Oral History of Luc-Olivier Bauer

Interviewed by:
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Uday Kapoor: I am welcoming Dr. Luc-Olivier Bauer. I'm sorry if I mispronounced your name. Dr. Bauer has served for more than 40 years in various executive positions in several high technology companies, often as founder or as a member of the early startup team, starting with an engineering education in Switzerland and in the U.S., his early responsibilities were technical in nature to cover later all aspects of high technology business: manufacturing, finance, marketing, sales and general management. You have done a lot of outstanding work internationally, so we'll come back to that.

Luc-Olivier Bauer: Thank you.

Kapoor: And we'd love to hear about that.

Bauer: Thank you.

Kapoor: So welcome, Dr. Bauer. What we'd like to do is to start from the beginning.

Bauer: Yeah.

Kapoor: I'd like to ask you where you were born and how your early childhood was like, and we can take it from there.

Bauer: All right. I was born in Neuchâtel, Switzerland July 6th, 1938. And then my father being a diplomat, I grew up really in Paris. So immediately after the War, I went to Paris, you know, just when the Americans were still there. I remember running after the GIs, begging for chewing gums, which they were throwing off to kids.

Kapoor: Right.

Bauer: And then, so I grew up there until I was about 18.

Kapoor: I see. So your childhood, early childhood, was spent in Neuchâtel, I assume.

Bauer: Yeah. From zero to seven, I was in Neuchâtel. And then from seven to 18, I was in Paris where I followed the usual grade school system.

Kapoor: I can imagine that growing up in Switzerland must have been like a dream, as for me, especially.

Bauer: Well, I mean, growing up in Switzerland at that time, you know, there was war, so it was-- But it was, you know, a very, very mild situation compared to all the warring parties. But we didn't have a lot of things we could do, because the parents had limited resources at that time and everything was restricted, you know. But again, we had a very privileged childhood compared to the rest of Europe.

Kapoor: Yes. Do you have siblings that you grew up with?

Bauer: Do I have?

Kapoor: Like brothers and sisters?

Bauer: Yes. I have three sisters who are still in Switzerland.

Kapoor: I see. So your father, as you said, was a diplomat.

Bauer: Yeah.

Kapoor: And so what was the early childhood like?

Bauer: I mean, you know, my father was a diplomat, so first a lawyer and then a diplomat. And then my mother was more of an artist. And both of them had an extremely intense life -- lives, to which I would say the thing that was shocking was their complete denial of death. Both of them felt that, you know, death had no importance to their business. They're not interested in it. And they just worked until ages of 92 and 93, until they dropped dead. And it was an interesting experience. But in Paris, I mean, we had, you know, a very normal family life in which I was mostly taking Latin and Greek classical studies because my father was on the classical side, and was not inclined to science at all.

Kapoor: I see. That's very interesting. I can follow up later on the engineering and science education that you went into. So how did that happen?

Bauer: So then, yeah the transition happened when I was about 13. Then I had some conflict, like all kids have, with their parents, so they decided to put me in a boarding school close to Paris, which was a religious order but not too-- not too religious. Very nice, very closely following kids. And then I had this awakening which was the professor of mathematics and physics, a guy named Professor Sciamma, I still remember his name, said, "But why do you, you know, have best grades in Greek and Latin, and you are-- you have very bad grades in mathematics and physics?" And I said, "It's because of genetics. My father was not good in math, my grandfather was not good in math, therefore, I cannot be." And he said, "That's an absolutely ridiculous statement. I will-- I mean, I will show you that you can be the best in class in mathematics and physics in a couple of weeks." And I said, "Really?" I mean, I was totally shocked. And then he helped me a little bit and sure enough, after three or four weeks, then you know, everything seems to be so easy and so nice and so beautiful. So that's the guy who really, you know, showed me the light to that that was completely closed. And then there was another priest who was a geologist who took us to a very big, you know, how do you call them? quarry I mean with large open trenches.

Kapoor: I see.

Bauer: And which was something like 500 feet or 600 feet deep. And he would go down, you know, by millions of years. You know, this layer is that, and these are the-- and so forth. And, I mean, that was a complete also awakening as to archeology and the past and geology and so forth. So this boarding school was really very important to open the mind.

Kapoor: Yes. Seems like it was a very fascinating experience of learning.

Bauer: Yeah. Absolutely. And the fact that just, you know, having confidence that don't worry about genetics. I mean, you can-- you can probably do much more than you think you can do.

Kapoor: Right. That's wonderful. So how was life like in Paris in those days? You mentioned the War-- after effects of the War.

Bauer: Well, there was, you know, immediately after the War the GIs progressively left. And then I think around 1949, something like that, when I was 15, no, when I was 11, 12 years-old, then there was a fear of the Russians and Berlin. You know, that's when the Air Lift was made, because the Russians closed the access to Berlin. So there was a-- there was a certain amount of fear at that time in all of the West, you know, for until maybe the end of the fifties.

Kapoor: Right. So did you go back to Neuchâtel periodically?

Bauer: Yeah. Then I did my high school degree in France. And then decided you know, just when I was finishing in '57, then Sputnik, you know, October '57, Sputnik happened, and that really did it. I mean, once, I mean, that professor which I talked about before, plus Sputnik. I mean, you remember, that had a huge-- I mean, it was for me a tremendous event. And so that really inclined me to go to the what's known now as the École Polytechnique Fédérale de Lausanne, which is EPFL.

Kapoor: Right.

Bauer: And then I started in a section in physics there.

