
# Oral History of Alberto Sangiovanni-Vincentelli

Interviewed by:
Douglas Fairbairn

Recorded: October 29, 2008
Mountain View, California

CHM Reference number: X5061.2009

**Editor's Note**
At the time this transcript was published, the interviewee could not be reached for review. Phonetically spelled, foreign, or other indecipherable words are indicated by [ph] or [?].

**Douglas Fairbairn:** Today we are talking to Alberto Sangiovanni-Vincentelli. He is a professor of Electrical Engineering and Computer Science at University of California at Berkeley. We're going to be covering a wide range of topics from his times when he was growing up and early studies all the way through the present day. We'll get his observations on the design and electronic design automation Industries. We'll start right at the beginning Alberto. You were born in Italy where you grew up for some period of time and eventually made your way to the United States. Where were you born? What was your family like? How did that steer you in the direction of technology? Any major influences that sort of steered you in this direction?

**Alberto Sangiovanni-Vincentelli:** I was born in Milano which is in the north of Italy and is the capital of industry in Italy and the fashion industry worldwide. I am an only child. I didn't have to fight with any siblings of any sort. Actually I missed that very much. I would have liked to have someone to play with and to interact with. So for that reason, I was very much interested in having this tight contact with my schoolmates and the like. I actually even dreamed to go to a boarding school because at least I would be with my friends, which is kind of strange because nobody wants to go to boarding school. I wanted to go to boarding school. That's a bit of my background. My parents- my father had a double degree in political science and law. He was a central director of the largest bank of Italy which at that time was called Bank of Mercani Italian. In fact, you talk about influence; the CEO of that bank and president was Raphael Matteoli. And Raphael Matteoli was one of the most prominent persons ever in Italy. He was also called a humanistic banker meaning he was a person very deep into literature and culture. So in fact, as a side he had a publishing company called Riccardi. It was the most accurate publishing company for classic books. So, going back to the origin of Italian language, philosophy and all that. The reason why I am saying this is because Raphael Matteoli took a liking of what I was doing and he was a very good friend of my grandfather. He was following my studies. He influenced me to go to classics and also to tell the truth. In Italy, if you were good at school, you could only do classics. Period. Scientific studies were considered to be kind of easy and a second class thing. So I ended up studying eight years of Latin. Five years of Greek, Ancient Greek. I knew how to translate Ionic into Attic and other things. We were trained on how to translate from one dialect; Greek dialect, in to another. So, just to kind of give you an idea of the kind of pain I had to go through. The classic was just no choice.

**Fairbairn:** Was it interesting?

**Sangiovanni-Vincentelli:** I loved it. Especially Greek was my love. So, two topics on the classic side what I really enjoyed were Greek and philosophy. Then on the scientific side, I loved physics. Even though we were doing a little bit of it, being in this classic lyceum. Mind you, classic studies in Italy were so deep and tough. School was really tough. When you come out with a high school degree, it is probably better than a Bachelor in Humanities here.

**Fairbairn:** You were heavily involved with that in high school?

**Sangiovanni-Vincentelli:** Heavily with the classics stuff. But this banker we were talking about, he would see me on a regular basis and he would ask me how I was doing. He said what you should really be doing is to go into engineering. You have to find a way of making tiny things that will help our

  

business. And so for example, he said that they were losing tons of money because of clerical errors in adding numbers. The actual cashiers. He said if you make me a device that you could keep on your desk but actually in the pen so that the guy that was doing the addition; he would do a tick, tick, tick on the pen and see the number, we would save tons of money. This was in the early 60s where we had the great integrated circuit with one transistor. It was very forward looking. He said "you should do this kind of stuff". So, if you are in Milano and you are a good in school, besides doing classics, for high school you have to do engineering. I had no choice even though I didn't want to do engineering. Classics was okay. I wanted to do either philosophy or physics. That's my path. I had to go to engineering. Also, because in Italy and in France, engineering was the top of the top of the top of a career. All the CEOs of all the companies in Italy were engineers. All of them came from either Polytechnic in Milano or Polytechnic in Torino. End of story. So it was a very close congregation of people. For instance, Pasquale Pistorio, the CEO of ST was an engineer and he got his degree from Polytechnic in Torino. So, that's what you have to do to be a player in the social and industrial framework in Italy. So I did.

**Fairbairn:** What did your parents think? Was everything that you were doing fine?

**Sangiovanni-Vincentelli:** My father said whatever you want to do it doesn't matter as long as you do it well, which is what I am transmitting to my children as well. It is a great teaching. My mother was from Milano. My father was from Abruzzi, the same region where this CEO of the bank was. But my mother was from Milano and so I was from a very good family in Milano. We go back hundreds and hundreds of years. I was lucky I was in a wealthy family. You also have to carry the family on your back so to speak. My mother was more into engineering. She would say you got to do that. In my place, we had often a very dear friend of my father's, Raphael Gerotti. Raphael Gerotti was the CEO of ENI. That is an oil company in Italy. It is the second largest company in Italy and one of the largest companies in Europe. He was an engineer. He liked that very much. I was forced to go to engineering. I remember he gave me this slide rule. This object, I hated it. What primitive horrible object. Then I remember that some of my colleagues in engineering were my students. You know you can go over scale. So you have to remember that you went over scale when you do the computation on a slide rule. So we were doing this [hand gesture] to remember and they went over scale this direction and this [another hand gesture] when you are going over scale in that direction. I said, "What kind of monkeys am I with." Oh my God. I love my Greek and I'm with these turkeys. Plus in engineering in Italy, the freshman class was 2000 people of which two were ladies!

**Fairbairn:** Is this the University of Milan?

**Sangiovanni-Vincentelli:** Polytechnic in Milan.

**Fairbairn:** By the time you started the University, you were on the engineering path?

**Sangiovanni-Vincentelli:** Yes.

**Fairbairn:** Were you continuing to study classics as well?

**Sangiovanni-Vincentelli:** On the side for my own. Especially philosophy and then I got into of all things - psychoanalysis and all that. I mean taken from a philosophical insight. At some point when I graduated from Polytechnic Milano with engineering degree which was a five year degree. We didn't have the PhD

  

per se. So this was a bit more than a masters in electric engineering and computer science. That was all we could do. But at the end of that when I wanted- I was looking at what I would like to do. I had also even an offer from a famous group of people that were doing family therapy in Italy; to join the group. I almost took a completely different path.

**Fairbairn:** Become a psychologist/psychiatrist.

**Sangiovanni-Vincentelli:** Psychoanalyst. Also because the family therapy, how interesting it is how things intertwine. Family therapy actually started in Stanford. They were talking a lot with the system people in engineering. So, in this family therapy there were concepts like controllability, observability and identifiabilities, all kinds of things that we do in engineering. That's the reason why when this person was talking and I met her in a presentation so she was talking about this new theory and how it was very effective in treating malfunction in the family. I said, "Gee, you know, that's exactly what we do in engineering. No difference." Because it's a sort of empirical therapy. I say, "Well, why don't you do this instead of that." Because that's what I would do as an engineer. She's says, "Gee. That's a great idea. So, would you like to come?" So I went. I went and actually participated in a few sessions with families. We actually had a very interesting session with a family and I figured out and say, "Why don't we do this instead of that - always behind the screen." Because people do family therapy with one therapist inside talking to the family and the others are behind a mirror - four people are in the room but for you it's transparency. So you see what's going on. So I started say, "Well, we could do this. Could do that." She said, "Okay. You want to sign? Do you want to come to work for us?" I thought really hard on it. Then I said gee, it's too fluffy things. I'm more into the hard stuff. I decided to stay at the university.

**Fairbairn:** You're career could have spanned anywhere from the classics to psychotherapy to engineering to physics.

**Sangiovanni-Vincentelli:** Yes. More or less. Physics, once you take engineering, of course you study physics but no where near what you study in physics. But we decide things. Along my career there have been a few other instances in which I could have diverted into completely different field. This was one. I quote this one because it's kind of interesting. I don't know. Richard Newton certainly knew about it because we discuss a lot about these things. He was also into it. Completely different angle because he was very much into eastern culture. I was on the western, Freud, this and that and up and down. He would say, "You're too rigid." I would say, "Richard, you're just making it up. It cannot be true." So, we would always have these discussions. We loved it. We went days and nights talking about this stuff. It's kind of funny to see how our cultural upbringing also has something to do with the kind of things that we ended up doing together. Anyway, afterward I decided to stay at the university.

