Computer History Museum

Oral History of Diosdado "Dado" Banatao

Interviewed by:
Uday Kapoor

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Kapoor: Hello, Dado Banatao. Welcome to the Computer History Museum. We are privileged to have you here today. I'm Uday Kapoor. We have been together for close to 36 years, so it's a pleasure to talk to you. Your name is Diosdado Banatao, and I remember many years ago you explained that it means "God given."

Banatao: God given.

Kapoor: So you use Dado.

Banatao: Thank you.

Kapoor: You were born May 23rd, 1946, in a town called Iguig in Cagayan province in Philippines. I'm probably not pronouncing it well.

Banatao: The first one, Iguig is the pronunciation.

Kapoor: I know it was a small place, and your father was a farmer and your mom was a housekeeper, and so you came from humble beginnings.

Banatao: Very humble.

Kapoor: I would like to let you talk about that period yourself.

Banatao: Sure. Well, my family, as you know already, is a very humble family. My father was a farmer, as you know, and the whole town is a farming town. So you can imagine a place that is fairly quiet and sparsely populated of course because the farm is next to the community itself, and so there are not a lot of resources. The families were all similar in their, I would say, quality of life, capability financially, access to things or no access to luxury at all. But growing up I had no idea what it is. Only when there is comparison that you begin to understand what that is that you came from, and now that I'm here I have to say my place is about a million years and a million miles away from here.

Kapoor: I understand that you walked barefoot to reach the Malabbac Elementary School....

Banatao: That's true.

Kapoor: ....and that your father left for Guam when you were nine years old, and so you had a pretty difficult childhood.

Banatao: Yes, my father was in Guam for seven years. He started as a handyman understanding that Guam really was more of a US military island, a lot of servicemen that had to be serviced, and my father went there, worked in a grocery store, handyman, and then after a few years worked himself into being a butcher in the grocery store.

Kapoor: I read that your favorite *pasalubong* was rubber shoes. Can you explain?

Banatao: Pasalubong is—literally it is a gift. That's what's the meaning, but in this case because you are coming from another place that word is more appropriate than other description of the word "gift" or translation of the word "gift." So pasalubong implies two things. There is coming in from somewhere and then giving someone that article, so that's what pasalubong is. And you have to do that because some relatives you haven't seen in a long time. It's always good to bring something back from the United States.

Kapoor: You graduated from the elementary school as a valedictorian, and then your secondary education was in a Jesuit school called Ateneo de....

Banatao: De Tuguegarao.

Kapoor: And you lived in a boarding house.

Banatao: Boarding house, yes.

Kapoor: I hear that you studied very intensely. You had a simple room.

Banatao: That's true. My town, all it had was an elementary school, and that's where I took my first years of schooling, first grade to sixth grade, and then went to high school. Now, understand that in those days the Philippines is different from the US. In fact they're just beginning to introduce K-12 system now, and so that's why I went to high school from sixth grade. Here it's decidedly different. You have middle school. And again I was by myself in another town, much, much bigger town. In fact it is the capital of the whole province now, where I went to high school, but the Jesuit high school was a gift for the entire community and for me, because that's where I really learned a lot of my learning habits. Of course being left alone, no parents, no siblings, you're there in your own little room. I did nothing but study, and then the Jesuits took care of the other sides of learning.

Kapoor: I hear that you excelled in algebra, trigonometry, physics, and the dean advised you to become an engineer.

Banatao: Yes. Our high school counselor, at the senior year they meet with us. The process is that they meet with every single student three times that whole senior year, and he followed up every time, three times that I met with him, with the priest. He always made sure that I did not forget his advice to go into engineering, which I agreed and eventually went into.

Kapoor: Then you moved to Manila, where you lived with your aunt, and went to the Mapua Institute of Technology.

Banatao: Yes. My aunt had three kids. She passed on recently actually. She passed on at 100 years old. But the eldest was studying engineering in the same school and was on his fifth year. Engineering in the Philippines is five years. As I was entering freshman he was already a senior or fifth year, and that helped me a lot that I was also staying with them. I'm not boarding. We could not afford to pay. In the Philippines families are very close anyway, so it was great to be there with them, not only the financial help but also my cousin, who is also about to finish his engineering, I got a lot of help from him.

Kapoor: So you graduated with a bachelor's of science in electrical engineering from Mapua Institute of Technology, and you had several job offers after that, and I think you turned them down. Can you explain what was happening?

Banatao: Yes. The Philippines at that time in the '60s, while they were really doing very well economically, one of the top economies in Asia, the technology side was not well-developed. While there were a lot of US companies there, most of it has to do with producing goods there. Not a lot of real engineering work was happening. So you can imagine the offers were more along the lines of practical engineering, and some are just technicians and so on, I thought I did well in engineering. I don't think this would fit for me. So that's when I joined Philippine Airlines to be a pilot.

Kapoor: I understand that you had a childhood wish to become a pilot, so you applied for a program within Philippine Airlines for pilot training. Maybe you can say a few words about that.

Banatao: Yes. The only aviation school actually outside of Japan and maybe Korea was in the Philippines, so a lot of the other airlines—for example, in my class that year there were 10 of us, five for Philippine Airlines and five for Singapore Airlines. So flying at that level in the airlines is it turns out—and I learned this while I was there but even more emphasized when I started flying here with my own airplanes—and it's all about systems. Sure, you have to know the fundamentals of flying, taking off, landing, turns, patterns and things like that, and of course navigation. Sorry. After a while it's about understanding the systems, meaning how does an airfoil system work, how does the engine work. So if

you're an engineer with all that technical knowledge it was a perfect fit. I had fun doing flying simply because I could almost predict how the airplane will behave depending on the motion that I do in the cockpit, but it's a lot of systems. So to me that was fun and what kept me to continue even if there were other jobs available.

Kapoor: Did they ask you to move to United States?

Banatao: No. What happened was one day after my flight it was early in the afternoon, so I stopped by my school, Mapua Institute of Technology, in the faculty room. And it's a small enough school that after you graduate you actually become friends with your favorite professors. So I stopped by, and he was there, and after the initial pleasantries he just said "Hey, Boeing was here to our school wanting to hire some of our graduates, and with your flying you should have an advantage." I said "No, I'm having fun flying. I don't want to." "No, here. Just take this application." So I put it there on the side, but a month later I wasn't doing anything on a Sunday afternoon. I just casually filled it out, sent it. Two weeks later I got an offer. I was shocked. It took me three months to decide to accept it. Finally there's this letter. "You should accept this now, or we will revoke that offer." <laughs> But I did, and then eventually they got my visa, and then that's when I moved to Boeing. It took a process....

Kapoor: Yeah, I was going to ask you, because visas are required, so they did that for you.

Banatao: Yeah. They expedited that for employers. The embassies prioritized them.

Kapoor: So then you moved to Seattle.

Banatao: Yeah, that's where Boeing was or is still, although their headquarters now is in Chicago, yeah.

Kapoor: Chicago.

Banatao: Chicago. Yes, sorry.

Kapoor: Chicago. So you moved to Seattle with Boeing then, and was that still in a training status, or were you already working as a pilot or pilot trainee?

Banatao: No, I was hired as a design engineer.

Kapoor: Oh, okay.

Banatao: And the program they assigned me to was the 747. And as I mentioned earlier, it was in the integration phase of a lot of the systems, and I learned a lot about systems from the airlines, so I was familiar with panels and so on, and that helped me a lot.

Kapoor: So you helped design the final stages of the 747.

Banatao: Yeah. I would say, though, that considering the number of people that helped design that thing I was probably one of a few thousand. <laughs> I don't know the exact count. There were a lot of engineers in different expertise and others.

Kapoor: Were you able to still fly at all at that time?

Banatao: At that time my flying was on very small aircraft. I had coworkers who were also pilots, and over lunch two, three times a week we'd go out, and of course we lease a aircraft for like an hour or so, and we share the cost, and we just go up and fly. That stopped after our boss one afternoon at 2 PM said "No more flying for you guys. I want you guys to be back here at 1 PM, not 2 PM." "Yes, Boss." <laughs>

Kapoor: So you had that opportunity....

Banatao: In the US, yes, early on after I arrived.

Kapoor: While you were with Boeing I understand you had got an opportunity to go to University of Washington in the work-study program. How did that come about?

Banatao: Well, Boeing with so much engineers and serving the government mostly, a lot of military and aerospace, they have special programs to help employees. And one of those is a graduate study program where if you get admitted to a major university like University of Washington and assuming that your work is not critical enough at that time and you qualify—because you have to compete with thousands of other engineers, and I was shocked when I was picked, the only one in that whole building of hundreds and hundreds of engineers. I was so shocked frankly I got it. And then when I was accepted one of the engineers who was next to me actually said "What?" because he's been applying for years. I had no idea how frankly, so you get full pay as a full-time student during the day. You just need to put in a few hours in the evening, so I went in the evening and tried to do some of the design work or whatever work was given to me by my manager. Just leaves it on my desk and make sure I take care of it before I go home. It was not a rigid eight hours at all, so it was perfect for me to do that. I did that at University of Washington.

Kapoor: About when was this?

Banatao: This was from 1969 through '71, but—I'm sorry. End of '68 through '69, and then '71 I left because I wanted to go full-time at Stanford.

Kapoor: Stanford, right.

Banatao: Yeah. I looked at the ratings of universities, and lo and behold there was Stanford, Berkeley, Caltech, MIT.

Kapoor: It's interesting that I was there at the same time at University of Washington....

Banatao: Oh really.

Kapoor: ....in electrical engineering department. I was doing my master's and doing my PhD, which I did not complete.

Banatao: Moving on.

Kapoor: But Boeing laid off two-thirds of its workforce, and so we were getting all the people from Boeing to study on campus, and so I remember that time.