Kapoor: I see. Okay. And you completed your B.S. degree? -

Bauer: Yes, I did. I did my B.S. there, and it was a wonderful time. And Lausanne is a very pleasant town for students. And probably the only thing that was wrong is that I had too much fun.

Kapoor: <laughs>

Bauer: I mean, you know, I went skiing and so forth there. And so the grades were good but not that great. And also the competition, the competition intensity was just not there. I mean, it was, you know, as long as you passed, you had a passing grade, it was fine. And then at the end of the school, then everybody before their B.S., everybody's thinking, "What are we going to do?" So I felt, you know, on big-- I was very attracted to what happened with Sputnik, and then after that the American response, and I thought that would be very interesting to go study in the United States. And so very early, I tried to, you know, find a school. And then I, so I wrote to a series of schools, and then Caltech accepted me. And then I asked my professor, "Is that, you know, Pasadena, is that close to the sea?" And he said, "Yes. It's very close to the beach. Don't worry."

Kapoor: <laughs>

Bauer: And then, "Is it not too hard?" And he said, "No, no. It's, you know, it's fine. It's not going to be too competitive. Don't worry about it, all right." So that's how I started. And also, I should say that I was not speaking English, because my-- I had taken French and German, Latin and Greek.

Kapoor: Right.

Bauer: And so in the application, you could at that time have an American sign that you could speak English. That was sufficient. So it turns out I had a very nice neighbor who said, "Okay, I will sign that you can speak English," which I couldn't at all. "But you promise me, you're going to go three months before school start to the United States and go every day at Berlitz School and see movies." And that's how I learned English in the three months before joining Caltech. And after all, you know, many of the technical words have Latin or Greek or French roots.

Kapoor: Yes.

Bauer: So, as far as all the technical words, there was not a problem. It's more the colloquial situation which was difficult.

Kapoor: Exactly. So during this time, was your father playing any role in your decision to go to the United States? Or your professor?

Bauer: Yeah, my father was very much in favor, he was again in diplomacy [at the OECD, in Paris]. You know, he was working with Sweden. You know, Switzerland and Sweden were acting as the referees for the Marshall Plan [at the OECD].

Kapoor: Right.

Bauer: Because they were not asking for money. But so they were constantly dealing with the Secretary of State and people in the Marshall Plan, so my father was very close to the U.S. administrations and was very appreciative of what happened, you know, to save Europe. So he absolutely was encouraging me to do that.

Kapoor: Oh, I see. Wonderful. So of course, Caltech is a very great school and very competitive. How did you do -there?

Bauer: No, that was, I mean, that was a big shock. As I said, it was, first, it was not close to the beach.

Kapoor: Right. <laughs>

Bauer: It's very far from the beach. <laughs>

Kapoor: Right.

Bauer: So that was sort of a disappointment. Because I really saw coming to California as continuing a very nice life, you know, and so forth, and not working too hard. And so that was the first awakening, it's not close to the beach. And then it turns out to be super competitive. You know, that's something I learned the meaning of competition, really. Because you have, you know, the whole world is coming to these U.S. schools, and you have extremely talented people coming from all over the world.

Kapoor: Yes.

Bauer: I remember at that time, I was not that young. I was probably 22 or 23, and there were people who were 18-years-old who were more advanced in terms of courses that they were taking, especially on the theoretical aspect.

Kapoor: Right.

Bauer: So then that was, I remember the first, after, the first term. So they got you in for the Master program. And then, but if you wanted to do the Ph.D., you had to be, you know, at a certain class level of grades. So after the first term, I think my grades were a C plus. And I thought that was great, I mean.

Kapoor: <laughs>

Bauer: 'Cause my advisor said, "Well, okay, you're going to get your Master, but if you want to stay to do the Ph.D., you have to do much better than that." I said, "What is that?" And he said, "Well, A minus or something like that," right.

Kapoor: Right.

Bauer: So, okay, so I had two terms to do that, and I did it. But it was really hard.

Kapoor: A lot of hard work, yes.

Bauer: I mean, really hard.

<laughter>

Kapoor: Yes. <laughs> So did you then select your field for your Ph.D.? How did you decide?

Bauer: Yes. Yeah, there was, I was attracted by, you know, space and rockets and everything. And so there was a professor named Roy Gould who was already at that time, I think, president of the AEC Commission on Fusion. So I chose plasma physics. So that's the specialty that I did. And then as I saw that my level in terms of theoretical physics was you know, medium and I would have to do a lot of work to catch up to become a theoretician, then I decided to become more of an experimentalist.

Kapoor: I see.

Bauer: So - most of my work, then, in my thesis was experimental. And then I had another friend named Fred Blum who did [theoretical work in] this area, and we worked together to do that, and we had the good luck to be able to get a "Physical Review Letters" paper published. Which, you know, if you're a physicist, you know, it's nice to have that. So that was I think in '67 or '68 with this paper, which then made it pretty easy to get the Ph.D.

Kapoor: Right. So certainly that must have been a very great experience for you in terms of your career.

Bauer: Oh, yeah. I mean, the intensity-- You know, the intensity of the, I mean, for the first time, I learned the pleasure of intense work. What you gain by being very intense. So it really transforms your brains.

You are, you know, you have access to many more things than you had before. You learn how to concentrate and also you're meeting people. At that time, you know, Feynman was teaching.

Kapoor: Right.

Bauer: And in fact, my mother came to see me in Caltech. We were at the cafeteria and I told my mother, "This is a Nobel Prize winner there." And so my mother constantly looked at him. And finally, he came to our table and said, "Why are you looking at me?"