**Fairbairn:** During that time did you have any contact with the US?

**Sangiovanni-Vincentelli:** Zero. Except for the fact that in Polytechnic Milano, we were all studying American text books. It's funny because in physics we had the Berkeley physics course. Then for Physics III, which is a third of the year physics, we had Feynman's book. The reason why I'm saying is because I ended up meeting Feynman later on. We talk about this book. I studied that and then we had the books on, for example, System Theory, on Network Theory and all that, were all coming from Berkeley. So System Theory was Charles Desoer and Circuit Theory was Ku and Desoer. That was a connection to Berkeley. I studied all these books from Berkeley. When I was 16, this is another connection to Berkeley to see how things are really strange. I read an article when Emilio Segré won the

  

Nobel Prize for his work at Berkeley. So I thought he was stationed in Berkeley. When I was reading this, there was this Italian journalist who wrote about where he was teaching, where he was studying. <Inaudible> he depicted the Bay Area with a beautiful sunset and the Bay Bridge and the Golden Gate and all that. I said, "My God." I started dreaming. This is a place I would like to be, at 16. So I was also thinking I love it. And I also wanted to do philosophy. So, I went to the University of Milano and zero connection to the United States. I was a young assistant professor. We had a different title but essentially it was assistant professor.

**Fairbairn:** You graduated and then became an assistant professor at the same university?

**Sangiovanni-Vincentelli:** Immediately. Same university. That's what happens in Italy. You are graduating from the university. If you want to do an academic career, then you're an assistant, then associate, then… and so on. You never change, which is very wrong but that is what it is. I started there. Then I got my Associate Professor position after two and a half years, which is almost unheard of. I was the youngest professor at Polytechnic at that time.

**Fairbairn:** You were teaching a range of electrical engineering classes?

**Sangiovanni-Vincentelli:** In Italy, you teach only one class and always that. You're attached to that. One thing. It's called Catada [ph?] System. Same as in Germany. So, you're a professor of that topic. You teach that topic all your life.

**Fairbairn:** What was that topic?

**Sangiovanni-Vincentelli:** It was Network Theory. Actually, I was very fascinated by American methods. I was in Network Theory but my main interests were sparse matrixes. When I got this position, Associate Professor, one of the big professors at my university, the full professor, we were 70 faculty but three full professor on. So they decided they could invest in me. They said, "Pick your bag and go to the United States and go learn what it is to do research." I said okay. They say, "Where do you want to go?" Guess where? Berkeley. I have to go someplace so I'll go to Berkeley. So 1975, I land in Berkeley on the Fourth of July. At the university, they had this wonderful program in which there was a family that would take care of the visitors, the students, graduate students and visitors. I was assigned to this wonderful family.

**Fairbairn:** You had arranged to be a visiting professor at the University?

**Sangiovanni-Vincentelli:** Visiting researcher because I was here only for six months. I came here with a Fulbright Grant, which I refused actually because Fulbright wanted me to go to University of Arizona or Colorado and I didn't have any interest in going there. I wanted to go to Berkeley because it was way number one in the world in the kinds of things I was interested in. Why should I go in another place? So I wrote to Ernie Ku who was the Dean of the College. I said, "I would like to visit." He said, "Sure you can." So I arrived with zero preparation almost. I didn't really know what I was getting into. The other interesting thing, I'd never been in the United States before, so my image of the United States was pretty much what you see on movies, in particular the nice villas, the large gardens and so on. I don't know how many people who are listening to this conversation have seen Berkeley. But that ain't exactly what Berkeley looks like! <laughter>. I land. I have this nice family coming to pick us up with my wife and one

  

year old son at the airport. They pick us up at the Oakland Airport. The University has set up a room until I would find a place to stay. It was at the Golden Bear Motel. If you have ever seen the Golden Bear Motel, it's like down …<laughter. You got me. Then this nice group of people pick us up. They went through downtown Oakland to the Golden Bear Motel. I look around and say, "Oh my God. I want to go back to Italy. Why am I here?" I am resilient in front of difficulty so I say, let's try it out. Then we found the place. To find the place was a disaster because at that time people who rented houses wanted no children and no pets. Students don't want to have noise. Children equal noise. Pets equal noise. We had a really tough time finding a place to stay. I found it. I went to the University. I got my office, started working.

**Fairbairn:** What was your impression of the University once you arrived there?

**Sangiovanni-Vincentelli:** It was fantastic. The University was fantastic. The people were okay. Mostly because I bump into the people who had authored all the books I studied. Plus I met Emilio Segrè. All my "heroes." Then I noticed they were very normal people. The Dean Ernie Ku would ask me to play tennis sometime? Sure. We went out playing tennis. It's NOT the way it works in Italy!

**Fairbairn:** You don't play tennis with the department chair?

**Sangiovanni-Vincentelli:** No. Let alone with the dean. I played tennis with the dean who was author of one of the books I studied and has written tons of papers in my area of interest and I say, this is a different place. The other thing is you have all these other visitors you start interacting with. One of the visitors was Satoshi Goto, the Japanese guy; eventually ended up being the president of NEC Research. So we kept in touch a lot. Another one was Bruce, I forget the last name, but he is now one of the most prominent professors in— Bruce Francis, in Control Theory. He teaches in Toronto. It's kind of funny. We were young kids. We started interacting and working together. When the six months were over, I say, thank God it's over. I'm going home. Yay! Bye-bye, I'm going. But the people there, and particularly Leon Chua, say, "Gee, this guy is good. We should try to keep him." So, since he won Miller Fellowship which allowed him not to teach, he said why don't we ask Alberto to come back and teach the classes I would have to teach. So I say, "No, no, no. I can't possibly do it. I have to teach my classes in Polytechnic Milan. No." My professors would never let me do that. I said, "Bye-bye." And I went back. Little did I know but these people wrote to the chairman of my department saying do you realize if you don't let Alberto come back, it's a great honor for one of your professors to teach at Berkeley. So when I landed again in Italy, Milano, I went to my office to get my mail and I bumped into the Chair of the Department. I said, "Hi. How are you?" We let you go back. I said, "What are you telling me?" He said, "Yeah. We received this very nice letter. How can we keep you here? You must go back for one year and fulfill this." I said, "Oh, thank you."

**Fairbairn:** You brought your family back and…

**Sangiovanni-Vincentelli:** Six months later, back again. The unfortunate thing is my English was classic high school English where you study three years of English and that's about it when you're 14, 15, 16, end of story. My English was kind of broken. Not that now it's much better but it was much worse then. I had no idea what the education system in the United States is. The other thing is that when people say, well, come and teach, they assume that you know everything there is to know because it's so normal, right? What you teach, how you teach a class, the homework and this and that. Well, I came to Berkeley

  

and then was in the end of August so the classes start 15th of September. I said, "Okay, what do I need to do?

**Fairbairn:** This is when you came back to teach?

**Sangiovanni-Vincentelli:** After the six months back in Italy. I came back and said oh my God. I have to teach five different courses over one year. Berkeley is a slave driver when it comes to teaching. All different. All damnation different. So three graduate classes, two undergraduate classes, quarter system. It's like two quarters you have to teach two classes and one quarter one class. First quarter I teach 104A, which was a basic Network Theory class.

**Fairbairn:** At least that was stuff you'd been teaching back in Italy.

**Sangiovanni-Vincentelli:** Yes. Undergraduate. But then a graduate class was about computer aided analysis. It was essentially a simulation class. How do you formulate the equation? How do you solve it? So, that I never taught. But this was pretty much along the line of my research. That was kind of easy from that side but was very difficult because it was a graduate class. I didn't know what the difference was between graduate and undergraduate because we didn't have it in Italy at all. The first class was actually a graduate class. I go to class and I was afraid to be late so I was early. I didn't know what to do so I sat on the table where the students sit. The students start percolating in. This student sits next to me and says, "Boy, I don't know if I want to do this class. There is this funny name. Have you ever seen a professor with that name? He must come from some strange place." Yeah. I decided it was probably time to start teaching so I stood up and said, "Hello. I'm Alberto." The guy kind of dropped. His name was Joe Gray. We kept in touch since then. I still know what he's doing. It was a ball. I asked help from my students. What am I supposed to do? Some people were just, "Oh my God" and some others were enthusiastic because they had the chance of helping out the teacher to teach them. They wanted to hear.

**Fairbairn:** So this is computer simulation, some part of it anyway, right?

**Sangiovanni-Vincentelli:** Yes. The theoretical side.

**Fairbairn:** Had you been doing a lot of computer related stuff when you were teaching in Milan? Was it more mathematical theory stuff?

**Sangiovanni-Vincentelli:** I'm a mathematical theory guy. I started that way. It was mainly algorithms. I used to program in FORTRAN with the deck.

**Fairbairn:** Card Deck.

**Sangiovanni-Vincentelli:** Card Deck. That dates me. When I came the first time it was 1975. Second for this was 1976. Berkeley still had the deck also, not only in Milano. I remember once we were going with this big deck of spice cards, right? Richard Newton came exactly the same year, 1975, as a graduate student. We came the same day at the same time. I tripped. All the cards on the floor! That was between Cory Hall and the Computer Center.