Banatao: Yeah, yeah.

Kapoor: That's why I'm here in the Valley. I moved my career to semiconductors.

Banatao: Well, you were much earlier being smarter than I. I learned that later on.

Kapoor: About this time I think you met Maria, whom you later married, so some friends introduced you to her. Can you say a few words about that?

Banatao: Yes. The Filipino community in Seattle was small enough that it typically is just a matter of time that you meet most of them, right, at parties or other events. There were quite a few Filipino engineers at Boeing around the time I was there, but there was this downturn. A lot of them were laid off first shot, right, but the community, most of it was still there. Maria was also going through her master's at the University of Washington in educational psychology. That's why she went to Washington, left the Philippines. I met her in one of the parties, and that was it. I guess I fell in love.

Kapoor: When you moved to Stanford you were not married yet. She was still going to University of Washington, and so this was like a long-distance relationship.

Banatao: Long distance, yeah.

Kapoor: There was an anecdote where you were still saving money and you had code making phone calls waiting for a number of rings.

Banatao: Yes. Graduate student and she was just finished and no job. I could not afford it, so we had to come up with a system where—and I had to tell my roommate, who was Indian. I said "Hey, don't answer the phone right away. There's a code here." So it worked actually, but you do what you have to do even without money, right?

Kapoor: Right. So you were at Stanford, where you got your MSEE and in computer science.

Banatao: Yeah, computer science was more of the orientation. It's still BSEE, but you have your typical degree. You have your concentration, right? That's what I did. I was more interested in architecture, although I had to take a lot of good solid-state stuff, which I then leveraged, and that's how I met you, because I went into semiconductors also.

Kapoor: Yes. So I think computer architecture is again what gave you the strength in your entire career following that.

Banatao: Oh yeah. I always leveraged that, even during the time that you and I were in the same office involved in a processor design and so on. So that was good. And just continued to leverage that.

Kapoor: So then you got married about this time. Was it in Seattle or in....

Banatao: No, it was in LA. I was still finishing a few courses at Stanford in the summer, because I had to leave. I had no more money, so I used that summer to take more courses. I had all the credits already, but I was so intrigued with that whole area of semiconductors, because I knew that that was what I wanted to be, and I finished all the computer science, architecture and some of the basics in semiconductor physics, device physics, but I wanted to get more practical stuff. During that summer also I consulted with NASA here in Moffett, because they had some software projects, and my professor said "Hey, they need your expertise." "What expertise? I don't have any experience." "No, no, no. Your background is needed there now," because I crossed hardware and software.

Kapoor: Since you moved to United States you kept in touch with your family. Did you visit Philippines in this time period?

Banatao: No, not at that time. Again, no job, no money, and then I got married, so you can imagine it's a little bit hectic. You have a career to take care of. It was four years after I was able to go home. I have three siblings, two brothers and one sister. And so after four years I was at Commodore at that time, and I told my boss "Look, I finished this project. I'd like to go home to the Philippines for Christmas." And he was good enough to say "All right, no problem. Who are you bringing?" "My entire family." "We'll take care of everything. Just go." I was shocked. I didn't even ask for them to pay. I just said "I will go on vacation." So that was good of Commodore, and that was the first time I went back. It was great to kind of refresh and go back to my roots in that little, little, little, little barrio town to get refreshed. To me it was refreshing actually.

Kapoor: Was Commodore your first job after graduating?

Banatao: No. It was National Semiconductor.

Kapoor: Let me go back to that. You had offers from Intel and AMI and National, I think.

Banatao: Right.

Kapoor: And so you chose National. Can you tell why?

Banatao: Yes. Remember I said earlier that because of my courses at Stanford I combined software and hardware, hardware in terms of semiconductors, device physics and circuits. And I made the conclusion, I have to give credit to Bill Davidow. At Stanford we had every Wednesday a seminar series. They invite industry. Mostly the PhD candidates present their thesis, which—most of us sleep, but <laughs> it's not exciting. Occasionally they bring in outsiders. Bill Davidow, he said "Very soon we will put a computer on a chip." Well, since I was already close enough in that thinking that sealed it, and I was looking for that job. There were only three companies locally, Intel, National and AMI. I interviewed, and National had the best CPU architecture defined. Intel was nowhere in architecture. That's why I went to National. AMI was—I don't know. It wasn't much.

Kapoor: I think AMI at that time was a custom chip company.

Banatao: That's right.

Kapoor: And Intel was more into memories. And it's interesting that AMI's sales in 1972 were roughly $30 million, same as Intel.

Banatao: Oh really?

Kapoor: Roughly. And Intel wanted to get into more custom chips, and AMI wanted to get into more memories, but Intel succeeded in that and AMI did not. AMI never went into memories.

Banatao: That's interesting. <laughs>

Kapoor: So then you started at National. What did you do at National?

Banatao: Well, I was assigned to the microprocessor group. There were a total of nine of us. All of them were there already, and then we added one from another school, so there were 10 back in 1972. So there were two managers. I was assigned this manager, the manager who was in charge of logic and then manager in terms of the chip design itself, right, so there's soft and hard kind of thing. And my first week I did nothing but again read all the specs and so on, and then finally my manager and I talked. He just left me alone, so I went back and said "So what do you want me to do?" "Well, there's this section that we are dividing right now, and maybe you could take part of that to design." I think it was some sort of a decoder. And "Yeah, okay." So I sat down and started asking "So how do you design these things? Do you have any tools?" But I already observe in pieces of paper there's ones and zeros, ones and zeros. I went back to my manager, and "Hey, let me volunteer to suggest this. Why don't you let me write some software so that we can automate the design here?" Of course in those days they don't understand what computer science is. What is software, right? It went up to my director, Dan Izumi, brilliant engineer but, again, nothing to do with computers and so on or architecture. He just said "Fine. Whatever you want." It took me about six months to design—or to code a microassembler, because it is microprogram. That's the other thing that I liked with the architecture. It was microprogram. And then an assembler, which I derived from the microassembler. I wrote a rudimentary operating system for a development system, because I asked "So what do we do when we have the chips?" "Oh, we have boards here and there." "Well, how do you test your software?" "Well, we will put switches." "No, no, no, no, no. It'll take us forever." So I and another engineer in the group—"Hey, let's design this system." So we had a teletype as our IO with a bunch of toggle switches, and then eventually I wrote the beginning of a compiler, but that was much later after the chip worked, and I was there six months doing software. And then finally I went to the manager. "All right, I want to design the chip now." "You're a chip designer?" "No, no. Yeah, I am," because I was doing software. But that was the first thing I did, and it helped a lot of the engineers. Finally they understood what software means in developing that chip, which is a microprocessor. Without that, well, you're stuck forever, assembly code and writing ones and zeros. That's no good. That's what I did initially for the first six months.

Kapoor: How long were you at National?

Banatao: I was there for close to three years, then I went to Commodore International.

Kapoor: Oh, okay.

Banatao: Yeah.

Kapoor: Was there a opportunity for you to do the chip design at National that came into production?

Banatao: Yes, eventually, but I was not there when it came into production. What happened was because of my initial work they were thinking of a communications chip, not the very first one. A lot of the tools that I wrote went into the overall design, but they asked "Since you know a lot about software we are beginning to think of an eight-bit communications processor." So immediately I exercised the initial work in computer architecture at National, where my guess was right. National was the right company if the experience that I was looking for fit, and it did, so I did that before I even left. I carried that. When I went to Commodore I looked at how they designed their calculator chips. "No, no, no. You'll be designing things forever. Let's just make a little processor," which is what I did at Commodore.

Kapoor: What was the size of the overall engineering team at National when you were leaving?

Banatao: When I left there were about 30 of us, yeah, because then the chip was in design. Easily there were like six circuit design guys, and there were layout and so on, and then there was the logic group of course, and then a small software group. And in fact before I left they gave me a master's student from Berkeley for summer. "Here, teach this kid what to do, whatever you want to." I was just playing around basically, not a real management job, but....

Kapoor: What motivated you to move to Commodore, or was this also the time when you were starting to attend some of the Homebrew Computer Club activities?

Banatao: Yeah, around that time, from '72 and on but not '72. It took me about six months to learn about these guys fooling around. Most of them are actually from Stanford too, some former classmates, although I left the program already at that time, but, yeah, when I was at National and then continued more intensely when I was at Commodore, because Commodore was in Palo Alto, and we usually go to Xerox PARC, where we had our evening get-together. We don't call it "meeting." It's just everyone peddling each other. <laughs>

Kapoor: So that's where you ran into Steve Jobs and Steve Wozniak.

Banatao: Oh yeah, those guys, Lee Finkelstein [sic], yeah, there and a few other names. And I actually tested the idea of "Guys, what if we have a floating-point processor? Can you guys use that?" "Oh yeah. Oh, where is it?" "I'm just asking you the question. I don't have a chip." <laughs> But of course that had its own life eventually.

Kapoor: At Commodore you designed a single-chip 16-bit microprocessor-based calculator.

Banatao: Yeah, 16-bit, yes.

Kapoor: Was it the predecessor to PET computer or something like that?

Banatao: No. It was not intended for that even if I designed it, because it was more oriented for mathematics. It didn't have a lot of the nuances of I would say a simple ALU. Everything happens, as you know, in an ALU. The more general purpose it is, the simpler it is. My ALU was really more of a floating-point ALU where I can do shifting, realignment for the floating point so that when you actually add numbers—so on the side there is this binary to decimal converter, so it's a very dedicated microprocessor. But if I had wanted to take it as a general purpose to do general purpose processing, I would probably have cut it in half, took away a lot of the mathematics, the floating point stuff, which was not needed at least at that time. Years later, we have a floating point chip. <laughs>

Kapoor: So I remember your mentioning the family dynamics of Commodore, where Jack Trammell and his family and how they influenced the culture at Commodore and how it affected later on how PET computer was, so can you say a few words about that?