<laughter>

Bauer: It was a fantastic experience. I mean, you know, all these guys. And you had people like Mössbauer who was a German Nobel Prize winner. And naturally, in Europe, you could not meet him, but there you could meet him. And then the other thing was that you had all these graduate students, you know, coming to the lectures barefoot with maybe cut-off jeans.

Kapoor: Right.

Bauer: And in the middle of a lecture from Feynman, students would stop him and say, "Hey, what you are saying is not clear. Can you start-- can you start again?"

Kapoor: <laughs>

Bauer: And then the professor would actually stop and start again.

Kapoor: It's very different than in Europe.

Bauer: Something completely different from Europe.

Kapoor: Right.

Bauer: And I'm sure from where you came from.

Kapoor: Yes. Exactly.

Bauer: I mean, it's a totally, totally new experience. So that means you were really motivated and, you know, learn the meaning of [being motivated]…

Kapoor: So much more informal in the sense of--

Bauer: Yeah.

Kapoor: Yes. So I notice then your first professional job was at the Hughes Research Lab.

Bauer: Yes.

Kapoor: So is that correct? So you went from Caltech to--

Bauer: Yes. I, you know, the first thing I think I had a choice where to go, at that time it was a lucky time that they just don't have now, that as soon as you had a degree, I mean, you could-- You know, if you didn't have five or six or ten jobs, I mean, you were really no good. So, I mean, you could really have a choice at that time.

Kapoor: Right.

Bauer: So I had a choice from Bell Labs and then Hughes Research Lab because that was a classical--

Kapoor: Right.

Bauer: ---place to go for a Caltech graduate. And then I went to New Jersey at that time [to visit Bell Labs]. And I don't know if you were there then, but there was - tremendous pollution. On freeways, you were driving on freeways, there were clouds of sulfuric acid going through. And so versus Malibu, you know, so.

Kapoor: I was in this country in '67, so yes, I remember.

Bauer: Yeah, it was--

Kapoor: Los Angeles was terrible.

Bauer: Oh, much worse than now.

Kapoor: Yes.

Bauer: Yeah, much worse than now. So the choice was relatively easily made. There was a little note which said, it may not necessarily be in Malibu. It may be in another division that you're going to get hired. And finally, I wound up in Newport Beach on Superior Avenue, which was also very nice. And that's where this-- So the reason they-- Bob Bower was the guy who hired me-- wanted me is because I had experience with plasmas and ion sources, there was a new division formed to use ion implantation to make CMOS.

Kapoor: Right.

Bauer: To do the P-well and threshold shifts, which is something that could not be done with conventional diffusion methods, because the doping was not accurate enough so you could not control thresholds. So naturally, I knew what an ion source was, and Bob Bower wanted me to generate first Boron, and then other ions, like Phosphorus or Arsenic and so forth. And it was very easy for me to do that. And so I worked on this accelerator you know, from the source down. And then basically, it was just a mass separator with a scanning and electronics to be able to implant wafers uniformly. And very soon, then, you could see that the doping was going to be accurate by a couple percent, because you were just counting charge and time, and so you knew the dose. I mean, the current and time, and you could-- you knew the dose. So this was very successful, although I mean, the production engineers, and some academic people, said that we were going to destroy the silicon. And then there was, I had to do an

experiment in which I had a wafer and I did some square, you know, checkerboard mask in which in some areas were implanted, some areas were not implanted. And my idea was to see, okay, then you were measuring the difference of threshold. Not the absolute value.

Kapoor: Right.

Bauer: And you could show that the difference of voltage was very, very good. I mean, it was in a one percent range. But the absolute value of the threshold went all over the place. So I said to the guy, the production guy, "Look, the fact that the absolute values are all over the place, that's your problem. What I'm doing is shifting. And you saw that the shift is perfect." So that stopped the criticism, because it was obvious that there was another problem, which was solved eventually.

Kapoor: Right.

Bauer: But that also attracted me to the fact that production is an area maybe where I could be useful, because I could see a lot of things looking at production which I didn't like, and thought should be done better. And since I felt that I'd lost anyway the real research angle that was in university, why don't I go in production and not be in between. So either I go back to a university or I go in production. And also if you remember, at that time, the people who could produce were really-- could progress very quickly in management.

Kapoor: Exactly. Exactly.

Bauer: Because nobody could produce.

Kapoor: Exactly.

Bauer: That was the key.

Kapoor: Yes. So it was a natural, especially with your background in physics and plasma physics, too, and the ion implantation and becoming part of the production. So there was such a--

Bauer: Right. So I understood that, you know, that the semiconductor at that time, it was clear the semiconductor was going to take off. Already, I mean, it was '68, '69, but you could see the tremendous progress. And so by working on ion implantation, I managed to naturally work on all aspects of silicon after that.

Kapoor: Right. And I think you stated that it could have been that you were the first person to use that for CMOS ion implantation.

Bauer: Yeah, I think our group, I think the group of Newport Beach was the first group to really put that to work and to do thousands of wafers for that division of Newport Beach to the point then they started to do the first application, as you remember, it was watches already at that time.

Kapoor: Right.

Bauer: And made in '71, '72. But the problem was, then, that this division started to make commercial sales and a relative large amount of sales, like $20 million. And then the system guys who really had paid the bill for Newport Beach for a long time because they wanted to be able to get two wafers of this and three wafers of that could not get access to it anymore. So there was a conflict on that because the system guy who wanted to have access to Newport Beach and they couldn't anymore because it was full-- So then we could see that Newport Beach was going to be scaled down again to serve the system division. So most of us went to Silicon Valley at that time.