  

**Fairbairn:** Everybody's worst nightmare when it comes to decks of cards.

**Sangiovanni-Vincentelli:** Oh man. The other interesting thing is that I didn't know I was supposed to give homework because we don't in Italy. Homework is high school stuff. You don't give homework in the university. You're a grownup. You don't need to have homework. At some point the students say, "How about the homework?" After two weeks. I said, "Homework? What is that?" They had to teach me you're supposed to give homework. I got that. At the end of the class when I was scoring the exams and all that, in Italy, what we do is we have a big table at the end of the class with last name, name, class and grade. So people were going up and checking what their grade was. Here, apparently this is a no-no. I was posting the grade like that. I had a colleague of mine playing football tell me not to do that. I said, "Why? What is wrong with that?" "Don't put names." "Don't put names? What do you do?" He taught me how to cut around the names and leave only the matriculation numbers with the grade next to it. He said it was privacy. That was the first time I bump into this idea of privacy. I didn't know what that was. In Italy it's nothing like that. What is privacy? It doesn't exist. That was another tough learning. After first quarter, then I said, I am a disaster. I did a terrible thing. I want to go back home. So much for all the people wanting to be in the United States. I want to go home. But then I found out that in the United States you have grading by the students. I can't imagine a student grading the professor. It's unheard of. I said, "What?" It was <inaudible> was taking the score. There was a student coming into the class and said, "Please can I take the opinion of the students?" I say, "What is that?" I look at the thing and it says is the professor good, not good, teaches clearly and so on and so forth. I became white was a sheet of paper. Oh my God.

**Fairbairn:** Nobody told you about this.

**Sangiovanni-Vincentelli:** No. I thought it was going to be all ones on a scale from one to five. I'm dead. Everybody will know I'm a total failure. And so I said, OK, and went back home and thought "disaster". Guess what? It came out quite all right. I couldn't believe it. The students must all be completely drunk. It could not possibly be true. Second quarter, boom, 104B. It was another undergraduate class and a graduate class about Network Theory, really intense network theory. By that time, then I started getting the people like the Dean Ku and Leon Chua and Charlie [?] and they kept saying, why don't you apply to Berkeley. What do you mean, "Apply to Berkeley?" They said, "Let's do this. There is this opportunity, this opening in System. It's the only open we've had for 20 years and the only opening we're going to have for the next five years. It's genetic code. There were a group of people who really wanted to have a team in computer aided design but from a system point of view, so a theory." There was another group who wanted to have a network, network theory. The people who wanted to have computer aided design said to apply. If you want to back to Italy, fine. Just throw away the application. They wanted to give more weight to computer aided design, so they say. Guess what, the final call was between me and a guy in network. I can even remember his last name, Schwartzlander, who ended up in Stanford. Lucky him, maybe he was infinitely better than I was. We had this kind of stand off. This guy got his degree from Harvard and MIT. The call was to the chairman of the department. He called me up and said, Okay. Here is a proposition. We got a guy from Italy, Polytechnic Milano. We don't know what Polytechnic Milano is because they had a professor from Polytechnic Milano without knowing probably that Dominico Ferrari was a professor in computer science. Of course this guy comes from MIT so has the big letters, so on and so forth. But at least you are a known quantity. You have been here for six months and then for a year. So I think we're going to offer you the position. I said, "Oops." I went back to my people and said, "Remember I was supposed to withdraw my application, right?" I'm going. I'm saying no. Then it was a big deal, "You cannot do that" I said, "You guys told me to apply and then fine, withdraw." "Yeah, but you don't know what horrible thing

  

you put us through." Then I said, "Okay. Time to have a conference call." I called them back in Italy and asked my professors over there. They offered me this thing but I want to be back. What do I do? They say, "You must be stupid." Come back right? "No. Stay." What do you mean I must be stupid? They say, "Don't worry about your position here. We keep it for you. Any time you want to come back, open door." I said, "Okay. Good." There I was Associate Professor with tenure. Here I was going to get in as Assistant Professor. Life as an Assistant Professor in American university is tough. It's 1977 now. I get my Assistant Professor position. It's a full-fledged position. Right now you get the start up package. I got zero in the start up package. Absolutely zero. The reason being is you don't need the start up, you are here. I started writing proposals and going to conferences, this and that, always with butterflies in your stomach thinking, I'm going to be a failure. Everybody's going to find out that I'm terrible. They're going to kick me back home. Why did I do this? First year, horrible, right. The second year, things started moving. Some of the people at the university were really nice. I wrote some papers that had good follow up. I bump into my great influence again, into the people at Yorktown, IBM Yorktown. So Bob Brayton, Gary Okton and Gustav Sinasov who were the gods of sparse matrixes computer design from a theoretical point of view but they had also great impact on the practical things. By that time I start already being a very close friend to Richard Newton, just because we're young. Between he and I, it's about three and a half years difference in years. We're close enough. We start going out together and all that. He was finishing up his PhD. I was already professor. We started looking at different things. We first put to work what I was used to on the theory side. I started getting interesting in Spice. Richard was saying, there are these problems and this algorithm. I said we can do better. I inserted a few real tricks into Spice and so that's when Don Peterson went non-linear meaning, "Oh my God! This is fantastic. Look! You solved this incredible problem." It's such a stupid thing. In fact, it all was done with <inaudible>. I remember when I solved this important problem and he would say, this is stupid. I keep thinking it's stupid and anybody could do it. What is the problem? But he got me into the good side.

**Fairbairn:** You brought the network theory and the mathematical algorithms too?

**Sangiovanni-Vincentelli:** Network theory and mathematic algorithms and sparse matrix theory and the like. By 1980, when I met with Bob Brayton and Gary and I spent one year at IBM Yorktown because they invited me to go there. So I took industrial leave, not enough to have a sabbatical because I started in 1977 and went to 1980. That was a fantastic period. I was working elbow to elbow with Bob and Gary every single day. Then we started interacting also with people who were more on the applied side. I made friends with people like Eric Bloch and Armstrong. We still talk to each other a lot with Eric. I met Ralph Gomery. Ralph Gomery was at some point the CTO of IBM, was also on the Board of IBM and now is chairman of the Sloan foundation, one of the most influential persons ever at IBM. I was in the math department at IBM, the mathematics department. Guess what? After a quarter, the director of the lab was Sam Winograd, the famous Winograd of the Fast Fourier team. He came to my office. He asked, "How about staying at IBM?" California.

END OF TAPE 1

START OF TAPE 2

**Sangiovanni-Vincentelli:** —and also the simulator stuff.

  

**Fairbairn:** So this time that you spent at IBM and the time that you spent, you know, a similar time frame you got started on the work on SPICE, it sounds like that was the time when you really got active in electronic design automation and more—

**Sangiovanni-Vincentelli:** Mainstream.

**Fairbairn:** —mainstream kind of things, is that right? Is that sort of how it worked out?

**Sangiovanni-Vincentelli:** Yeah, that's correct, because between 1977 and 1980, in addition to doing little things for SPICE, actually my main topic of research was optimization, and so my papers were all about, you know, non-differential rollup optimization, which is a very arcane thing and like very theoretical stuff, and I was working with Lucien Pollack, who was one of the best people in continuous optimization, and there I learned a lot of stuff. And that was also the reason why the Yorktown people were interested in getting me as a visitor, because I knew a lot about optimization, and that time was the time in which we started doing optimization for finding the best parameters in an analog circuit and we had to tune the parameters, and so Apple Stat was one of these programs that we were trying to close the loop in terms of having an intelligent optimization algorithm - that would sit on top of SPICE or equivalent. It would then do the simulation, and then the top program would say which direction to poke. And so the idea was I would go there doing this but, lo and behold, then what we started doing was the logic optimization, and so the— and PLA design. So at that time we were doing optimization, new generation simulation, because I started working on relaxation techniques in 1980 with some of the— Arthur Rulie, for example, at Yorktown. And then we started the work on Espresso, as it was two-level logic minimizer and the multi-level logic optimization and the layout work. So everything started in 1980, and so—

**Fairbairn:** Interesting. Now, you said you were invited to stay at IBM. Did you actually give it any serious thought?

**Sangiovanni-Vincentelli:** Yeah, yeah, yeah, because it was a— I mean, I was living in a very nice place - you know, villas and stuff.