Banatao: Yeah, it was a good company if you want to really stay there long term. They do respect technology and technical people because none of them had that. The very first semblance of someone technical in their family was one of the sons who went into physics which after he graduated from Santa Clara, Jack came to me one morning, "Here, use him, he's probably useless." You know how he is, it's a little bit rough on the edges but he always means well but, you know, "Just, occupy him this summer." So I said, "done" but it was a nice environment. They did everything like a family. Our summer parties were in their very nice home up in the Saratoga Hills and a small... a small staff basically. The only thing was that we were lacking in I would say objective discussions. <laughs> It was kind of one dimensional but they always mean well to their employees. They gave us a lot of good benefits, trips. You know, just.... you don't even ask, just sound out a little bit just like well, I... "oh, I'm going on vacation." "Go, we'll take care of everything, don't worry." <laughs> It was a good environment and learning experience. That's where I really... I would say, ballooned as a beginning manager and tested my managing abilities whether I can actually partition tasks.

Kapoor: So you had a group of... group engineers?

Banatao: It was a small group. There was one circuit guy. Even in those days, I did all the software and the logic design, the architecture. <laughs> And then two layout guys. Actually two circuits and then I had a couple of software guys. I would say it's a very small group.

Kapoor: So how did the concept of PET computer originate and who initiated it, did you play a role in that?

Banatao: Oh yeah, a major. What happened was because of the... I would say some of it was influenced by the Homebrew Computer Club and because of my background, I thought that, you know, there could be beyond calculators, little computers that people can use and so... so what could that be, you know, we started to. So we did the initial system design for the PET around that time. It was more of a side project. Okay, then, remember MOS Technology 6502, because I wanted to use a 6502. I've gotten to know some of those guys. There was Chuck Peddle, which eventually in his own translation, he called it, Peddle Electronic Transactor... okay, c'mon. The way it happened was that one morning we had this thing that was running BASIC and I went to my boss' office, "Hey, how do you wanna call this thing?" "Well, something computer." Well, you know, if you use the word computer, we should soften it down and around that time, this thing about rocks, PET computers... I mean, Pet Rocks he just said... I guess there's some brilliance there, he said, "Why don't we call it just PET computer?" "Oh, yeah, okay, fine." That's how it happened. From there on it became a PET computer. We went on and then of course, Chuck... I spent about a week transferring to him. Here's the design, here's everything. You know, already the 6502, this is this where we are. Take on, finish that because I was still doing all the other chip designs for the calculators, although we did this only on the side. _____ this guy got.... loved it so much and I think that's how I got him to stay <laughs> that PET computer. And that was history of the PET. It was an amazing thing because it took off in many areas.

Kapoor: So how did it, in terms of timeframe relate to the IBM PC and of course Apple came later but?

Banatao: No it was around that time that Wozniak and Jobs started Apple and there was a... the only difference was that at the very... the very first time we had it working, we unveiled it at the Consumer Electronics Show, we beat them. Ours was working, there's was still not there and maybe that's why we had that lead and we gained momentum in Europe, strong in Europe. Commodore International had a lot of roots in Europe by the way and I think...

Kapoor: Because of Jack Trameil?

Banatao: Yeah, right. And no... that, it was around the same time and there was a time actually that I was asked by Jack, "Hey, do you think these two guys here"... they actually went into a launch that is more eminent I think.

Kapoor: I see… yeah, how things happen, yes.

Banatao: I don't know exactly what happened in that meeting because they didn't invite me, they just.... before they left, they had just asked me, "What do you think, are you?" "No, I'm almost done, no problem." <laughs>

Kapoor: Very interesting. So, after Commodore, you said you were there for about two years?

Banatao: Three years. Yeah, three years, '76 through '79. That's when we were at Intersil.

Kapoor: So how did you come to Intersil, was there an advertisement for a job or?

Banatao: No I got a call from a…

Kapoor: Headhunter?

Banatao: A headhunter, a recruiter, looking for a microprocessor design manager and I applied. Remember Shep?

Kapoor: Yes Shep Hume.

Banatao: He was a director right?

Kapoor: Right.

Banatao: So he was looking for a manager and my interview was in the afternoon. It was supposed to be from like two to three. By the time I got out of his office, it was five p.m. 5 guy. That guy was smart, you know Shep?

Kapoor: Yeah, I worked for him also.

Banatao: But he was more circuits and so he was so intrigued with the logic side that he didn't ask me a lot of circuit stuff. So how do you design... his question was how do you design a processor? And I thought the question was more of for him to learn because he never did it but I learned that later on. I thought he wanted to see how good I was. I think he just wanted to learn. <laughs> I went through all the different sections and then I explained, blah, blah, blah and so on. And then he asked one question, "Well how do you design the control, the decoder and the control functions?" "Oh, you just need to understand the instruction set and how it's bit encoded, although you can control the bit encoding" and... "What is bit encoding?" "Okay, well you know these little fields here, you can encode things in there if you want, depending on how complex the logic is." "Oh, you can do that?" "Yeah, you can design <laughs> the logic." [ph?] It was fun actually, I had fun...

Kapoor: That's why it took so long.

Banatao: Yeah and then he said, "How do you design a little bit... a little adder?" And I just drew, you know, vertical lines and horizontal lines and alright, so I'll put the transistor here, transistor there and then I'll put a gate thing here and so on. "What is that?" "No, no, no you need to pre-charge this so that when the code arrives, you pick only the right vertical thing and then it discharges and that's your active line." "Oh, so that's how you do it." <laughs> Anyway, it was a fun interview.

Kapoor: So imagine that here is a guy that you were training in a way who later at Intel ran the microcontroller group in Arizona?

Banatao: Oh really?

Kapoor: Yeah, he ran that.

Banatao: He did? He's good though. <laughs> Oh, I see.

Kapoor: In fact, he and another gentleman who was his boss, they went to Intel to start the whole CMOS design because at that time Intersil was big in CMOS as you remember.

Banatao: Yeah, by then, oh yeah. We were... you were at Intel then right?

Kapoor: No I was at Intersil when you were hired and at some point we both started reporting to Thampy, so I can't recall the transition. Maybe because Thampy was hired and then his expertise was computer architecture.

Banatao: Yeah, more on the computer architecture side, yeah. Yeah, I had fun with Thampy because he can actually... I can learn from him. I was not learning from Shep. <laughs> And so Thampy was, "oh, great, this is good." And you know, we were all very close friends.

Kapoor: I was designing some logic chips with Shep, of the 6100 or the PDP-8 family.

Banatao: That's right... a lot of the peripheral chips, you guys did that, right?

Kapoor: Yes.

Banatao: That was a good one. <laughs>

Kapoor: So then you joined Intersil primarily because I think you wanted to be in microprocessor kind of designs?

Banatao: Right.

Kapoor: And you were hired as a manger of the microprocessor group?

Banatao: Yeah. I had the hardest time with Shmuel Adir, Sam Adir, an Israeli. My gosh, that was the hardest management task. <laughs> He was a good engineer but he was rough.

Kapoor: He was always adamant about something, he was stubborn in his work, yeah.

Banatao: Yes and finally afterwards we became very good friends, actually, because he realized that there were things that I had to teach him 'cause he was a good circuits/logic, he had no idea what architecture's instruction sets are and we became friends years... even years after he left the Bay Area to go to Israel. Once a year he comes out here, we have dinner and he used to tell me, "You should come to Israel." "Excuse me? <laughs> Here I am Filipino working in Silicon Valley, you want me to go there?" <laughs>

Kapoor: So I remember at Intersil since we both worked on the same chip, we designed the CMOS version of the 8748 from scratch, you know, from a spec or a data sheet and I think you did the entire logic design?

Banatao: Yeah, but I learned a lot from you on the circuit side. I know I used to go to you, "Uday, is this sufficient drive here you think?" "Well, I think you should size this." Remember, this is the days when we have to size every transistor.

Kapoor: Yeah, there were no tools.

Banatao: Yes and you used to come and... but you may have forgotten this but those things never leave my brain because you really helped me there. "No, this is not sufficient, you put that in series, you need to double this thing." "Oh, okay, fine." Because the drive, you know, you won't get enough...

Kapoor: The falling stage, remembering the falling stage.

Banatao: Yeah and so <laughs> it was perfect because we were in the same office, we were not disturbing anyone and I was focused on the logic and you probably saw me with pieces of paper like coding and so on and it [ph?] had nothing to do with...

Kapoor: Yes, I still remember it on a single sheet of paper, you draw the RTL flow?

Banatao: Yeah, exactly but then I come to you, like... bug you about, "Uday, I need help here, I need to do this link. How do I interface that?" <laughs>

Kapoor: And I learned also from you because I, you know, learned about the architecture of the microprocessor and we had a lot of fun, we used to play tennis.

Banatao: Yes.

Kapoor: And those were good times and I remember those distinctly, you know, in my career as well.

Banatao: Yeah.

Kapoor: So then I think we actually did not have any tools, you know, for logic simulation or circuit simulation, or as you said, verification...

Banatao: Ah, I forgot that detail.

Kapoor: And this is a new process with the EPROM process and we were designing an EPROM version of the single chip microcontroller and when the chip came out, it actually worked the first time. It was just amazing.

Banatao: That work, yes. There was one instruction that I missed a conditional. If X, blah, blah, blah... I took the positive instead of the negative and so we were programming and the thing was not jumping or whatever or moving at rest until I looked at how I encoded it, "Ooh, I took the negative... I encoded the negative, not the positive." So then it's just a matter of, "alright, well, let's just change the code and then write the program" and then it worked but you're right though, we were all happy.