Kapoor: Okay. So naturally, then, the next company, Eurosil, Intersil. So you- worked in Santa Clara.

Bauer: Yeah. So then I came for the first time to Silicon Valley. And then I was approached by Jean Hoerni, one of the founders of Fairchild.

Kapoor: I was going to ask you.

Bauer: Yeah.

Kapoor: That's a whole-- how did you know him?

Bauer: So I mean, I think, when did I meet him first? I think I must have met him in Switzerland. Maybe my father knew of him, and I think he knew of me, that I was working at Hughes. So somehow--

Kapoor: I see.

Bauer: We both wanted to get in touch, and so we talked. And then there was no knowledge of ion implantation at Intersil. So then he convinced me to join Intersil, which I did in I think the summer of '72 or something like that.

Kapoor: Yes. I first met him in 1972 as well, when he convinced me to go to Eurosil and to Munich. So it's very interesting. <laughs>

Bauer: Yeah, he-- Yeah, so we must have come at the same time then. I was hired to, in the middle of '72, to mostly to look at equipment and, you know, transfer the technology to Munich where the production was going to be.

Kapoor: Right.

Bauer: But at the same time, then, since I was a process engineer, I was asked to also help the groups, the other groups [of Intersil]. And this was the extraordinary situation of companies at that time. I don't know if you remember, but when you went in a fab at that time, you could have wafers which were CMOS metal gate. Some of them were CMOS silicon gate. You could have P channel silicon gate, and N channel silicon gate. You could have bipolar digital and bipolar linear. And I remember being asked by specialists, "We don't actually know how this wafer functions, can you do something?" So I asked for an angle lap and discovered that, you know, the bottom layers were bipolar linear and then the top was

CMOS digital watch circuitry. So naturally, it didn't work. So I mean, you had a tremendous diversity and possibility of confusion, but a lot of creativity also.

Kapoor: Yes. So when you were at Intersil, was Eurosil already in existence?

Bauer: Yes. Eurosil I think was established probably in '71 or something like that.

Kapoor: Okay.

Bauer: And I don't know, what was your first function there?

Kapoor: So I guess what I heard was that Eurosil was established because of the watch industry's emphasis on electronic watches, because of the trend for electronic watches.

Bauer: Yes. From Japan, yeah. There was, yeah. I mean, Jean Hoerni kept in touch, naturally, with Switzerland and did talk to the watch industry key people, and there was some anxiety as to how they could get that technology as fast as possible, because it was clear the Japanese were going to eat their lunch if they didn't do something.

Kapoor: Right.

Bauer: So Jean, I think, started to work in the '70, '71. And I think he got together first engineering people like Ed Tang and others, design people, and then started to make design at Intersil for European customers. And then decided to create a production at Eurosil for these customers in Europe. And I was hired as the wafer manager then, to start organizing the construction and then the transfer of technology.

Kapoor: Right. I was actually working at AMI and then I interviewed with Jean who asked me whether I wanted to go to Munich. So that's, I didn't join Intersil. I joined Eurosil directly. I came back to Intersil later, after I came--

Bauer: After.

Kapoor: Yeah. But it was a fascinating experience for me in Eurosil. And that's where I met Jean.

Bauer: Yeah, yeah. I mean, that's one thing, I think a very good part of this interview is to, you have to go back and figure out why you did certain things. And I think one thing that I didn't mention when I was a kid, is I enjoyed tremendously cubs. You know, the cubs? Or the Scouts?

Kapoor: Yes.

Bauer: And then after that, when I went to this boarding school, it was also very much a team spirit. I mean, we did something together, sports and education and so forth. So this was a very strong thing that I did not realize influenced me. And then when I started at Eurosil, everybody said that you can only do semiconductor in California. And that always shocked me. And I said, "If you have a good team, a good team of people and you work well together, you can do it anywhere."

Kapoor: Yes.

Bauer: And that was one of the motivations that we did that.

Kapoor: Right. So going back, I forgot to ask you about your interest in sports. In Switzerland and in Paris and U.S., did you play any sports?

Bauer: My parents were very intellectual, so they didn't have sport at all. And again, I think when I started to learn about sport was in this boarding school. Again, I was trying to say, they said, "Why are you not doing any sport?" And I said, "It's genetics."

Kapoor: <laughs>

Bauer: And they said, "Okay. Forget that. Okay, what sport do you want? You are tall? Okay, you are gonna do-- you're gonna do volleyball."

Kapoor: Right.

Bauer: So then pretty quick, I became captain of the volleyball team and things like that. So that's, again, I think that's when this team spirit came in. And I think that drove most of my life, the pleasure of taking something that's not finished and getting young people and all kind of people together. And okay, we're gonna make this work. You know, and this, this I think was a very high pleasure for me at Eurosil in particular.

Kapoor: Yes. Very good. So at Eurosil, you were managing the wafer fabrication?

Bauer: So I started to be wafer fab manager. And then there was a phenomenon which happened, which was all of the ex-pats from California wanted to go back to California. So all of the senior guys progressively left.

Kapoor: Like Maurice Chidlow.

Bauer: Which was great, because then I could quickly take their place. But it wasn't that good, in a sense that I did not get a very good training, you know, for because I was good in manufacturing, but I had very marginal training in what we call now product engineering, product definition, product marketing. All these kind of skills which were developed, I think, a lot during the seventies, eighties [in California] with people like John Carey, co-founder of AMD and at other places, where instead of just talking about technology, you started to focus about what is a product? What makes this product so much better or (like) Linear Technology or these other people who could sell a product, you know, ten times more than the cost?

Kapoor: Right.