**Fairbairn:** Right, it really was nice there.<laughs>

**Sangiovanni-Vincentelli:** That was nice, that was. It wasn't a lie. They did exist. Almost at the border between New York State and Connecticut - and our home was on two lakes, and so I would go boating on the— kayaking—

**Fairbairn:** It was like the Lake District in Italy or something like that, right?

**Sangiovanni-Vincentelli:** Yeah, but the lakes were infinitely smaller, but for reason also much more usable. And I had time to go to New York, and, you know, Milano is called also the New York of Europe, right, so whatever you want. It has some similar connotations as to cultural life, fashion, food, you know, so I really enjoyed to go to the theater in New York and to go to the— it was the year of the famous Picasso exhibition, and IBM sponsored it, so I really liked to go when the museum was closed so I could enjoy everything. So I gave it serious thought. Also because the salary was two and a half times what I was getting at Berkeley, not, you know, ten percent, two and half times, 2 half x.

  

**Fairbairn:** Right. <laughs> And the cost of living was lower. <laughs>

**Sangiovanni-Vincentelli:** And, in fact, if I sold my house in Berkeley— now, granted, I mean I was coming from a fairly wealthy family, so I had a house, I bought a house, I bought a second house, a nice house, but with the kind of money that I could make selling this house I could buy a mansion <laughs> in New York state, and I— upstate New York, not in New York, upstate New York state. So this was on the living side, but on the working side I had this fantastic relationship with almost anyone in IBM Yorktown, and so I really enjoyed it tremendously. But then winter came <laughs> and so my son got pneumonia. Every morning I had to scrape ice, so—

**Fairbairn:** So it's a good thing you stayed for the whole year and not just six months, right?

**Sangiovanni-Vincentelli:** So I said, "Well, gee," you know. Plus when the people back at Berkeley got the gist of what was going on, you know, so they said, "Oops," so when I came back, they promoted me in the speed of light. Immediately I made associate professor, a big step, you know, step free because in California, I mean at University of California, we have these steps, and so every time you get promoted you jump one or more steps, right, so there are accelerations when you jump more steps, so I got a huge jump, right, and so I said, "Hum, interesting." And I found out that the people in my department, the chairman of the department, called up Bill Brayton and said, "Alberto is doing very well there, right?" And they said, "Yeah, we love him." And they said, "It's not that you are interested in keeping him there?" And they said, "Yes, we are." They said, "Okay. Don't do anything." <Laughs> Okay, so anyway, and so I got promoted, and I got all this new research starting that was mainstream EDA, so at that time I was just moving from obtuse theory to more into the domain – still was interesting, looking at and proving things and doing theoretical work. Bob Brayton is a mathematician after all, so we still had that, that we wanted to try to impact, and so that was the important thing, and plus Richard [Newton] was all on impact, right, so we were complementing each other extremely well. So, we are in 1980. So in 1981 Harris Semiconductors, in particular the CEO of Harris Semiconductors, wanted me to go there for a while—

**Fairbairn:** In Florida?

**Sangiovanni-Vincentelli:** —because they were deploying— In Florida. They wanted to deploy some of what I was developing. So I was called the light of SPICE, this optimization thing they were doing, and plus PLA folding and plus Jon Cornell, this was the name of the person, started funding my research since 1978, because we just bumped into each other in Berkeley. He was a big supporter of Berkeley. He liked what he saw, what I was doing, and so he was the first industrial person who ever gave me a buck, you know, Jon Cornell, second IBM, and then many others, but these were two, I mean, two groups that really got me started into industrial interaction. So in 1981 I went to Florida, stayed there a quarter, and we started developing things inside Harris Semiconductors that made them particularly successful in some of their designs, so they upped the money by a sizeable amount, to support my research. And we are now in 1982, so—

**Fairbairn:** How long did you spend at— did they ask you to come live in Florida?

**Sangiovanni-Vincentelli:** Oh that for sure, but that I didn't consider at all. Florida was not my high point— I almost got— you know, it's kind of interesting, because I like to run, so I was running in the morning, and I saw a beautiful colored necklace on the side, and I said, well, I'll take it and put it in my pocket, because somebody lost it. It's beautiful. I mean, look at the colors. And I said, well, I'm running,

  

so I'll pick it up when I come back. When I came back, the beautiful necklace was in another position, and was placed differently, and then I looked better as if it was moving. It was a coral snake. Can you imagine, I mean? <laughs> Phwaw!

**Fairbairn:** You may not be here if you'd picked up that beautiful necklace, right?

**Sangiovanni-Vincentelli:** That's exactly right. I mean, how lucky can you be, not picking it up? And the second thing is that a few days later I walked into a— we had a house together— I went there with three of my students, because I always take with me my students. So we went there with my students and we had a beautiful home on the beach, okay, so every morning we'd go running or swimming. Well, at some point, I hear audible noises. Guess what? Alligator in the garden? Okay, alligator in the garden. So we kicked him out, and so he went off. And then a few days later, I was swimming, and everybody's "Aaah!" I said, "What is going on?" So I came back, and they said, "Sharks!" Okay, it's not my place. <laughs> Not my place. No sharks for me, no crocodiles, no alligators, no coral snakes, not good. So I said, okay, Florida is not for me. Not that I even considered it, because that would not have been a research job; it would have been an industrial job, which is fine but, I mean, it's not my—

**Fairbairn:** Not your strength.

**Sangiovanni-Vincentelli:** —my, how do you say, interest, so— okay, so I went back, and we had a number of companies that started calling over and over again at Berkeley, and during that period Richard was doing this kind of things, a unified data base work, that led eventually to Open Access, right, and so we had all this interest from these companies coming in supporting our work and saying, can you— Espresso started being widely used everywhere, everywhere. And then Intel started knocking at the door, and so there was a strong push to start a company, okay, and so the industry, so it was a push, it was not— we didn't want to make a company per se <overlapping conversation>

**Fairbairn:** But you had all developments, all these tools that people wanted access to, and there needed to be something—

**Sangiovanni-Vincentelli:** They had, and they ran it, but, you know, it would, for them, they thought would be more effective if there was an outside company to support this stuff so that they didn't have to invest an arm and a leg, each one of them separately, right? And they said, "We'll support the company. We will pay for it. We will, you know, fund the company," which is good, because we, I mean, as a concept. But then they said, "So, guys, quit the university." So Richard and I looked at each other and said, "Ain't good, and we are not going to quit the university." So I said, "We'll find someone," so we started talking to venture capitalists, see if they had some people to be the CEO of the company, and started kicking around this name and the other name and the other name. And then at some point Jim Solomon said, "All right, enough. You guys are taking too much time. We need this stuff, so I'll do it." So Richard didn't particularly like that idea, and so he was fighting it. So I remember at some point there was a big meeting in my home, and Richard walked out of it, and he said, "I'm out of this. I mean, Jim is not the right person for doing this, and so I'm gone." And so I <makes an explosive sound> get Richard, "No, Richard, this is really important," and I said, "We are almost there. So, well, you may have disagreement with Jim, but, you know, who cares, right? Let's try to get going." So he came back, and we did the stuff, and we started in 1982, in December 1982.

**Fairbairn:** Solomon Design Automation.

  

**Sangiovanni-Vincentelli:** Yeah, and also it was called Solomon— it was not supposed to be called Solomon Design Automation. In fact, the original name, I picked it, was Isis, you know, the goddess, Egyptian goddess, but it was taken, all right? So we have the original business plan was Isis, and so I have the original business plan still. And actually both Richard and I were given the original business plan of SDA by Ray Bingham, signed by Jim Solomon, Joe Costello, and Ray Bingham, too. Both of us signed, you know. We formed a new company, thank you, and dah dah dah. And so— and it was in nroff, you know, no Word, no nothing, nroff, so— and if you read it, it still has all the— which is a problem, but it still has more or less what we are doing now in EDA, no different, which is a problem, because we are about 26 years later and still the same thing, you know.

**Fairbairn:** Yeah. We'll talk about that later.

**Sangiovanni-Vincentelli:** But it is an interesting connection. And so, well, so we started a company, and in 1983 another big, big, big, big impact on what I was doing is that Albert Yu from Intel came, together with Pat Gelsinger, and they knocked at my door at Berkeley and said, "Well, we heard that you have this program, "MIS and Espresso and so forth" So we are in the process of designing 386, and we don't think we can make it on time, so we need to take another view. And we also know that you have this thing, TimberWolf for placement of standard cell - and I said, "Yes." "And you have this yet another channel router." "Yes." They said, "We'd like to take a look at that, too." And I said, "Fine". They said, "So, okay, here is the way we are going to work. So we are going to give you about $200,000, which at that time was real money, to support your research, and we'd like to send two of our engineers in your lab. We'd like to retain you as a consultant, and you'll come once a week in Intel, and we'll look at the design of the 386 together, and let's see what happens." It was the introduction of logic synthesis into Intel. So Intel then – Ghadi Singer started a group, that's Addie Colodny and Sam Panini, started a group to support logic synthesis inside Intel that carried through with 486, 586, and so—

**Fairbairn:** And so logic synthesis is clearly a huge, you know, one of the major developments in EDA. And so there was this activity that had started at Berkeley, there was the Intel—

**Sangiovanni-Vincentelli:** Well, actually, I would say it started at Berkeley and IBM.

**Fairbairn:** Right, so I want to just—

**Sangiovanni-Vincentelli:** This particular thing. So I mean, the first, first, first, first, first look at some automatic way to go from— to manipulate logic, not to synthesize logic, it was to manipulate or optimize logic, was John Darringer and Bill Joiner and Louis Trevillyan, where the idea of using compiler technology to adjust the gates, and so that was a sort of peep hole local optimization. So that was in 1979.