Kapoor: And I mean for the functionality, for the complexity of the chip, for it to not have been checked, you know, by an electronic means, but by physically checking, you know, the layout for it to work right there, it was just amazing.

Banatao: But you know the first three months of that and Thampy probably didn't mention it to anyone but I was... there was a computer service called ISD. I was there for the first three months. After the first month, and I was pretty much doing the work there. I didn't go to the office, I go there sometime of course. Thampy came out to ISD, "What are you doing?" "Uh... Thampy, I am writing the assembler, I have to write a compiled code simulator." "Why?" "Well, this is complex enough that if you don't write a basic simulator, it won't work. You will have to iterate this thing many times." "Okay, well, whatever that means." I used the word compiled code, which was eventually used by the industry and I had... you remember there was this other Japanese engineer, Tak Shigihara?

Kapoor: Yes.

Banatao: I recruited him, "Tak, you need to come with me now. So here's the flip flop and here's the excitation equation. I want you to model that." So, you know a lot, you know this... the basic elements of logic, he wrote that for me and then I plugged it in and then I tested it. "Tak, you didn't code this properly, it doesn't <laughs> work." <laughs> It would have taken me a, you know, another whole month beyond the three months that I used up if he didn't help me. Luckily, Thampy was understanding that, "Yeah, okay, you need to do that, fine." But after that, we just went through the logic and I put in a code, simulated. In fact, eventually, I worked with our test guys to close the loop with the simulator to the tester, to test the test pattern that I wrote so that it does work <laughs> 'cause I had no idea what a tester was.

Kapoor: Exactly. So, what I remember is that the chip worked but from a point of view of investing in the future, the company was not interested. It's like they wanted to move on and we all got frustrated and that's when we started looking at alternatives to what we should do.

Banatao: That's when we have this triumvirate <laughs> We had to have a marketing guy and you and I can do everything else. <laughs> There's this guy called, you know, Steve Diamond. <laughs> That was fun too.

Kapoor: So I think... so I think we did try to get management to you know, commit to the follow-up roadmap but it looks like at that point they didn't want to invest anymore money. They wanted to be bought by another company which eventually happened, I think General Electric bought.

Banato: In fact, weren't we still there when... no, I'm not sure now.

Kapoor: I think it happened afterwards.

Banatao: I forgot the sequence, it was afterwards, yeah.

Kapoor: And so, then we were... we as a group, moved to Synertek, so I can say I know that you went there and I went there together. So maybe you can talk a little bit about that?

Banatao: Well again that was an extension of the things that we talked about when we were still at Intersil. This market, a processor, we can do a lot. And in fact, you remember, we tried to leverage that knowledge between the three of us at Synertek and there was a guy, a process guy, Dana Chase, who also moved ahead of us and he was our best inside sales. I mean, for us to be hired and he was... apparently, he told me this later on once we were all on board. Apparently, he told the management that, "You guys better hire them because they know what they're doing in this market" and I mean... and Synertek was a very basic, a bunch of memories and... I don't know what else they had at that time. They had game chips, something like that.

Kapoor: They were also in logic design as an ASIC vendor also. I think there was also the 6502.

Banatao: Oh, the second source. Oh, that's right, that's right.

Kapoor: Bob Schreiner had made this special deal...

Banatao: The second source, yes, that's right, okay. And what attracted us I think is that, "Okay, some time we will design our own" but then we got caught up into selling again. <laughs> We never did what we wanted to do. I guess that's what I...

Kapoor: So I think you were at Synertek managing the microprocessor group for some time and I was part of that group and then I think at some point you left fairly quickly?

Banatao: Fairly quick and I remember our friend Eli after I gave the notice convincing me, "Dado, I would like for you to manage this group." "Manage what group?" "Well, there's the existing processor but I also want you to manage the process development." "Excuse me, that's not my expertise." He said, "I don't care, I just want you to please stay." <laughs> I turned him down but I don't know what would have happened if I stayed there.

Kapoor: So I think you had ambitions to do some new things and at that time I think you moved to SEEQ, so maybe you can say a few words about that?

Banatao: Yeah, well remember what we did at Synertek, microprocessor and non-volatile memory, that's what they wanted to do. So, what we...

Kapoor: That's what Eli was there for, for the non-volatile memory, flash.

Banatao: And what we did there was to get one of the standard microcontrollers and eventually we did an 8051. Because by then we had also some marketing guys from Intel, remember they came from Intel.

Kapoor: Right, so this was Gordon Campbell?

Banatao: Yeah and others. So.... but you know I would not have left Synertek if there was a clear roadmap to the things that we liked to do. It was just not there and I think eventually we all left, you went to Intel then right?

Kapoor: Yes.

Banatao: So... and you stayed there for another year right?

Steve Diamond: Yeah but you know, Honeywell was not interested in investing in a sixteen bit processor. They pushed us in the microcontroller direction and we made MC-8, second source.

Banatao: Oh, I even remembered, you dragged me to Honeywell multiple times for a high level meeting.

Steve Diamond: I think we went to Honeywell to try and talk them into it.

Banatao: And we just got disappointed every time. <laughs>

Kapoor: So I think Steve tried a lot with management?

Banatao: Yeah, and as he was saying earlier, we ran into this funding model, you know where a lot of the funding was being given to Eli from other groups, so we were not getting the funding.

Kapoor: So, I understand. So, how was it at SEEQ, can you say?

Banatao: SEEQ was a very good timing for me and lucky company because it... years later, and now looking back, some of the things that I did there, contributed to my first startup.

Kapoor: So this is about what time now?

Banatao: This is from 1981, through '84, I was at SEEQ but what happened there was... so we did the processor and then because of John Doerr, I got introduced to the guys at 3COM, where they also invested and remember the guys from 3COM came from Xerox PARC, Ethernet? In those days there was Bob Metcalf and Birenbaum and that very sharp engineer under Birenbaum, Ron something. But they have two big boards of Ethernet and John Doerr and Bill Krause, who was the CEO, came to Gordie and they talked about this Ethernet thing to connect computers and here's this bluebook, please read it and please define a chip. <laughs> Okay, I had some definition a month later, we invited them in. Oh my gosh, these guys were brilliant in networking and so on. I could see them roll their eyes and I'm like, oh, what is this but this guy, this engineer and Birenbaum, I forgot his first name, eventually he went to Cisco, one of the top managers there. He said, "Dado, you know I like what you said about your approach in design." I didn't know what he meant by that because I didn't ask but then if you are willing, I will help you in the definition. I will tell you exactly what we want to see but I like your approach in designing this thing. Later on, he described it as uncomplicated, elegant, it can do everything and yet it can be programmable. By then, Intel... because Intel and AMD, they were racing for the first Ethernet controller and afterwards, once we got going and working this out, I asked him, "Why didn't you just go use them?" "Dado, it's expensive, it's hot, it's.... they put so many things in there that we will not even use until I don't even know when but I like your simplistic approach to the MAC layer" and so on. "I would like to see the five layer but you know, one thing at a time." That's what introduced me to the connected PC. At SEEQ, I began to understand how small computers eventually will work and be capable at 3COM. It was a very successful chip. In fact, SEEQ was losing money until these designs came out, 3COM started buying and... <laughs> and then there was this DEC, VAX chip that again John Doerr asked my help to go and make one.

Kapoor: So John was on the board of SEEQ?

Banatao: Yeah, so but my experience at SEEQ, besides more microprocessors, it was taken to another dimension where I began to learn the potential evolution of computing platforms, meaning, because these guys at DEC... at Xerox, had this, I don't know whether they called it personal but I don't think they called it personal, it's just small stand alone computers. It was not as compact because they were not using a lot of integration but I learned it from them and also the networking part which eventually, you know, became very important. So that is my SEEQ... what I got out from that job. I knew I can manage a group, design things with them but this next dimension enabled me to...

Kapoor: So the other person who was there was George Perlegos, so he was responsible for the nonvolatile portion?

Banatao: Well, he was in charge of all engineering. I reported to him. But he left me alone because that's not his background. <laughs> It was beautiful. So when he leaves on vacation, he just said, "Dado, you manage this okay, I'm going to Greece." <laughs> He goes to Greece for like, you know, a month.

Kapoor: I know... you know it's interesting that George and I shared an office at AMI many years ago. We were just like you and I shared an office, we were in the same office for the first one year and all he was doing was characterization of chips, you know, 'cause that was his... he's a product engineer, so.

Banatao: Yeah, and I think that continued at Intel, right?

Kapoor: Yeah.

Banatao: A nonvolatile?... So, again, at SEEQ it was more exercising some of my management because he just left me alone. So it was a good... good experience, which gave me the confidence to eventually leave and...

Kapoor: So you got to know Gordon Campbell well?

Banatao: Yeah.

Kapoor: And in fact, maybe you can explain more how... what the next step was, how Mostron happen and so on?