Bauer: This was part of education I had not received, but I-- So I became president of--

Kapoor: So I was going to ask--

Bauer: Yeah.

Kapoor: Bob Freund who used to be the president--

Bauer: Bob Freund was for a while was president. I was reporting to him. And then he after four or five years, then he decided also to move back to California. And then the new owners, which were this company, a German company named Diehl, promoted me to be the president of the company. And so that was another two or three years, which I had, you know, an interesting time. So we went from a fab-- one fab in one area of Munich, and then we built another fab in Munich, and in that respect, then, I asked Bob Freund to introduce me to Gordon Moore to be able to talk to Gordon as far as concepts of new fab. So I think that was '72 [actually '79 or '80]. So Gordon said, "Okay. Why don't you come?" And so I went to the Bowers Avenue Intel facility. I think it was fab number two.

Kapoor: Yes.

Bauer: And Gordon received me as a very kind person. I mean, a very, very amazing person. I mean, I just saw him for a few hours, but I think this contact was great. And he said, "Okay, I'll show you everything with the condition that when you go to Japan--" Because I had also some meetings in Japan. "You tell me everything that's new in Japan." Which I did. So I wrote everything that I had seen. And so that was an interaction I had. We also had a few years before Eurosil was bought [other Intel contacts]. I think Jean Hoerni talked to Intel to see if Intel was interested [to buy Eurosil].

Kapoor: I see.

Bauer: And so we had Andy Grove-- I don't know if you remember-- but Andy Grove came to Munich.

Kapoor: I didn't know that. I see.

Bauer: And he looked at what we were testing, the yield we had. And he said, "You know, that's really impressive what you guys did. But it's all consumer stuff, and we-- they failed, you know."

Kapoor: Yes, in the watches.

Bauer: They failed completely at Microma, so they didn't want to touch that, right.

Kapoor: Yes.

Bauer: So that was it.--

Kapoor: Right. <laughs>

Bauer: Basically. But there were a lot of compliments from him in terms of yields and so forth.

Kapoor: So I wanted to ask you something. For some reason, I remember from way back when, there was mention that maybe your father was as a board member of Omega Watches or something? Is that true?

Bauer: My father was on the, what's it called? It's some sort of Swiss watch umbrella organization. I don't know if that's the right word. My father was President of the Swiss Watch Federation.

Kapoor: I see.

Bauer: So it's basically an association which worked on things like tariffs between the various countries, control of quality, publicity for Swiss watches, special events, and also worked a lot on antitrust litigation. There was an antitrust proceeding which started in the U.S. against Swiss watchmaking. So my father was active in that, and I think obtained more or less favorable decisions.

Kapoor: So that explains a little bit more of the connection between him and how he approached Jean for the--

Bauer: Yeah. No, I mean, there was definitely some contact there.

Kapoor: Right.

Bauer: I mean, yeah, Jean certainly knew my father. Probably my father told him that he had a son in California working on that.

Kapoor: Right.

Bauer: And that's probably-- I don't know exactly how, but I'm sure it was in Switzerland because of that. You're right.

Kapoor: Right, right. Very nice. So after Eurosil was sold to Diehl, you came back to California?

Bauer: Yeah, so then I think I'd like to say that if you have been in California for five years or ten years, it's like you almost had a spring attached to you.

Kapoor: Right. <laughs>

Bauer: You can go out for a while, but then you are gonna be pulled back.

Kapoor: Right.

Bauer: And so yeah. And then people contact you every so often, "When are you coming back?" So finally, I decided to. And Jean wanted to start a new company with me, which was this company, Telmos. So then I think that was in, yeah, '82 I came back to California being CEO of Telmos then.

Kapoor: Right. So Paul Nance, did he--

Bauer: Yeah. Paul Nance, in Telmos you had, let's see, Paul Nance, Steve Nelson. Who else? We had other people which I don’t remember from Eurosil-Intersil who came back to Telmos.

Kapoor: Right.

Bauer: And then I, at that time, as investors, I think you had Eugene Kleiner. Arthur Rock. So I met Arthur Rock at that time. It was a unique experience, because he had a small office in San Francisco. It was maybe 500 square feet at most, and that was sort of the experience in which he put you on a couch almost, and you know, talked to you and decide what kind of guy you are and so forth, and then decided to invest. I also raised money in London, which was just a very different, interesting experience. But in the end, Telmos was not successful. I think there was, we had Jean who was not an easy person to deal with.

Kapoor: Of course.

Bauer: It was well known. I think the biggest problem was he had a mood which would shift very quickly. And so it was difficult to have a logical discussion. And then we had different views on to what products we should do. We both felt that we could not be in the microprocessor area. That's already gone by with too much competition. But we wanted to take care of the interface around the microprocessor.

Kapoor: I do remember his mentioning high voltage.

Bauer: And so there was one which was high voltage and one which was A to D-- I mean analog.

Kapoor: Yes, right.

Bauer: And since, you know, we had discussion. Yeah, there was a discussion early in Telmos with Bob Dobkin and Bob Swanson. Bob Dobkin and Swanson saw that we had started Telmos, and before them, a year before, six months before, and they offered to Jean, why don't we take half of your company? You give us half of the company and we make one company. So with that being 50 percent of Linear Technology, right.

Kapoor: Oh, wow.

Bauer: But and this is-- this is where, you know, the recommendation for the young people, and I think that was a typical case of not looking enough at your own strengths and the strengths of the person making you an offer.

Kapoor: Right.