**Fairbairn:** Okay, so that the root. That was where—

**Sangiovanni-Vincentelli:** That was the root of the idea.

We couldn't— even before that you could trace it even—

**Fairbairn:** Right, but in terms of practical application—

  

**Sangiovanni-Vincentelli:** I mean, in terms of LS— L— what was it called— LSSD—LSD. I forget. I mean, the tool that—

**Fairbairn:** LSS, yeah.

**Sangiovanni-Vincentelli:** Something. No, LSSD was the—

**Fairbairn:** It was the test stuff.

**Sangiovanni-Vincentelli:** —testing stuff, so it's LSD, something similar to it, okay. And so that was their effort. Now, in 1980, we started the other effort with Bob Brayton, and that was orthogonal. So what we wanted to do was take a global view. So this was like, okay, a technique. Now what we wanted to do is a theory, right, and so we started a theory of logic manipulation.

**Fairbairn:** Now did Bob come to Berkeley? We're getting there.

**Sangiovanni-Vincentelli:** Wait just a minute. We're getting there, right. Because and Bob was trying to get me to IBM in the end, okay, so but in any case— but we had this logic work that would keep on going since 1980, so every summer we would spend at least a summer together with my students at IBM Yorktown and work on additional stuff there, so 1981, 1982 and 1983. And by 1984 then I invited Bob to come as a visiting researcher to Berkeley, and he did that. And then eventually Bob then— we hired Bob <laughs> in Berkeley, right? So we always joke and say, "Who really won?" So I won.

**Fairbairn:** You won the tug of war.

**Sangiovanni-Vincentelli:** Yeah. He says, "Well, yeah, because you are Italian." <laughs> "You young and I say, "Okay." But at the end, you know, that was a very, very, very important step, but again. So that was the root of the logic synthesis. We took a different angle. Then there were the start-ups that were formed in logic synthesis around 1986, 85-86. Sylk, that was around— oh, well, you two guys, but I forget when you guys—

**Fairbairn:** No, we didn't— we did not do logic synthesis.

**Sangiovanni-Vincentelli:** I mean, you did some degree of manipulation.

**Fairbairn:** Yeah, some optimization and so forth, but not at VLSI Technology and—

**Sangiovanni-Vincentelli:** Yeah, VLSI.

**Fairbairn:** Yeah. It was not— so I'm curious as to sort of where does, you know, Synopsys come in, where does GE, and, yeah, so tell me the whole—

**Sangiovanni-Vincentelli:** We are at Cadence, though, and 1982 was the formation of Cadence, right, so the formation of Cadence, SDA.

  

**Fairbairn:** SDA.

**Sangiovanni-Vincentelli:** So we formed SDA, and then Richard and I went also to a different, and Jim, we went to a different funding model. So instead of going to venture capital, because of what we— we had the companies chip in, so they took the two most interested companies, Harris and National Semiconductors. Harris for obvious reasons and my connection to Jon Cornell, and then we picked up Erickson and GE. So four companies supported this stuff, right? And GE, at that time, had the GE microelectronics stuff, right? So one a European, three American, and each one of them put in $1 million, and then the last— we went to $5 million, so the last $1 million was put in by a venture capital, Don Lucas and his friends. And we also had Paribas, a European funding company, for small chunks, right, you know, not the big chunks. Everyone had a small piece. And so that was a different model, and also because we got so much of the investor money, then also we had to give out less of the company than you would have done otherwise. Well, so here we go. So there is a— how to say— branching, so Cadence would go into a layout optimization only, where in research we were deeper and deeper into logic synthesis, right? So at some point what happened is that the SDA work was getting tough, because we were very late with products, we almost went out of business, and at that time was when Harris came in big time. So they supported. There was a third round of financing, and they took almost all of it, so they ended up with 40 percent of the company. And still again, I claim that without my connection to Jon Cornell, we'd never have that, because at that time nobody wanted to put a penny into that company. It was a really bad time. So then we decided to open to technology partnership, and so to get people to access a database, and so I went around with Joe Costello and Larry Rosenberg to convince people, so I got in ST Microelectronics and Kawasaki Steel, of all places, that had decided to start microelectronics….

**Fairbairn:** Yeah, I remember they wanted to get into the semiconductor business.

**Sangiovanni-Vincentelli:** And they did.

**Fairbairn:** It was a foundry, right? It was—

**Sangiovanni-Vincentelli:** No, no, no, ASIC.

**Fairbairn:** ASEK. No, but they wanted to build their own—

**Sangiovanni-Vincentelli:** Fab, and they did. And, you know, the other interesting thing is all the steel companies did that, so the only one still making semiconductors is Kawasaki. So, anyway, and then we had other companies coming in and being— but the two— I mean, the first one was ST that really was a big supporter of this deal, and it was like millions of dollars to support this stuff, right, so all of a sudden we became profitable, right? And so we decided to go public, and that was in 1987, and Black Monday in 1987.

**Fairbairn:** Yeah, that's when the stock market crashed?

**Sangiovanni-Vincentelli:** —a lot of luck that so we made it. In the meantime, so, back a bit, so we are talking about Intel and logic synthesis and the like, where it started, so in parallel to my activity with Intel then there were companies started out of CMU. So there was this company called Trimmeter, and then Sylk was out of GTE, and so both of them had, and more Trimmeter, this expert systems kind of flavor,

  

right, and at that time CMU was very big in expert systems, and I always hated expert systems. You may remember some of this.

**Fairbairn:** <laughs> I don't remember the details, but—

**Sangiovanni-Vincentelli:** Of the panels, right? I was the only guy in the panel saying, "It's bullshit, don't even think about going there," you know. Anyway, and so we started thinking – well, this is mature, right? And so originally I went to— and Jim Solomon would never say that this is true, but it is true. I went to Jim Solomon and said, "Look, you know, this new technology is coming up." I had students who were coming out – the guys who wrote MIS, right? Arthur Wang and Richard Rodette, and saying, "Not all we have to be is doing this thing, you know, it's too advanced. Nobody wants to do automatic design," so we said, "Well, how about if we start another company, then what would happen?" And they said, "Well, sure, go ahead." In parallel to this was the story of GE , right? So I ended up in the advisory board of Calma. It was a GE company. Then GE decided to merge their activity on the GE microelectronics group in design with Calma. Ron Rohr was also an advisor, and Ron Rohr introduced me to Aart de Geus and I loved him immediately. So he was doing logic synthesis in North Carolina in the GE Microelectronics Center, and he was trying to bridge the work that we were doing, right, all this algorithm stuff, and the expert systems stuff, if you like, so then he would do technology independent optimization like we did and backend logic, I mean, the technology mapping expertise and the like, rule-based methods, right? And so he had this system there. And so at some point he just got sick and tired to be at GE, because they decided to downsize Calma, and he was associated with Calma. So he started looking around, and so I introduced him to Yorktown, and he really wanted to go to Yorktown. And so we had long discussions with Yorktown, then Yorktown at that time was not hiring, and that's one of the reasons why also they were trying to downsize. It was the beginning of the crisis of IBM, so that's the reason why also Bob came to Berkeley, is because they offer pre-retirement packages which are fantastic, right? So Bob decided to take it as did many other top scientists at Yorktown during that period. So Aart didn't find “an offer” there. Then he interviewed several different places and, of all things, he interviewed also with the SLA company, Cirrus Logic, and it was kind of interesting. In parallel, we were talking to venture capitalists, Richard and I, Jeff West and others, and so we put the group together and said, "Well, why don't you talk to them instead of going to Cirrus Logic? Why don't we try to make a new company?" So then it was discussion, discussion, discussion. So then Aart would take his team, right, and by the way, two of people came in, took their PhD, actually Master's, in my group and then they came back to his group. One was Craig Whitcombe, and the other guy was Jim Reed [ph?]. Anyway, and so they decided to take that group. It was Gregory, also as well, the two brothers, Gregory brothers, and Aart, and they would start selling what they had, so sort of cleaning it up and making it look better while Richard and another one graduating, and they were to bring in all the technology from these and try to merge the two. So we did that. And Aart and his people wanted to stay in North Carolina. They were really enjoying North Carolina, but after he saw California, and so actually Aart agreed to move over here. Now, we were also looking in that period for a CEO, because Aart didn't feel that he was a CEO, or didn't want to be a CEO, and so difficult, very difficult until we bumped into Harvey Jones. And Harvey Jones really wanted to be a CEO. We were not convinced because of his background at Daisy, you know. We didn't particularly like Daisy, and but he was so insistent, and actually I did like Harvey a lot, and so I said, "Well, why don't we? Let's see what happens." So, we “gave him a chance”, and the funding model for Synopsis was exactly the same as SDA, except that now only two companies: GE, because they were letting — and so in part the financing was to let the technology go out, and Harris.