Banatao: So around that time, towards the end of '83, summer, I started to look into the evolution of platforms, computing platforms and I actually bought an HP... what was the number... it was a BASIC machine. It was a small thing and I bought it for two thousand, it was very expensive, you know, at that

time and... but I wanted to see how it works. It was more of a box that is used for an engineering lab, not a tool for general purpose. <laughs> I said, "Why did I buy this?" But, you know, you have to learn. And then, I started to write things down. I remember going on vacation with Maria and the kids to Lake Tahoe, I brought, you know, two bags of notes and I started to write down the basic requirements of a personal computer. I dipped back to my experience at Commodore and then all the cumulated experience in computing, but most significantly what the guys at 3COM were doing and I put it all together in my notes. By end of the year, I thought I had defined a pretty good system. But then, IBM released the first IBM PC, PC-1, in '83 and I stepped back and said, "Whoa, wait a minute, this is a big player." I looked at it and it was simple and I could sense that they have a very basic approach but it could be a future... at that time I didn't think it would be a personal computer because it was, you know... it was not like the PET or the VIC or the Apple. You could see that their bent is more for enterprise. So around that time, I changed direction and I also made the conclusion, crucial conclusion for my career, that if anything happens in this form factor, I will go with IBM. So I studied their design. I read the entire code and made the very first PC chipset in '84 at Mostron. I quit SEEQ and by '84, I had all my notes. I took over our dining table at home to Maria's objection of course. I had all the design pretty much on what it takes to come up with a chipset because it was busy. It was a busy board. And then—oh excuse me, the first PC was before that. They came out with, wait... no... yes, I worked on the... I looked at the PC-1 for my notes but then the PC-AT came out... perfect timing. I looked at it and, yeah, this is better, because then they have some basic graphics. But I put out the chipset first. It took me years to do the first... you know, later on to do S3 for the graphics accelerator but the PC-AT was what I thought, this is going to be more of an enterprise for two important things: One, it had a better software architecture, some semblance of an operating system, although they just got something very basic from...

Kapoor: Microsoft.

Banatao: …Microsoft! God, how could I forget that name? <laughs> And also the... the idea that you can separate... it has the basic architecture for expansion, you can block things out, although it was still a mishmash of things. And that was it. Mostron was not funded well, we ran out of money.

Kapoor: Right. So I remember, of course...

Banatao: But I still had the chip set though.

Kapoor: Right.

Banatao: We had boards, we were selling the boards at COMDEX. After one year I had the boards done.

Kapoor: So as you had mentioned earlier, after you left Synertek after some time I left for Intel. And I remember we stayed in touch, and at some point when you have started Mostron, or starting, you had asked me to join you...

Banatao: Yeah.

Kapoor: …at Mostron.

Banatao: Yeah.

Kapoor: But I had so many embedded things with my career that I couldn't leave at that time. So I remember that.

Banatao: Yeah, and I think I probably told you that, you know, we don't have money.

<laughter>

Kapoor: Yeah.

Banatao: That's probably why, I think.

Kapoor: It could be, yeah. That was... yeah.

Banatao: It could be the reason.

Kapoor: Yeah.

Banatao: You made the right decision.

Kapoor: For Mostron.

Banatao: For Mostron, yeah.

Man 1: I think we had the same conversation.

Banatao: Yeah, yeah. God I was asking for help just to—we could not raise money.

Kapoor: Right. So this is in 1984...

Banatao: Right.

Kapoor: …roughly around that timeframe. And Ron Yara was with you at that time? Ron Yara...

Banatao: Yeah, towards the end. He was there all of three months in Mostron.

Kapoor: I see.

Banatao: And then we could not—my cofounder, we couldn't work with him.

Kapoor: I see.

Banatao: I guess Ron proved that it was not my problem.

Kapoor: I see.

<laughter>

Banatao: Because he came to me one day, "I don't know how you..."

Kapoor: Francis Siu is what you...

Banatao: Yeah.

Kapoor: …mentioned, yeah.

Banatao: "I don't know how you took this for so long, I can't take it anymore."

Kapoor: Yeah.

Banatao: "Really? So I'm not the only one."

<laughter>

Kapoor: So then what happened after that?

Banatao: Well what happened was Gordy was let go at SEEQ. And he befriended a real estate guy and we met... and also around that time, his wife Maria wanted to work with us at Mostron. Like, "We don't have anything here, you know, we can't hire you."

Kapoor: Right.

Banatao: Fine, but... so the connection was made about what we were doing and well, the short of it is that Gordy had this real estate guy friend who wanted to invest one million. And I told Gordy, "If you have a million we will have a product, I guarantee you." Well what product is that? So I described... chip set; "Let's do it." That's how Chips and Technologies got started. Because I was looking for money, as much as Mostron didn't work because we ran out of cash, I was still so hot on the idea because I thought, "This is it, if ever there is a system to ride on, this is it." I had my own definition but I looked at that as, well there is IBM behind it, you know, marketing wise. Enterprise buys IBM right? <laughs>

Kapoor: Right.

Banatao: Even in those days as early as I was in understanding the dynamics of markets, you know, you hear that phrase and in fact it does happen. So we started Chips with that one million. We ran out of money around the time that the chips were still in production, meaning being fabricated. So we had to go raise money, we were using our own money, the founders <laughs> and some friends, to pay salaries. Luckily the chip sets worked first time. I did the same thing that I did again, like at Intersil, where I wrote all the software and simulators and so on.

Kapoor: So this was a fabless model...

Banatao: Yeah.

Kapoor: …and so who was the fab? Who was fabbing it?

Banatao: Initially I worked at LSI Logic, but Toshiba was their partner, and while I got the first production parts from LSI Logic, eventually—or not eventually, I moved quickly to work with LSI, I mean with Toshiba. Because they were clearly a much better production house, so I redid all the—I had three guys, redid all the simulations. And that's when LSI Logic went and bought this company to do chip sets. Because their volume is not there anymore from Chips and Technologies <laughs>. And I thought, "What? You guys are gonna die on that one." Because I knew those guys who were doing that. And somehow for four years no one could compete on our... because even Intel, they started their own but like—I don't know, now I don't understand why no one—because it was simple, at least from my point of view. The thing missing was that they did not go through the process that I had to go through, which is I read the entire software code of IBM. There were secrets in there, like there was this code that if you don't understand what it was... one of the peripheral chips would not work.

Kapoor: I see.

Man 1: They published the BIOS.

Banatao: <laughs> Yeah.

Kapoor: So the assembly code, the BIOS ROM, was published in the Technical Reference Manual.

Banatao: Yeah. And so you have to do the trick of them using the peripheral chip. These are standard peripheral chips. But if you don't read that stuff you would not know what they did, and it is not compatible. I gave it eventually, after we were already in high volume production, we were growing chips leaps and bounds, went public in 22 months, 650 million at the end of four years of revenue. Someone translated that these days to—you understand, in today's numbers what that 650 is at? It's probably about 4 or 5 billion.

Kapoor: Oh really?

Banatao: Anyway, I gave it to one of my friends who was doing his own PC, right? Because he said, "Dado, this is not working." "What are you doing? Why don't you just buy our chip?" "Well you know, I'm doing something special for a peripheral." "Okay fine, but... here's what I will do. I will not give you my code but I will give you an equation. <laughs> You translate it yourself." He calls me about a week later, "Thank you very much, it works." "Oh, you translated it?" But I didn't tell him the connection because... but that's the thing that did it, it was not easy to go through the BIOS, that was pain. And then when I finally cost reduced our chip set to one chip, we even made it cheaper because half of the features of the peripheral chips, the DMA, the interrupt controllers, the timers, I/O, they were not using. Again, you can do that if you read the code. <laughs>

Kapoor: Right. So would you like to take a break?

Banatao: Just some water.

Kapoor: Yeah. Is that okay?

Man 1: There's actually water right there.

Kapoor: Oh.

Banatao: Yeah, yeah, yeah.

Man 1: But you can take a break.

Kapoor: So... ready? Okay. So we were talking about Chips and Technology and... grew really rapidly, and the whole chip set concept grew like wildfire...

Banatao: Right.

Kapoor: …and I think it caused a growth of the PC industry as well. So can you talk a little bit about that?

Banatao: Yeah, the impact was phenomenal. There were a few factors that were important in that solution process. One of course is software compatibility. At that time it was what we called them, "Register Level." In other words, the application controlled all the way down to the peripherals, the registers in those peripherals, which is unheard of but that's how it used to be. So that contributed to the issue on compatibility a lot. And again, if you don't read the code <laughs> you will violate every single thing and the applications will not work, basically you don't have a PC. So early on Chips and Technologies had that advantage, and understanding that semiconductor companies really did not care much about software. Well it's easy therefore to make that mistake. Understand—okay, here's what happens, there is Intel, AMD, who had all of those peripherals, there was VLSI who also had those peripherals, or cores, and there was another company… was that Zymos or something like that? Anyway, they had that. And out of the blue, here is Chips and Technologies affecting that entire business. It was compatible right away because of the way we did the designs, again, very software oriented. And then of course the integration part. Although it was not fully integrated because I was using gate-array so that was also very revolutionary in the sense that I didn't go through the chip design cycle, I used gate-arrays, so things happened fast. And then of course the ability to put out the product right away to be used. And

so if you combine all of those things it's like the answer to the overall question, how did that happen? Did I plan every single one of those? I would like say yes and no, okay... yes I had to do gate-array because we had no cash. Understand, we had one million only. If I went through the normal chip design that you and I do that would have been finished in one month, or not one month, in six months. So I had to innovate. The other thing of course is, which is a result of what I did, although people now describe what Chips and Technologies did as the "first fabless semiconductor company." Well because I was using gate-array, I didn't have to have a fab. There is a standard solution to everyone but somehow the semiconductor industry did not think that you could come up with a standard product using gate-arrays. So I was forced to do that simply because we didn't have the cash. So that's the yes part, that it was deliberate. The other two that, well we were the first company to be fabless and so on, well that was a result of the first action <laughs>. But fine, I mean if people say that, yeah of course, we didn't have to have a fab and we didn't—and so on, before that everyone was, Cirrus Logic was. But once we were out people understood that, "Oh my gosh, you can actually do this." But it has to be a select class of application. Like in the PC, I optimized everything, I took out so many registers out of those peripherals because they were useless, they were not being used at all. The risk was will IBM or Microsoft risk coming up with a new application that requires those registers? That were not used in the first version. That was the only risk I had. And I justified it in the sense that well, if they do that then every single PC will have to be retrofitted anyway simply because the BIOS was not using it. So every single BIOS chip will have to be taken out. The industry will not do that, so no one dared to change that. Until at S3 I said, "Enough is enough, we will start with graphics using an API, Applications...