Bauer: And also, obviously, if we had made this deal, it would have been, you know, a fantastic deal for all of us financially. But there was Jean, I think, had his ego and second, myself, also, I was president of Telmos and obviously, I would not be president of Linear Technology/Telmos. It would be Bob Swanson. So there was, you know, very weak reasons why we didn't do that. And I think that was one of the problems at Telmos. The second is that Jean wanted to do high voltage and I wanted to do A to D converters, which I think was much easier to do.

Kapoor: Right. I still remember, he was saying that when I was still in Munich. He was talking <laughs> about SOS and also the high voltage.

Bauer: Yeah, yeah.

Kapoor: Those were the two things.

Bauer: But, you know, I mean, eventually it did happen. I mean, this high voltage circuitry, you can see it in every big foundry that you see [ph?] and so forth, they all have a high 70 volts, 80 volts. It's no problem with some people having 500 volts.

Kapoor: Right.

Bauer: But at that time, you know, there were simple problems. Like, you come down with your probe cards [on the high voltage wafers]. Steve Nelson was, you know, afraid because when the probe card came down sometimes, you would get a spark flying.

Kapoor: Yes. <laughs>

Bauer: And the plastic of the package would melt and, you know. So there were all kinds of issues like that which I felt in a startup you cannot solve.

Kapoor: Right.

Bauer: So then there was a transition in which the board decided I could not be the CEO anymore. And I then, I quit and then joined IDT-- I kept in touch with Maurice Chidlow, who had been at Eurosil.

Kapoor: Right. And he had gone to IDT?

Bauer: And gone to IDT to take over IDT operations with John Carey as CEO, from the original founders….

Kapoor: Yes.

Bauer: Frank Lee, Norm Godinho. These guys, right.

Kapoor: Right.

Bauer: But John Carey had joined and John brought, I mean, he was a fantastic teacher in terms of what I was missing: product engineering, product marketing, you know, these are all aspects of how you define products which will win in the market. So it was a fantastic experience at IDT to retrain, basically, on that line.

Kapoor: Right. So you were there for three years.

Bauer: I was-- so then I was there for four years. Four years at IDT.

Kapoor: Okay.

Bauer: Then I was wafer fab manager of-- I was given a couple small product lines, including I was going to try to do again some linear stuff with very advanced CMOS. I thought there was some potential there. But John wanted me most of all to run fab one, because he knew I was a good fab manager. And Maurice Chidlow then suddenly got very sick.

Kapoor: I heard that.

Bauer: And in fact died very quickly after that.

Kapoor: Yes, right.

Bauer: And so there was, so then my whole focus was to get fab one working full speed, because that was the only fab we had. And also running the R&D. You know, so we had two shifts of production and one shift of R&D, and while fab two was being built. So it was needed to get fab one to be to the utmost potential output so we could pay for research and for the construction of fab two. So during that time, I think we went from something like $30, $40 million to about $400 million sales.

Kapoor: Right. So by around this time, Jean also passed away.

Bauer: John Carey?

Kapoor: Jean Hoerni.

Bauer: No. Jean Hoerni. No, he-- I kept in touch-- I kept in touch with him, and he first he was living in Idaho, you know.

Kapoor: Yes.

Bauer: And but I think his house where he was, was at least at something like maybe 3000 feet elevation or higher. And then he was diagnosed <sic> with a blood cancer.

Kapoor: Right.

Bauer: Which basically, he could not oxygenate his blood well enough. So the first step, he refused to do any chemotherapy and decided to then move. I think he went and moved to Seattle close to the sea level.

Kapoor: Yes.

Bauer: And I kept in touch with him. And I think I talked to him maybe three weeks before he died. That must have been when? It was probably in the nineties that he died.

Kapoor: Yes, yes.

Bauer: '92, '93, something like that. [Jean died on Feb 13, 1997]

Kapoor: Yes. That's correct.

Bauer: After I left IDT.

Kapoor: Okay.

Bauer: And he was, as usual, you know, somewhat cynical, joking and, yeah. I mean, I think until the end he was exactly like Jean Hoerni always was.

Kapoor: Right. Right.

Bauer: A fantastic guy. I mean, he really impressed me very much, I mean, and despite the fact it was not easy to be working for him.

Kapoor: He was a fascinating person, absolutely.

Bauer: Yeah.

Kapoor: I went to his memorial service at Stanford Memorial Church.

Bauer: Okay.

Kapoor: And, you know, and Joe Rizzi and I think Gordon Moore also spoke.

Bauer: Yeah.

Kapoor: And then the mountain climber who had written the book, "Three Cups of Tea," who he worked with in Karakorum Range in Pakistan, spoke. About his experience of trekking with him in mountains and how he started a school.

Bauer: Who is that?

Kapoor: The mountain climber. I forget his name [editor's note: it was Greg Mortenson].

Bauer: Yeah, yeah. Oh, yeah. Yeah, no, I mean, that was, he had every time Jean had some, I think had some-- too much stress in his life, he would take off for three months and go through the [Karakorum Range]? Around the Himalayas, I mean you have a trek that you can do.

Kapoor: Yes, yes.

Bauer: And it stays at about 5000 or 6000 meters, but it's not actually the mountain, but--

Kapoor: Right.

Bauer: He'd never climbed, actually.

Kapoor: Right, right.

Bauer: There's some people who asked me recently whether Jean Hoerni had climbed 8000 meters. I said, "No, no, no. He liked to go in the Himalayas because he liked, I think, the Nepalese. He liked the people there. And he would--"

Kapoor: Yeah. And one of the schools was named after him.

Bauer: Right?

Kapoor: Yes.

Bauer: Yeah. But no, he was not really-- I mean, he was a very good how should I say-- a randonneur.