**Fairbairn:** Still. <laughs>

  

**Sangiovanni-Vincentelli:** <laughs> My baby, right? And so Jon Cornell said, "Well, I don't know about this stuff. It looks far out to me, but if you say it is good, okay," and then Aart is really a technical guy, you know. You don't want to give the company to Aart to run, and say “Now we are looking for a CEO.” You know, in business he's really naive. But he knows, you know, which is one thing that I stressed on the comment about Aart is that he could become a very good, solid businessman, learning how to become one, but he was a technical guy all the way, all the way.

**Fairbairn:** He wasn't there.

**Sangiovanni-Vincentelli:** So, okay, so that was that. And then Jeff West was a venture capitalist who was supporting it, and we had Benchmark as support as a venture capitalist, so the percentage of venture capital was higher than in the other one. And so the company was started in 1987. Now, how come that I met Harvey Jones in 1980? Because in 1987, I was at MIT for a sabbatical, and so I took with me eight of my students, PhD students. Also because MIT was interested to see how you could do different things. In 1987 we were doing all kinds of different research. I mean, we were doing research in machine learning, in integrated circuit design, in control, and in what was considered to be artificial intelligence, because we were looking at machine learning stuff, right? And so MIT is divided more strongly than we are in different groups, and so they were interested in how you can keep the groups together. And so I went there, and I had a ball, also. I mean, I worked with a lot of people. At that time I got involved with thinking machines, and that's where I met Dick Feynman. Remember I studied in his books and so we went out for dinner a couple of times, and I really enjoyed the company of Dick. And it was the time when he discovered the reason why the space shuttle broke, right? It was the O-ring study.

**Fairbairn:** Yeah, the O-rings, yeah, yeah.

**Sangiovanni-Vincentelli:** So I demonstrated— he demonstrated it first with me, and I did not say, "I'm going to do this," and say “Oh my God <inaudible>,” said, "That's very effective." In fact, he mentioned to me a special commission. He was a character. He was a character.

**Fairbairn:** Oh, he was on the commission that was investigating that, right?

**Sangiovanni-Vincentelli:** He was a character, so because he marched in, picked up a glass of water, ice water, put the plastic in, took it out, did like this, and left. That's all he did. It was <inaudible>—

**Fairbairn:** Okay, so I'm glad we got sort of the picture. I've never been clear exactly how the various pieces of synthesis research and so forth had come together in different forms.

**Sangiovanni-Vincentelli:** And, by the way, Trimmeter by 1988 went out of business, Sylk in 1988 was acquired by Viewlogic. And in the meantime, in 1987 I also joined the Viewlogic board. And in 1987, Black Monday, it was supposed to go public, no? So Joe figured it out that one way to do a reverse merger, merging into ECAD to go public. ECAD was public, so it went public, and that's why we changed the name into Cadence, and then we started— I mean, during those years, I was a strong, strong, strong supporter of sea of gates, and I really liked Tangent and the people there, so I convinced Joe to acquire Tangent, okay, and so now was the time in which Cadence really was growing by leaps and bounds, and so—

  

**Fairbairn:** So let's go back in your story, the—

**Sangiovanni-Vincentelli:** But the interesting thing— this is something that people may not realize, but in 1988 there was a time when Cadence bought the company, the Verilog company— what was it called— Prabhu Goel's Company. Yeah, gosh, that company. <overlapping conversation>. And interesting because Synopsys depended completely from there— Gateway.

**Fairbairn:** Gateway.

**Sangiovanni-Vincentelli:** From Gateway. Exactly 1988, before this talk about buying the company and all of that, then I was offered by Prabhu to be on the board of Gateway, and then the bomb exploded with this acquisition thing, and so I said, "Better not," you know, I stayed away. Synopsys went into panic, because if indeed Cadence wanted to tighten up the thing, they would be dead.

**Fairbairn:** The language. Synopsys was dependent on the language—

**Sangiovanni-Vincentelli:** The language and the simulation.

**Fairbairn:** —as the front end of their synthesis product, right.

**Sangiovanni-Vincentelli:** And so when Aart called up and said, "Oh my God, what do we do?" And then we did an attempt to saying, "Well, why don't we do a three way merge," almost there, almost there, but at the last minute Aart and Joe couldn't agree on who was going to run the company and other things, so that's the end of the story. But that's a kind of interesting thing, because the world would have been very different, I think, if that would go through. So that was, as I say, in 1988. So in 1989 when we went through this issue of the disappearing of other synthesis companies and essentially Synopsys being the… By the way, Synopsys was not called Synopsys, when we started it was called OSI, Optimal Solution Inc. And so, like Isis, but we abandoned OSI because it was a really bad sounding name. Synopsys sounded much more interesting, and so that's what. So in 1990 then we did so well, and then we started the same idea, right? So we did technology partnership, brought in ST, you know, the same story, I mean, all over again. And by the end of 1990 we went public with Synopsys. And then in 1991 it was a time where Cadence started competing with Synopsys in the logic synthesis area, so they started developing something inside with some of my students, but I didn't want to know, because there was a big conflict of interest. So in 1991 then Aart proposed me to be on the Board of Synopsys, and so on and so forth, which I really considered very seriously, and the same day Joe asked me, "Why don't you join the Cadence board?" Because I preferred to stay out of the board, because I was running the technology advisory board of both companies, and that's what I cared more than the board, but they felt that I could contribute to the board much more intensely, and Aart's idea was that he wanted to give more technical slant to what the board was doing and to in general the company. At that time they decided to have Aart run the company, and so he wanted to inject different people in the board. The venture capitalists were going out, naturally, because it was going public, it was already public. So then it was the worst three months of my life, because every day I would wake up from the other side of the bed, Cadence, or Synopsys, or Cadence, or Synopsys, and actually the person who really convinced me to go into Cadence was Richard Newton, because he was doing work only for Cadence. He stepped down from the board of Synopsys and he was doing work with Cadence. And so he said, "Well, gee, you know, we can have more fun, and this and that if we work more closely together," and then I said, "Okay, sure."

  

<laughs> And this was the tilting decision thing, so— even though my research was much more aligned with what Synopsys was doing.

**Fairbairn:** So I want to— I don't know if I'm moving ahead or whatever. I'd like to move on to some other topics. One of the things you do is, you know, you've talked— you were in Italy, you came to the United States, you were at Berkeley, you've been in various places in the United States, but today you're sort of half and half.

**Sangiovanni-Vincentelli:** Half and half. Family reasons.

**Fairbairn:** So tell me sort of how that evolved, and what the focus of research is, and how that works.

**Sangiovanni-Vincentelli:** Yeah. Well the focus of research, by 1988 or so, there was still some interest in logic synthesis. There were quite a few things still to do and so on, but we had Synopsys, all the layout stuff was more or less done, right, so I was looking around for different topics. So in 1988 I met the CEO of Magneti Morelli electronics division. So Magneti Morelli is one of the large European providers of electronics to the automotive industry, and in particular they have most of the Formula One teams. And so I met this person who knew that I was some Italian professor at Berkeley, so he wanted to team up. And he said, "Well, we have problems in designing this stuff, and it's getting harder and harder and harder, and so is there something that we can do to guarantee safety in our product?" He was very concerned about errors that would cause accidents, and in 1988, the electronics was minimum in the real cars, but in the Formula One cars it was intense, starting really getting intense, and they were afraid that something bad would happen. And so, in particular, they were doing this very interesting thing, this semi-automatic gear switch, you know, the one that you have on your steering wheel that you control when you change gears. It's not the automatic. It's not fully automatic. You can keep your control. And for Formula One that was a revolution, because then you would allow pilots to be infinitely more effective, but the control problems were horrendous, because you need to— it is with a clutch, so that the clutch is completely automatically controlled. So you need to control the number of turns of the power train, and you need to control the speed at which you get the clutch engaged, and you need to make sure that it doesn't slip too much, because otherwise it burns the clutch, especially at that speed and that RPM. And so it was a very difficult control problem, so we tried to help out in verifying the control algorithm, okay, but the interesting thing was there was no control algorithm to speak of. It was code, and code was written in assembly languages. And so I said, "Well, if you want to know if this thing works or not, the first thing give me the algorithm." They said, "<makes a strange gasping noise>." And so the first time when I started doing this separation of concern, remember function vs. architecture— you heard too much about this? And so I said, "This is the right way to do it. So you cannot possibly put the algorithm together with the implementation; otherwise, you cannot debug the thing." So we started that discussion with Magneti Morelli in '88. So by 1992, we changed their methodology in the electronics division to use a lot more of EDA tools, because they were using very little, because they were doing systems and not doing the chips per se. They were designing in collaboration with ST and Motorola, now, not Motorola— and not developing their own. So, well, I introduced that way of thinking and design methodology into Magneti Morelli. So my research topic, and then all of a sudden I said, "This is a really an important problem, and this is going to be the next generation tools, so we'll have to address this problem." And so by 1990, about 60 percent of my research was devoted to that, and by 1995 or '96, it probably was the majority, and by 2000, almost everything was on system level design.