Kapoor: Programming...

Banatao: …Interface."

Kapoor: So for the growth of Chips and Technology the primary PCs at that time were PC-XT and PC-AT, that's what caused the growth?

Banatao: It was a PC-AT.

Kapoor: PC-AT.

Banatao: Yeah.

Kapoor: Okay.

Banatao: From all over Asia, all over the world, I used to travel all over the world, even developing countries. I traveled just to see what's happening and talk to real customers. Some of them I thought,

"These guys will never make it, blah, blah, blah," and so on... but it was a—there was this hunger for computing that was never satisfied because of cost, until the PC came in. It was explosion, within about two years Taiwan became the largest PC manufacturer, using all our chip sets. TSMC was not funded until after we went public. And, you know, some people at the GSA say that TSMC started the fabless revolution, that's bullshit.

Kapoor: Right.

Banatao: You may wanna take that from the video, but... <laughs>

Kapoor: No, that's alright.

Banatao: They saw the handwriting that a company can be fabless, as successful as Chips and Technologies was at that time. But frankly I don't call it genius at all, I was more solving a problem of not having cash. The innovation is, I was using my engineering instincts, it was more an engineering exercise of, will this work? How can I partition this? So it's a little bit of architecture because the gate-arrays were slower. So I just had to make sure I—in fact I had three bipolar chips and two CMOS [ph?]. That's how I partitioned it to meet the performance numbers. <laughs>

Kapoor: Right. So you went public in 22 months...

Banatao: Mmhmm.

Kapoor: …that was pretty record at that time.

Banatao: It was record, even today it has not been broken from a semiconductor company point of view. It has not. Even the growth phase, there's always—as recent as about five years ago I saw, when someone dares to put a growth of their company, a semiconductor company, there's always the Chips and Technologies and there's everyone else clumped here. It's gone now, they don't put that anymore because it's been too old and Intel has all that already, Intel bought it eventually.

Kapoor: So I hear that the next phase was S3, so what caused you to look at the next phase?

Banatao: Well it was, I would say Apple envious... workstation envy <laughs>. Their graphics were just so much better, and for so much purchase of PC [sic], to continue with that kind of graphics performance I thought was never... I would say the growth would not continue. It would never get to a point where it rightfully should belong. And seeing the results of what's happening from the other platforms. So I then...

made a risky move of leaving Chips and Technologies. People thought I was crazy, you know, "You guys are riding high," and so on. "No they'll be okay, don't worry." That was very risky, at least also from my family point of view <laughs>.

Kapoor: So you were running engineering at that time, or...?

Banatao: No I was running... general manager for division, the System Logic division. Ron was running the other division, the Graphics division, which we eventually gave to Keith Lobo who came from LSI Logic. And then when I left they swapped, they gave the System Logic to Keith and there was another guy who was there... anyway, gave him the graphics. And yeah, so I learned about what it would take to run a company by then because my division was already like $450 million at that time, working with the other operations people, marketing and sales of course. Finance there was always a controller.

Kapoor: And you called it S3 because it was the third startup?

Banatao: Yeah, Startup Number 3. It's hard to come up with names...

Kapoor: <laughs> Yeah.

Banatao: …if anybody asks it's called Startup Number 3.

Kapoor: This was in 1989?

Banatao: Yeah. Just to solve the graphics bottleneck in the PC. But at the same time I said, "Even if we have all this performance, if we do not get away from this register level compatibility and make it API, it probably would not work anyway." So I challenged myself, and to some degree the whole industry. I had long arguments with Michael Dell on that one; "Dado, I will not buy your chips." "Michael, you will. I guarantee you because your competitors will use it and you will have no graphics." "No, you have to be at least—put register level and API." "No, that would make it so bad, I will not design a system like that." I went ahead anyway, but before I did that I made sure the VESA, the graphics committee, the standards committee, bought into it. You know, as much as I was daring, you still have to cover something there just in case. And then we worked with Microsoft a lot to establish the APIs, Intel eventually, finally embraced it and now the three of us defined DirectX.

Kapoor: So Microsoft saw an advantage in that?

Banatao: Oh yeah. In fact they helped us a lot, including things like, "Dado, we don't have that capability, we will not put it in Windows yet. Why don't you wait for a year and then you can put that in your hardware?" I said, "Okay, great, thanks, I don't need to complicate it, that could be our second generation." And then I was late by about three months when they released Windows 3.0. I told them, "Please don't do that." "Well, we have to, we committed already." Okay, well, graphics was so bad, right? It was not Windows. So we finished, we had characterized our chips, we told them, "Okay, we're ready." So that's when 3.1, right? 3.1, I have never seen a hundred software engineers jump up and down in... rhythm, when they saw our cards running Windows. It was nice, fast and everything, and the manager said, "Can you give us a hundred more boards so we can use this for our development? Because our guys are having a hard time with their graphics." <laughs> Yeah, how can you develop graphics with that kind of... So that was it, we dared two things and luckily the industry bought into it. And that was the beginning of high performance graphics. The CPU and graphics chip were sitting side by side. It was a true accelerated graphics—in fact we were the first to say "graphics acceleration." And that's how we called it at that time. And then of course the APIs...

Kapoor: So by then the bus issue was resolved, everything was standard, right?

Banatao: Yeah. That's when, remember a year later Intel came and...

Kapoor: Yeah.

Banatao: …yeah okay, so we had that bus... in fact I helped them change their chip set to accommodate that because what I did was I designed at S3 the chip set to go with it, because there was no chip set from Chips and Technologies. There was no bus, there's no concept, so I designed that. But I didn't give it to them because they were working on their own, and I just warned them, "Alright, let's sit down, I'll tell you exactly some of the issues here that we solved..." They got most of it but there was one thing that they did not somehow put in their... maybe they didn't listen or whatever. So they had to go back and delayed more of the performance. <laughs>

Kapoor: I see, okay. So the IPO was at 30 million for S3, is what I read.

Banatao: Yeah.

Kapoor: In 1996, that is correct.

Banatao: Yeah.

Kapoor: But then I think maybe...

Banatao: '93, that was '93.

Kapoor: '93.

Banatao: Took it IPO in '93, like four years after starting.

Kapoor: Okay. In '96 it says they were leaders in the graphics chip...

Banatao: Yeah.

Kapoor: ...market over Cirrus. Cirrus Logic was...

Banatao: Yeah we killed Cirrus's graphics division, Intel's graphics division. There were a few others. Then NVIDIA came with their 3D... we already had our 3D then also, which I started on the side, because I had a CEO at that time after we were profitable, we hired a CEO that's more operational. We called it Verge 3D. Basically... it was the first 3D so we occupied that but it was a small market for 3D at that time. NVIDIA came out, the first version was pretty much dead on arrival, they did not understand what PC is. They had good 3D of course, but to put it on the PC is not easy as I said earlier <laughs>. A lot of those things are embedded, not published.

Man 1: And these were... some of the people were workstation people, not PC people.

Banatao: Yes, Silicon Graphics.

Man 1: Dave Rosenthal I think, from Sun.

Banatao: Yeah, yeah. And then even their second one. Finally, this is—I was long gone from S3 already by the way, when all of this happened. I was involved in the first 3D, I was still there, but we got that out in '95. So the events I think I'm talking about is around '97, '98 already? I was already in my VC practice for three years.

Kapoor: Yeah, so we'll come to that phase.

Banatao: So finally somehow some of the engineers went to NVIDIA, who understood PC. After that I finally understood why Intel bought Chips and Technologies. The PC is a unique animal if you don't really spend the time understanding the guts of it. Intel could not compete with Chips in the chip set. It always bothered me, "Why? What's wrong with this thing?" Right? But it's those little nuances. Not until I saw what happened in the first versions of NVIDIA did I finally realize, "Wow so what we did was actually quite a bit of other IT that... you know, unless you really know how to do it, it's hard to do." But by then they had a new CEO I think... yeah. Because when I left in '95 to be a VC I left the board, you know, because I didn't want to look back.

Kapoor: So at that phase you were looking at the next stage of your life...

Banatao: Yeah.

Kapoor: …to go into.

Banatao: Yeah, right or wrong, I mean this sounds bragging now but I said, "There is..." I know how hard it is to be an entrepreneur, to start a company and make it successful, it is really hard. And after two IPOs where I had a very instrumental role in defining the strategy for the company, and this is the bragging part or the, I would say boastful part, which is hard to say but that's probably what it is, I thought there is nothing more I can prove as an entrepreneur. But there's one more if I go to the other side, maybe I can prove myself, challenge myself and see if I can be a VC <laughs>. That's what prompted me. S3 went public in April of '93, it took me six months—there's always the lockup, right? So by then it's towards the end of the year, you don't want to be selling. The whole of 1994 I had four windows because I am an insider, to sell enough shares of S3 to have the beginning fund to use for investment. So by '95 I became active, because then I had the cash to begin to invest. So that was the one reason... I thought... well maybe the other secondary reason is that, if I do another company as a founder, if that fails that will be my legacy.

Kapoor: <laughs>

Banatao: That would be hard.

Kapoor: Yeah.

Banatao: So I took advantage of that but, you know, it started with, "I don't have to prove myself anymore as an entrepreneur, I did it, you know, my own way, blah, blah, blah." With a lot of help from everyone of course, I mean... there's always help needed in those kinds of... hard things.

Kapoor: Right. So in terms of venture, or VC, you considered many options? I know you were in Mayfield, you went to Mayfield, or was there something else before that?