Kapoor: Right.

Bauer: But not a technical climber of 8000 meters.

Kapoor: Right. Was it similar in Switzerland? He would not climb, but--

Bauer: Yeah, I don't know. He could have done 4000 meters, I think, you know, easily. But 8000, no, I don't think so. No.

Kapoor: So, then after IDT, you started nChip?

Bauer: Yeah, I was approached by-- maybe another characteristic-- I like companies in which it's between tens of people to hundreds people. But when the company starts to be thousands of people, then it becomes a much more political environment where the team spirit is not the same and doesn't-- it's not exactly my cup of tea. So, then I was approached by nChip, which was a startup. The two guys who started it were Bruce McWilliams and David Tuckerman from Lawrence Livermore National Labs. Bruce has made many startups, including Tessera, which-- actually, that's the one where, I think, it was most successful. And nChip, and then we did SVISION together also. But Bruce was, I think, just a guy who got his PhD when he was 19 at Carnegie-Mellon. He was I think the youngest-- one of his award of youngest scientists in United States and was involved in a special project of the, at that that time, CIA for satellites and designing special optics for satellite cameras. Super bright person, very kind guy, very intelligent, and became more and more strategic in terms of his thinking. So, the interesting part of nChip was the fact that you could not do-- that was a time of RISC microprocessors, and even people like Roger Ross and others would not try to integrate the whole thing. They would cut it in pieces: you had the CPU; you had the floating-point units; and you had the cache. So microprocessor was four or five pieces, and then the problem was that you had too much parasitic capacitance and inductance, If you put these chips in various packages and put it on a PC board-- and so the idea was that you would take these chips bare, put them on a substrate, which had Aluminum interconnect embedded in very thick oxide, and in this thick oxide, you had some 75 ohm impedance. And then you had pads that you could-- then you bond these chips in very short bonds directly to the interconnect, and so, you put these chips close together and the whole thing into a package. All the high-speed communication was made in between chip on this substrate. The substrate would be costing 100 Dollars, but the customer, which was Sun Microsystem, would pay for a chipset. Instead of paying maybe-- at that time, it was pretty expensive-- 300 Dollars was

willing to pay 800 Dollars, because the speed went up by almost a factor of two with the chips [in the nCHIP package]. And so, we are talking about a very slow speed, but it was what-- you were talking about maybe 25 megahertz in packages, and maybe 60, 70 megahertz with that new package, so it was very interesting--

Kapoor: At various places, whether it was at Sun or, I think, Fujitsu, I dealt with Tessera and also nChip, I think, later on.

Bauer: Yeah, so this was an area: multichip modules, you remember, and it was fashionable, and it lasted a while until, finally, you could integrate everything in one microprocessor. It still exists now, but then it's more combination of different technologies, which are, for instance, A to D converters, or you have compound semiconductor function which are put together-- so this was very intense company. I was also responsible mostly for manufacturing, and then, we sold ourselves to Flextronics International, which was a good return for investors, but also possibility in terms of-- I was in business development in the end, especially for Europe, and managed to get Sofinnova Partners interested in the company, which was the last investor that we had before Flextronics. And they fixed the price and gave us another 10 million, so that, I think, helped us succeed to be bought by Flextronics. The other interesting thing was the relationship with DARPA, because Bruce and I would go very often to DARPA to get contracts from DARPA, which was a unique possibility, for non diluting funding, you would get 10 million. I think we got 10 million twice. And then, I always remember, that's when I really started to know how to write English correctly, because if you write proposal for DARPA, it has to be perfect. You cannot have something where you have English mistakes. And to see this agency with very young people-- and patriotic, energetic-- was really interesting-- very bright people. Not much experience in terms of--

Kapoor: Technical writing.

Bauer: Yeah, in business and industry, but fascinating organization.

Kapoor: So, you mentioned nChip and SVISION in the same--

Bauer: Yeah, I mentioned them in the same breath, because a lot of the people were the same, because as soon as Flextronics bought nChip, then Bruce stayed for a while at Flextronics. But we were interested to do a combination of technologies, and this was basically liquid crystal and silicon, and that was the beginning of microdisplays. Again, if I want to say something to young people: it's great to follow your dream; it's great to look at exciting technology, but you also have to look at the big picture. How are you gonna make this work-- who is gonna be your customers? Who is gonna buy it? And what exactly the product is-- these are consideration that, for too long in my life, I did not spend enough time on, which, as a venture capitalist now, I spend a lot of time on. <laughs> And so, SVISION was-- so we had very good people, people like Jake Vigil. I don't know if you know of him; he was more of a system guy. And then we started this operation for liquid crystal, because it was putting liquid crystal in silicon, basically. On the last CMOS layer [Aluminum], you put standard process of liquid crystal. Where can you have liquid crystal process on your silicon in the US: There aren't too many places anymore. It's only at Kent State in Ohio which has kept an expertise in liquid crystal. They do all kind of different technologies, and have very bright people. So, we selected a site close to Kent State, and then we hired a local guy named

John Erdmann-- very, very bright guy-- and we started manufacturing then for this to put liquid crystal on top of silicon. We're buying wafers from UMC, eight-inch wafers, and then doing all the liquid crystal processing on top of that and making some, basically, small display, which then you can mount on [flex interconnect] -- the only successful product was for Philips. They were doing rear-projection television, because you have a small engine, and with optics, you can project it onto a large screen [50 inches]. And then, the total thing naturally needs some depth. It's something like ten inches, and so you could do-- Philips produced, I think, 50,000 of these television with this rear-projection engine. But then, suddenly, the liquid crystal became also one or two meters large, and so this model-- but in the meantime, then the operation-- SVISION does not exist anymore, but the operation of SVISION in Ohio still exists now. It's called Hana Microdisplay Technology.