**Fairbairn:** Okay.

  

END OF TAPE 2

START OF TAPE 3

**Sangiovanni-Vincentelli:** So, in 1991 when I decide for Cadence and so on and so forth, then I started being, call it forced to consider to move at least part of my time to Italy because of family reason. You know, I am perfectly happy here. If I could spend 100% time here it would be ideal. But I'm an only child, as I said, my mother-in-law is 93. My father passed away two years ago. He was 93, so I do something to do, plus my wife wants to stay in Italy so— and so, what happened is that in 1994 I started doing half time here and half time in Italy. So I resign partially from the University of California so because that's my, you know, my real attachment to the world is UCB. And I took 50% appointment and then I started looking at what I could do in Europe. And with the help of Cadence, we decided it would be nice to have a lab in Europe and because of family reason again I have to stay in Roma. So we opened a lab that was a three-way lab Magneti Morelli, ST Microelectronics, and Cadence would support my lab. Plus Cadence would have a piece, alone, it was called the Cadence European Labs in Roma. And so that is a nice position. It's in Piazza Novona, it's 500 Palace. And, you know, that was also another change that I think I had an idea that few people had because in Roma, as well as in Paris and other European town, there is an area where the industry is and it's ugly. I mean, it's just as ugly as it can get, like in Paris with the and then here. It was called Tibotina Valley, like Silicon Valley Tibotina.. It's where the Tiber River goes by, and but all of the electronic industry is there, right, and so the same thing in Paris, all electronic industry is there. And then I said, "Well, I want to try something different. It has to be a research thing." And by the way, their rent is very high in this place. And say, "Why don't we change radically the way in which we think about locations." And so I said, "Let me see if I can find the best possible looking place in Roma that is affordable." And I happened to know the family of Prince Massimo. It goes way back. I mean, if you remember when history book from the Roman Empire when they had the fights with the Carthaginians, the general won that it was Quinto Massimo. That means, the guy who can take his time, right, it was letting— actually, even before that, it was Annabel [ph?] was coming in and coming in and coming in towards the Roma and he said, "Stop, don't engage," right, because all the time when you engage with Annabel, we lose. So, don't engage. Let them be tired and adjusted to the nice Italian climate and then we— okay, so, that guy was the ancestor of the family own <inaudible> and I knew of that. And so then we, this very nice gentleman was remember me very much when my father was 83, 84, when we decide to do this thing. And then I told him, "Look, you know, I know that you have an apartment for rent and I would like to change it, to make it a research lab." And then he said, "Oh, you have equipment?" I'm like, "No." I said, "We have only computers." He said, "Oh, geez, this is fascinating. What do you do?" I said can you imagine explain to an 86-year-old prince who is a descendant of the Roman warriors. How the heck am I going to explain this? Hell, so anyway, but he got fascinated. And so he gave us very good rent, very good rent, extremely good rent, and in exchange we redid the façade of the building. And then we had the big inauguration, it was fantastic, 1996. And so that's where— and we decided to call the joint research group Parades, it was a project on advanced research in architecture and embedded system design. So you see, architecture and embedded system design.

**Fairbairn:** So, this really sort of carried forward this whole area of systems design and research, which is your focus of your work now.

**Sangiovanni-Vincentelli:** My work, because, I mean, I'm doing in Berkeley exactly what I'm doing in Roma, more or less, as the research goes. In Roma, since it's all industry, we also try to solve. And now United Technology is coming. Cadence is going out, for obvious reasons. And UTC, United Technology

Corporation, is coming in. UTC is one of the largest corporations in the United States. It has helicopters, Sikorsky, engines for Pratt and Whitney. It's got Otis elevators, Carrier electronics, Chubb security. You know, you name it, they have almost a little bit of everything and they are very much interested in the design methodology that we developed to inject it into their corporation as Magneti Morelli did. So, they want to do the same path. So, they want to bring this stuff in. And in the meantime, we got connected very much with the automotive industry. I'm on the science and technology advisory board of General Motors and I was a consultant to BMW for a long while and Daimler-Chrysler, just to inject this design methodology, this method way of thinking in the automotive— and by now, you know, it's pretty much in automotive very much this idea of function separated by architecture, mapping, platforms is pervasive, so that has had success. And we are trying to export it to this other things. And in Berkeley we do more of the theoretical side behind it. I also found out that why the integrated circuit per se digital domain is— I'm not interested in logic centers or even transaction level modeling, but I'm interested in one level above, which is how do you apply the same methodology to design cars and then to chips, right. So again, my old friends at IBM and so on and so forth, at Intel, we are looking at together and a few other places. But I found out that in the analog domain we have not made a major inroad in design methodology and so I have three students now working on bringing, again, this general methodology to see if we can really change the way in which analog circuits are designed. So, I'm coming full circle, right, I went all the way out to big systems and in fact, a good part of my research today is about energy saving for buildings, so, how you design buildings to save energy. So, we have several initiatives in this domain.

**Fairbairn:** You mean, in terms of the—

**Sangiovanni-Vincentelli:** Where you place the sensor, the actuators, how you do the control algorithm to control temperature, lighting.

**Fairbairn:** Oh, I see, interesting.

**Sangiovanni-Vincentelli:** And how you design also building having in mind that you can do all this kind of things. So, there are even configuration control of a building and change of angle in which you can take light on. You can change the inclination of part of a building according to a time of the day. So, it's really an integrated system design problem. And one of the thing that I'm most interest in seeing, okay, this building, but I can also think in terms of multiple buildings and I can even think in terms of a town. So, I mean, if we push it forward, and so we are looking at hierarchy to control algorithms and tied with sensor deployment, so while this sensor network is another thing that I've been involved in very much.

**Fairbairn:** A lot of Berkeley research in that?

**Sangiovanni-Vincentelli:** Yeah.

**Fairbairn:** Right.

**Sangiovanni-Vincentelli:** And me too, so I wouldn't say that I'm a major driver in sensor research that I am using them a lot.

**Fairbairn:** So, one of the things you alluded to earlier on was the fact that the traditional EDA companies are still doing the same things that you set out 26 years ago in the business plan for Cadence.

  

**Sangiovanni-Vincentelli:** I mean, is a push in a sense that of course, something is done differently and some— but basically, all of the ideas that we put down in the business plan of SDA and the one to somewhat lesser extent in Synopsys was more focused, right. But SDA was about the building of , the EDA company, the global EDA company with a touch of everything. So, you would have the database stuff. It was Richard's work, open access today. And it came of age only maybe a couple of years ago, right, so it took a long time. Unified user interface, automatic place and route, automatic generation of blocks, assembly of blocks, design services, it's all in that business plan, all of it.

**Fairbairn:** So, I would observe that the EDA industry today and for some time has been in malaise, you know, not growing significantly and so forth. What's your take on that, is it self-inflicted or what are the opportunities? Is there an opportunity for a new EDA company? Do the current EDA companies have to transform? Where does electronic design automation go?

