have a happy academic and a happy industrial life and I feel very lucky. And I'm meeting with a lot of good people. So maybe that's kind of shape a lot of the way I approach problem. It doesn't mean there are no problem. All of us, actually, have many issues. It's how we deal with it. And then how long we can continue dealing with it. 'Cause there are no ea-- there are no easy quick-- in my mind the most worthwhile thing have no easy quick solution. Somebody have done it. Jump in. So I don't know. That's kind of what I think.

Kapoor: Thank you very much.

Chan: Thank you very much. I appreciate it.

END OF THE INTERVIEW