Banatao: Oh yeah. That came later, Mayfield I was there in early '98. I started investing in '95. So in '95 I really sat down and tried to form a strategy for my investments. And I lucked out again in picking communications as an investment area. So a lot of my initial investments were all in communications. Now imagine this, this is '95, by 2000 the market was in a bubble and a lot of them were communications companies. I just got lucky on that one, there was no genius at all, I just got tired of computing. I had done a lot there and so on. It's probably the same reason that I departed being an entrepreneur, I didn't want to look back into computing, maybe <laughs>. I thought that we needed a lot of work to do in communications so I focused on that, and a lot of my initial investments were in that area.

Kapoor: So were they companies like Newport and Acclaim, were some of them?

Banatao: Yeah, yeah. Acclaim was one of the first, SIRF also. Marvel, Newport Communications, Cyras.... those were all, now—Marvell was a combination of both networking and hard disk read channels, but we looked at it as—that even if it is only a short distance, it was so intense in bit rate that it was the algorithms in filtering and so on was just identical to long distance network, because of the minute signals. So for all intents and purposes Marvell started out as a communications company. But we came out with the read channel and the preamp first, that was successful, and then we quickly followed it with a one hundred and... a gigabit Ethernet.

Kapoor: I see. So was there a commonality in management in any of these companies that you found some people that had the expertise and they were just looking for funding? Or they were separate islands of investments?

Banatao: Right, they were all separate companies with different founders. They were unified only in that whole space of communication.

Kapoor: Okay, okay.

Banatao: SIRF of course, GPS, that's… very strictly communication in spread spectrum of course.

Kapoor: Right. And Wave Semi was another...

Banatao: Wave?

Kapoor: Yes.

Banatao: Oh that's very new <laughs>.

Kapoor: Oh that's new.

Banatao: Wilocity, which is also I would say... I think we recently raised our last round on that one. It is 60 gigahertz RF... high bandwidth, up to 2 gig, you could use it in a—as far as a big room, it still works. Anyway, yeah, those are our communications. There's a couple of others that we did.

Kapoor: Stream Machines was another one.

Banatao: Stream Machine was more in the video encoding/decoding. After about, I would say, three years of development, we sold it to Cirrus, Cirrus Logic.

Kapoor: Right. So these were investments from that period, and then what was the next phase? Did you want to be part of a partnership like Mayfield, or how did that happen?

Banatao: Yeah. By '98—let's see what the sequence was. Well, Mayfield was always talking to me about being part of them, but because I did not feel that I knew how to invest, one, and, two, that a singular focus in semiconductors would work, I thought, right or wrong, that I would rather take the risk myself, use my own money in investments, which is what I did. By '98, I was starting to feel good that, wow, this can be a fairly—there are actually a lot of potential investments. I found out that I can really leverage my expertise into these companies because I was an operating guy or was part of that industry. And then that I knew a lot of people that I could leverage the question in moving people around if necessary—executives in marketing, sales, engineering. So I said, "Okay," to Mayfield, "Just give me an office," is what I did, and I learned a lot there as to what a typical partnership venture fund is, that there are structures, there are practices, which gave me the idea for my own formalized venture practice, which is now a Tallwood venture capital. And I did that in 2001. That's when I, with George and Ron, we did Tallwood 2. Before that, it is Tallwood 1, which was all my own funding, and then Tallwood 2, majority is still mine, but we added a few partners, limited partners, seven of them, big guys, so I didn't need a lot of them. And then that moved on to Tallwood 3, also.

Kapoor: So in terms of the kind of investments, were you focused on—I think I'd read somewhere that semiconductor-oriented solutions that will have an impact. Is that still the focus, or you are expanded into green energy or this or that? Anything else?

Banatao: Well, we look at all the different market sectors, of course, but in terms of how we classified companies at that time, primary was it has to be a difficult-to-do technology for the reason—you know, again, right or wrong—for the reason that ultimately the biggest difference here or in a product is the technology, especially from a pricing point of view. And so we define difficult-to-do technology two ways. One is that truly a few guys or one person came up with a brand new technology that no one else has, and clearly, therefore, that is hard. I mean because if it is easy, there would be a few of them, right? Or another way we defined hard-to-do is that the engineers are just that much better than anyone else that they can out-design you every time. An example of that is Marvell. We went into mature markets. There was no taking risk in the market at all. In fact, even today, we generally do not like to take risk in markets because of this approach. So that was the key strategy that we put in place, so a lot of our companies that we invest in, their strategies are defined similarly.

Kapoor: So in terms of relationships with expertise, have you worked with—I understand you have also consulted, worked with research establishments, like SRI or Berkeley. Has that played a role in—?

Banatao: Oh, yeah. What we do—and there's a little bit of that now, less of that, but what we do is we rotate the top research institutions, a lot of them universities, of course. At one time, we did it every year and we then made that every two years or three years because it turns out that technologies are not developed that fast. What you heard last year, you go there the next year, most likely it's the same because it's really hard. You know what I'm saying?

Kapoor: Right.

Banatao: So we cut that back. But it's a good practice to do that because if you have a focus on an area that needs many technologies and you spot one of these from any research institution, then you will be ready to look into investments in that area from a technology point of view, again, going back to our roots of we will always have technology in there. Otherwise, we would not invest.

Kapoor: Right, right. So digressing a little bit, to add a little bit of levity to our discussion, what are your interests? Certainly, you are very intensely focused on technology and science and education, which we'll talk about a little later.

Banatao: Sure.

Kapoor: But what are your interests, in general? What are your hobbies? What gives you a lot of pleasure? You like to travel? You like to vacation, go skiing? What are your interests like?

Banatao: Yeah, there's only one, actually, and that continues to be flying. Nothing has displaced that all these years, ever since I was with Philippine Airlines, and everything else is more of a temporary diversion or satisfaction, like we played a lot of tennis.

Kapoor: Right.

Banatao: And that was good, but it was a filler, and once I got very busy with start-ups, complete stop. Golf, I started that early on, and I really loved it, but work somehow took over every time. But flying is part of work, the way I did it.

Kapoor: Great.

Banatao: In other words, I have meetings here and there and so on, and, "Guys, can you get the smaller jet? I need to go there." "All right. We'll go there. Where do you want us to meet you?" "Let's go to San Jose, or I'll see you guys there." So it is there always, and that's why it is the one thing that stayed, and that is flying. But I had to now be cognizant of the fact that I'm getting old. There is a limit, actually, from an FAA point of view, especially health, all that stuff, and flying is demanding enough…

Kapoor: Of course.

Banatao: … that you really have to be careful.

Kapoor: Attention to it, yeah.

Banatao: One little mistake like that Asiana thing. I think the pilot there was not looking at the instruments. I don't know what they were doing, but that can happen.

Kapoor: Right.

Banatao: So if flying stops today, I'll still be a happy person that I did it my way rather than an airline. That's work. I don't know that I would be happy with that as my primary job. What's satisfying with what I do is I incorporated it in my engineering work, which is still my first love, of course, engineering, but if flying is there, perfect. That is heaven. So I wish I could continue this for as long, but I am practical enough that there's a limit to flying, especially with fast planes and so on.

Kapoor: But you have pilots, so you can still…

Banatao: I have pilots.

Kapoor: … fly but not be flying.

Banatao: I fly. I control the plane. They prep everything. I don't need to call the fuel truck and, "Hey, we need 100 gallons here." And, of course, there's preparation for the flight.

Kapoor: Of course.

Banatao: You have to have a flight plan. You have to do all of those things. So what I do is before we board, I sit down with one of them, "So what did we do? Take it out. How about weather?" you know, as if I did it myself, but I don't have to do because of time because that takes time. Flight planning easily takes at least an hour. So meet them at the airport, they deliver the stuff, and they come with me because they are experts. You never know just in case something happens, but they do all the other miscellaneous stuff. They make sure that fuel balance, left and right, these are really good stuff. Physical checking the airplane; you walk around. I don't need to walk around. They did that. And occasionally I rotate the knob for system check. But then they said, "Boss, we did that already." "Fine." But instinctive like. No, it's even more ideal because I can rely on them because they're professionals, so I don't need to do the mundane thing, and then once we're in, of course, you do the usual prep and then a flight plan. You enter your flight plan on the computer, frequencies, and then I say, "Let's go," meaning, "All right. Call tower." Or, actually, "Call ground, permission to taxi," and then transition to that tower will take over, change frequency. They do that. I check, of course, the routine, and I look at the charts, and sometimes FAA puts some notes in there below or limits of altitude or above or low kind of thing. You have to watch the charts. And then approaches, you have to have all the approach plates and so on. Those things, yeah, you have to go through it. But the nice thing is I ask, "Can I have the approach plate?" Okay, all right fine. It's good. I would say life's good.

Kapoor: So when you go with family, do they get to fly along with you, like some of your children maybe?

Banatao: Yeah, many times I'm in the cockpit. But if it is the whole family, we always take the big plane. That I cannot fly because I haven't trained, and that's why I have two of them there. The small one, yeah, we have parts of the family with us, shorter distances. We go to—I think the farthest is about somewhere in Colorado or New Mexico, Oregon, kind of thing.

Kapoor: Great. So anything else you'd like to talk about in terms of your VC function, any vision that you have that you want to for the next phase? Right now, you're a chairman of Ikanos, and you also—are you still with Inphi, president—I mean chairman?

Banatao: Yeah, they're public now…

Kapoor: Quintic?

Banatao: … but I am still there. Yeah, Quintic, yeah.

Kapoor: So are they also in the same domain, or are they—?

Banatao: Those three companies are all in semiconductors.

Kapoor: Okay, semiconductors.

Banatao: Yeah. Inphi is the one that is public. Ikanos is public. What we did there was we bought the- a division of Conexant in DSL and then combined it with Ikanos—that is also VDSL—and ran it still as a public company. So I ran that thing in the beginning and then got a CEO. That didn't work out. I had to go in and run it again. Now, I think we finally have a good CEO, and that's—I'm happy when I don't need to be CEO. Frankly, that is hard work for a public company. Inphi, the same way. I ran that thing in and out. I mean it's hard to get CEOs.