**Sangiovanni-Vincentelli:** I think that we are in really a circular reasoning because for one thing, if you talk to the IC companies, right, like I do all the time, they always have a sense, and say we would pay too much for tools. There's always this view that "Boy, we paid too much. We paid too much." And so there is a strong push from your customers to drive down the price, drive down the price. On the other side, and that's the reason why I was saying the world would have been different, right, if something, some happening would have taken place, you have four companies that are vying for the same customers and they are offering similar things, right, especially two: Cadence and Synopsys. And so what happens that the customers have good pull to lower the price because these guys are going to compete also in price. And I would argue that sometimes it can be too much on price than they should instead of features. And so what happens is that if you look at the percentage of the R&D spending of IC companies, in let's say a few years ago, 16% was tools, now it's 11%. So, it went down, and because of this pressure, right. So, it's a structural issue, right, it's not so much as about, "Oh gee, we have lousy tools." It's not so much, right, but it's just the dynamics of the thing because you have commoditizing. If the flows of Synopsis are similar to that of Cadence then, you know, what differentiates? It's basically price and how much better can you be at layout and logic synthesis. We are down a few percent, right, it's very difficult to really to get a significant leg up that would convince people to make them move unless you really go to a technology that is not well supported by today's algorithms and methods. So, for example, 22 nanometers we don't even know how these circuit are going to look like. Maybe there is an opportunity really to compete on novel ideas on how to do these things because a lot more statistics has to come into place, a lot more consideration about technology have to come into place when you design integrated circuit, right. Now, on the other hand, when you start, you know, I'm in 1998, we had a big effort in Cadence with VCC, for example, right. That was mapping was a real—

**Fairbairn:** This is a systems platform?

**Sangiovanni-Vincentelli:** System, you know, because you were right, you were right. And so VCC was a platform design methodology and at that time, among the customers that sign in for this from Cadence, we had BMW, Erickson, Nokia, so I mean lots of system companies because they say, "Ah-ha, this is the way in which we are going to link up with the IC companies." It was a good way— we like the idea, which this thing. We like this. Now, then what happens? On one side, you got your traditional customers and they were all there, right, TI, Freescale, (Motorola), ST, and so on— were there and were very interested in seeing this thing to succeed, right. But if you remember what happened is that this was the bosses, right. Then the troops were going back to much more lower level design technology. You may remember all this discussion about cycle-accurate models versus non-cycle accurate models and what Jim Rowson and I had to spend so much time explaining and saying. Now, today, if you go around and

  

you say and you ask designers, "Do you care about cycle accuracy?" The people who are doing the top level design couldn't care less and say, "As long as it tracks, it's okay." So, it's all what we did way back would apply right on now. So, it's a big tool [ph?], right. On the other hand, there is also the point is that when I see companies say "we need, we need"— but then where is the money? So, the money to start the effort, like $1 million is there. is there. When you come to the point and say, "Okay, now we have to change methodology, apply this stuff," when I see companies like <makes gasping noise>, you know, they are reluctant. And especially when you don't have the entire flow, it's a big change, right, and you may not want to risk. And so there is no incentive for the IC companies, I mean, for EDA companies to invest in a place where your customers are not pulling you, now you start seeing it because of embedded software and so on, but not big ways like we had in logic synthesis. Logic synthesis we propose, it was a new thing, people did not— but we seed it very much at the university with Intel, ST, and so on, DEC, TI, they were already using logic synthesis out of Berkeley when Synopsys was founded. So, it was not completely new, and I mean, they got used to and was much more of the focus and point tool thing rather than we perceive it as a whole new shebang, right. So, in some sense when you say, "Where was the space for a new company?" If we were not with Cadence, we would have been better funding a new company, a brand new company, because then you don't have to listen to your customers, present customers, you have a different set of customers. You're not forced to certain dynamics that goes with the way in which tools are sold. And so that—

**Fairbairn:** So, do you see that changing?

**Sangiovanni-Vincentelli:** Eventually, I mean, I look at all the system companies I'm discussing and they feel the pinch. They are— meaning that there are bigger and bigger things. Their requirements are growing harsher and harsher and the cheap companies are dealing with cost of designs that they cannot support any longer. So, you're talking about a new design start is about $100 million, right. Now, if you want to be profitable at the cost of the design, R&D $100 million, right. You have to sell, what, $4 billion or $5 billion worth of one chip.

**Fairbairn:** Well, and that's the other problem, right, is that things are becoming so complex that only a few systems or a few products justify the investment in R&D and whatever.

**Sangiovanni-Vincentelli:** Unless you really radically change the design methodology in which it becomes affordable, let alone with manufacturing costs. But the design costs now are becoming bottleneck for design starts. And so even though we know— or by now the manufacturing problem is created this very few foundries that are around and very few companies that can make their own chips, that's solved in that way. And so you don't have to support the cost of developing that stuff, right, because somebody else had done it and their business model is based on how much they should charge you to make the chip taken care of, right, so, the investment not there. The cost of making the chip, but then you farm it into the price. But the other big thing that is resting on your shoulders is R&D costs and if you don't solve that, what do you do? I mean, the entire IC industry disappears, so you have to solve it. And so there is hope that this higher level way of thinking is taking place. So, because the only way in which you do that is you use infinitely more software and you do a plug and play kind of assembly of ideas or previous designs and the like to lower the $100 million plus cost. And that is in the cards, cannot be otherwise. The system side, we already said, so we are in kind of a triple witching hour where things are set so that you could come in and do a good job. Now, the point is that takes a long to develop these kind of tools because you have to develop all kind of different things that are not available today.

  

**Fairbairn:** And people that can develop and absorb the methodologies to put them all together and to make it work. You can't just put them in piece meal, one by one, you have to—

**Sangiovanni-Vincentelli:** So, if I had infinite money and I did have this thinking, and three or four years ago there was an occasion in which I could have put together the money to do this. But, you know, again, in some sense I don't want to— I mean, I have one work so if I work with Cadence, I work with Cadence period and so I don't want to create in some sense a competitor outside Cadence. But we had the possibility to pull together a sizable amount of money to do a company, my view, that would have three legs. One leg would be design tools, one leg would be methodology and the other leg would be modeling. So, to offer services, too, with people to do the models, which are needed, to use the tools and to apply the methodology, and so because they come together. When you start thinking about this way of thinking and the papers that we wrote and the tools that we advocated, the ones we developed at Berkeley, is this thing. And so unfortunately, the tools that you develop at Berkeley, like Metropolis is one of the thing that we have done at Berkeley, so complicated because it's like this is this big, right. And so people are not willing to use it because they, you know, of course, is a university tool, right. While in the case of Espresso, or MIS, they were very focused, so you can just learn a few pages manually, you know.

**Fairbairn:** Insert it into a small part of design methodology and see what the—

**Sangiovanni-Vincentelli:** And off you go, right, and that was the top of the methodology was going from Verilog to gates. I mean, if you think about what we are trying to do here, now, is a much larger problem, much larger problem with many more different blocks and models that you have to deal with.

**Fairbairn:** Who needs to take the leadership in doing that? Is it EDA companies, the universities, the systems companies, is there—

**Sangiovanni-Vincentelli:** I think it's a combination of all of this. Now, the system companies are trying. So, for example, with all the support that we get from UTC, as an example, and the support we had from Magneti Marelli is another example. Is that enough to create a new industry any day? I don't know. Because as I said, if you don't start already big, you know, to do these things, you're never going to go anywhere. So, my view is that watch out for the UGS and the DeSoto, in my opinion. I mean, I already said this two years ago, remember when we did—

**Fairbairn:** UGS?

**Sangiovanni-Vincentelli:** UGS is the company that does mechanical CAD and PLM, the same thing, the whole system. They are big, gigantic companies that do mechanical CAD plus PLM, Product Life Management stuff. And they are penetrating all of the big companies, of course, most of the big system companies are mechanical in nature. And their proposition is going more and more towards this way of looking at globally, right. So, if you had infinite money, I would put together an EDA company, one of these big DeSoto or UGS, then I think we start thinking about this stuff. But if you do this kind of big combination, then what happens is that there are a lot of forces, economic forces, that force you to produce results, right, or even in short time. So, you don't have the amount of the investment that you will need to do this stuff. And starting new is too big of a proposition. And so it's just again, you have to find—

  

**Fairbairn:** We really are in a bad—

**Sangiovanni-Vincentelli:** And it's a bad, bad crossing, bad crossing. And so, as I said, I mean, there was a time in which some of my friends from the groups were ready to sign a big check because they felt that this one could be bigger than Cadence, Synopsys and Mentor all put together, right, as the next generation thing, next generation thinking. And well, we tried, right, because that was a big upside, right. If it works, it would be a big upside. But again, I mean, it would be extremely risky. So, I told them, "It's risky." There's risk. And by the same token, you know, Cadence has tried many times to do something good in this domain and so this incubator for C to silicon.. But they did and in some sense at Synopsis, had to retrench in the past, now they are kind of reaching out again towards the system space. But Mike Fister had a passion for systems so he pushed the company towards the right direction. But I think now Cadence is going to retrench into the classical IC, yeah, IC customers space. So, I don't know what Synopsys is going to— I mean, I have no idea what Synopsys is going to do in their system space. I saw that they got a piece of Proven, which is a Swedish company that does formal verification for embedded system and big system like train systems, you know, underground systems where people who provided the tools to do formal verification for the underground control system of the Paris underground.

**Fairbairn:** Oh, really. Okay, well—

**Sangiovanni-Vincentelli:** I see signs, but I hope that we are going to make a big thing.

**Fairbairn:** So, the future is a little muddy in the whole design automation and system simulation but thank you very much for spending the time and it's been great insight into not only yourself but the industry, and we appreciate it. Thank you.

**Sangiovanni-Vincentelli:** Thank you very much.

END OF TAPE 3

END OF INTERVIEW

  