Kapoor: Of course. Of course.

Banatao: But you have to be ready to step in at the right time.

Kapoor: Right. So I just wanted to add that certainly you've been honored with many awards, Master Entrepreneur of the Year Award by Ernst & Young, Inc. Magazine and Merrill Lynch Business Financial Services. You were in The Forbes Midas List multiple times. Asian Business League of San Francisco bestowed its distinguished Asian Leadership Award upon you. And I mean I could go on. There's so many. So this is quite an amazing award list.

Banatao: It was hard work, I would say. I mean we do the work because we enjoy it. We don't do the work for those, but…

Kapoor: Yes, of course.

Banatao: … the standard thing that I say to those—during the awards ceremony when you have to give a short speech, I always say that I cherish the awards coming from my industry. It's a little bit different when it's coming from somewhere else. You know what I mean?

Kapoor: Right.

Banatao: Because if it is your industry, they know what you did. To me, it means more somehow. Maybe that's not the right way to view it, but to me, it is because it is my industry. They know what I do, and in many cases, I know them, too, right? So that's how I differentiate it, and that limits my- any—I don't think and I hope I don't have it—sure, I'm proud that I got it, but it doesn't affect my behavior, and I don't think my behavior will change just because I have awards.

Kapoor: Of course.

Banatao: But it's more inner satisfaction. You know what I mean?

Kapoor: Yes, yes. And I know that in all the literature that I have read, I know you've come a long way from the barefoot child that was walking to school to where you are today, and of course, you are very modest. You don't like to talk about your net worth and things like that, and I won't ask you that, but I know you have achieved tremendous amounts. And then, of course, you're a real philanthropist. You want to give back.

Banatao: Yeah.

Kapoor: And so I just want to mention a few foundation and then you can talk about your views. You have the Dado Banatao Education Foundation, the Philippine Development Foundation, the Banatao Family Filipino American Education Fund, and the Center for Information Technology in the Interest of Society, CITRIS, and University of California. And I'm sure there are others.

Banatao: Yeah, there are others. It's just in the Philippines that Maria and I—. I get a similar question a few times about why people give, in general, or why do you give back, and I feel that—and this is how Maria and I feel about giving back, why we do that. Everyone has passion in their helping. That's always there. Whether they can afford it or not, it's always there. I think everyone has that passion in them built in. As human beings, we help. You know what I mean? There's always that.

Kapoor: Yes.

Banatao: Now, the difference is in the number of things you do, the quantity that you give back, the work that you give back, the kind of work you give back or help. And I have been asked a few times, quite a few times, "Why do you give back?" and my standard answer is that, you know, whatever I have, I worked for it, and because I worked for it, it is not because I was alone. I was with many, many people. If I didn't have the right employees, if I didn't have the right people with a lot of other ideas, I would not be here. So there's a point where you have enough is what I say. Years ago, I felt I have enough. It's just time to give back. And when I got to that thinking, of course, Maria and I sat down and planned it all out, and she was—she's in the same mode that I am. We felt at that time, yes, we have enough. Our ambition a long, long time ago, beginning our career, was that if we can only send all our kids to the university, to college, if they want to go to college, we will be happy. And we have achieved that many, many times over. But there is a point where you have enough, in our minds, both Maria and I, and given our passion always to look at things where we can help other people's lives like the way I feel I was helped by our community, the industry, by being able to get engineers to be productive, to me, that's always helping me, that they believed in the message that was given to them, they trusted me, they did all the wonderful work. While they enjoyed the benefits, also, through their efforts, I am reflecting that effort, also, into the helping that we do because I cannot forget those guys who I was with at Chips & Technologies, at S3. There is no way I would be here if they were not there. The work is just so hard that no one person can do it. You have to rely on so many. And so the dimension goes back out the same way in my mind, multiplied. Once I attain that, I say, "All right. Let's do as many—let's affect other people's lives also the way we got affected by others." So that's a simple way. And so it's endless. As long as we can give back—and I'm glad that our kids are now beginning their own process.

Kapoor: Yes, I heard that.

Banatao: Yeah, like at Berkeley, they're putting their own finances into giving back in their own way, not as significant as what Maria and I do, but they need to begin to learn that—.

Kapoor: You've passed on your values to your family, your children.

Banatao: Yeah, that's passing down that kind of value. And I tell them, we tell them, "What you have came from other people. It is your duty to give back to others, also." And they understand that, and they see us do it passionately. And on their own, they come to mostly Maria, "Mom, we would like to give to this cause." "Then why don't you do it? That's your passion." And they go ahead, "Well, no, we would like to do it with your foundation." That's what they meant. "Can you do it through that foundation?"

Kapoor: Right, right.

Banatao: So they're funding a few college students from community college in Berkeley in engineering. So they're funding—I think we have about eight scholars now going to engineering at Berkeley.

Kapoor: I read that, for example, your business and advocacy are geared towards helping young students and entrepreneurs who are set on making their mark in the field of science and engineering. So that's—.

Banatao: Yeah, a big chunk of our gift giving goes to that, in that area. The same thing with CITRIS. When we funded CITRIS in the beginning, it is about developing technology in the interest of society. Those two letters, I-S, in the end there, that's "In the Interest of Society." Because there's this thing. I read—there was one question there. If there was one thing that you think technology should do or whatever—I cannot rephrase it—but it's on that list. In my mind, we truly need to leverage technology to the limit to really better and impact, better people's lives. That should be what—and that's why we funded CITRIS, in the interest of society. It is important, I think, because technology can truly make a huge impact. So my next career—actually, someone told me this because we were just BS'ing, talking, and, "Oh, gosh, you know, I don't think I want to do this VC. I think I'm satisfied with my career. But I don't know what really I can do next." And he said, "What do you mean? You're doing it already." "What are you talking about? I don't—." "No, no, no, your philanthropy, that can be a full-time task." I said, "Well, you know, that's a good point." It does require a lot of work. It's not just—and this is the form of giving that I think works better. You just don't give money, in our mind. What is better is you are there not working but be with them. We do a lot of counseling, by the way. We hire experts to work with our students, come to _____ to work with our students in the universities, and they're in the top universities in the US—MIT, Caltech, Stanford, Berkeley, Harvard—so they are good students. But there's always something that goes on, so we hire counselors for them as necessary. So it's those things, and then we have twice-a-year retreats in the summer. It's a long three to four days of retreat, and we bring in executives, we bring in Ph.D. students, we bring in professors, very planned three-day event for them, and the feedback this year was they would like to make it longer even. But it's this kind of additional work beyond the financial that right now we think is even more important. So it is a lot of work.

Kapoor: Yes, yes.

Banatao: But in some cases, it's also fun, by the way.

Kapoor: Of course, of course, very satisfying, I'm sure.

Banatao: Satisfying. So this probably is the next phase of my life.

Kapoor: Very good.

Banatao: It's like having hundred sons and daughters and so on. And my kids are still not as well involved, but occasionally they come- they pick the finalists just so they get a glimpse as to what it really is, and then we involve them as much in the process, like Ray [ph?], who had a Ph.D. in bioinformatics,

and one of the topics this year was on the health side. So he was there talking about his Ph.D. work and his post-doc at the California NanoSystems Institute, where he did a lot of work in proteins and things like that. So they begin to get involved, meaning for Maria and I, it is also the natural way of inducing them to help. We don't tell them, therefore, "Go and help." It's like, "Hey, Rey, the topic this year is—. Do you think that you can participate, talk about—?" "Why, yeah, of course, I can do that." But there's that. They are great, which is good, and they tell us when they have no time, too. I mean, "We're busy." That's fine. That's, I would say, frankly, the work that the two of us have done for the industry and in the industry, it is very satisfying, but philanthropy is also satisfying. I don't know today which one is better. I still favor doing all the significant work that we did over philanthropy, so don't misunderstand me that I have not crossed yet. I still have companies to work with and so on, so maybe someday, and maybe something will replace flying, too. I don't know.

Kapoor: So, Dado, any closing thoughts?

Banatao: Well, I am glad that the museum is here because you and I have not talked like this for, what, three hours in a long, long time. I still remember those days we were in the same office, and we discussed things, as I told you earlier. I learned a lot from your side, the nuances of semiconductor circuits, which I was not really—my expertise was on the other side, and I hope I gave a little bit back…

Kapoor: Certainly did.

Banatao: … to you, and then Steve with his marketing side, when the three of us attempted to—it was not a coup, but it was a good full-force leverage of a complete set of expertise, and they heard us, and we all went there. I guess that's the advantage of not only a group but the kind of uniform thinking that we had. If there was one thing that I always remember when we were there was that how similar we thought about things, about products, and so on, and that there was no—even if we did not explain it fully, we just somehow understand what we all said to each other. And I think Synertek saw that.

Kapoor: Yes.

Banatao: Like, "We better get these three guys." So that was—I haven't told you this, and Steve, also to you, but I relished those times because we made an impact, not only individually but as a group.

Kapoor: Yes.

Banatao: So the work that you guys do here is giving back, by the way. This is a form of giving back, and this is pure because it is time. So whether I get involved in the next step here, I don't know yet, but

I'm glad that this is the reason, however, that I am with you again for this span of time. We had lunch at, what, one hour. Okay, no big deal. We were just BS'ing good stuff.

Kapoor: So thank you so much for coming.

Banatao: Oh, you're welcome.

Kapoor: This was a lot of fun to talk about those days.

Banatao: Yeah. I'm glad we did this.

Kapoor: Thank you.

Banatao: Thanks.

END OF INTERVIEW