Kapoor: So that's the next phase of your career? So with Hana Microdisplay, what was your role in that?

Bauer: So my role was-- the problem at the end of the '90s was-- the middle of the '90s, you remember, that's when the internet took off. So if you were a hardware company and you did not meet your goals really well, they [VCs] were just going to drop you, because they could go right away put the money into some internet startup in '95, '96, '98. But I was adamant that I was gonna try to keep this operation going, because it's a wonderful operation. The quality of people was great. The product they were doing-- the technology was fine. So I found a Thai company named Hana Microelectronics, because one of my ex-sales manager of Eurosil, Hubert Meyer, joined that group, and then I talked to him. And he said, "Yeah, we are looking for operations in the United States that we could take over, and maybe we can take over this Microdisplay Technology if the investors don't want to do it anymore." And so, I managed to do that, to make this transition. We kept all of the people hired, and then, this operation continues now as an entity of Hana Microelectronics. It's 17 years old. I think it's doing 30 or 40 million, and basically, it's not a big operation, because the main operation is in Thailand and China. But they use it as a debugging of technology or introducing new technology into the fabrication, and John Erdmann is still there and a good friend of mine. [Luc's note: my role was to be an advisor to John Erdmann until Hana Microelectronics felt that John was ready to become the CEO].

Kapoor: So it seems like, around this time, you made a transition, so can you tell us--

Bauer: Maybe one thing in my career I should-- my wife at least tells me that I should've probably stayed in California and not do this back and forth. But I was attached to Europe and California, and so, always after something like 10 years or 20 years in one place or the other, I would move back. But at the end of the '90s, I decided it was maybe time to retire, so I went back to Switzerland in '99, 2000 [actually 2002-Luc]. And then, the main activity I had there was still with startups, and the state of Neuchâtel, where I was born, wanted to create an incubator. And so, they hired me as a consultant and board member to help start this incubator. So this is now an incubator which has about 40 different companies, and there is a flow in and out in two different locations. It was to try to look at high-tech companies-- not any kind of company-- high-technology company with a potential of growth and substantial added value. So this was sort of an exciting time to look at startup, evaluate startup, so that was part of my activities. I think the other part of my activities-- I had a couple other startup that I was helping with in life science-- one company doing very small nanoliter dispense system for pharmaceutical R&D equipment and now diagnostic equipment also; and so, that's the company I'm still on the board of. And then, almost by

accident, I started a private incubator business, because the problem was that, at the state incubator-- people were very pleased to be there, and they didn't want to move out, so there was absolutely nothing to try to-- and then, when we tried to kick them out, they said, "But where can we go? There is nothing like that." And it's true that a company which has, say, two or three million or five million of revenue cannot build its own building. It's just too small, and in that state of Neuchâtel, there was no really shared facility. It's exact same kind of business model. So then, with a few friends, what we did was buy some buildings which had been abandoned, it turns out, mostly by American companies who had come in Switzerland and then found it to be too expensive, and so, the headquarter decided to close it down, and since Americans like to go fast, then they were willing to drop the price to a very low level. So we looked for all these kind of facilities and bought a lot of-- finally, I think we have something like four facilities now, 200,000 square feet in which-- then, we have the same concept. We bring people in, and then we have a very strong team of services for everything: gas, air conditioning, electricity and all that. So it's all lined up when they come in. "What do you need? Okay, we'll build things for you," and then they move in, and they sign a five year lease. This is well known here, but it's still not very typical in Europe, so that's one of the things I did.

Kapoor: I also noticed that you were elected for three terms as an executive minister of government, you were saying, to the small village where you lived between 2002 and 2013. You were on the local village government. That must've been something interesting.

Bauer: Oh, yeah, in addition, that's a good point. Yeah, when I came back to Switzerland, there was a house that belonged to my family for some time. It was a vacation house in the mountains, 3,000 feet high, in the middle of nature, something like 100 acres or something. It was never used by any of my family as a house for the whole year, so I did put everything in it: air condition, insulation, so forth, and I moved in and then, for the first generation, lived there. And then, I was in this village, see what happens, and then pretty soon, I was asked to serve on the executive board of the village, which was elected-- so elective position. And they said, "Don't worry. It's a couple hours every two weeks," and actually, that's not true at all. But it was a way for me to get to know the people better and to see how they think and so forth, because I'd been for so long elsewhere that, when you go back, you are seen as most-- maybe okay, they know you, but why did you leave? This kind of thing. This was a way to say, okay, I'm willing to help, so then I was elected two or three times until I left.

Kapoor: So did they learn from you about the technology and sciences or something like that?

Bauer: No. I kept active in this area, because of all these various activities. I think the University of Neuchâtel is very strong. They have a lot of microtechnology, and also interfacing with Lausanne is now almost one university, so there is a lot of technical stuff. But I think what brought me back for the third time permanently, because now that's the third time I'm permanently in California, is because I met a very young guy named Aymeric Sallin, who founded NanoDimension and founded it in Switzerland. NanoDimensions is a venture capital fund, and the dedication was nanotechnology. We're gonna fund a company if it has nanotechnology content in it, whether it's life science or physical science. And so, Aymeric had heard that I just came back for about three months, heard that I was back. For sure, the people knew-- there was this old guy who just came back, and that he had a lot of experience, and he felt that he needed maybe some guy with grey hair to help him raise money. So then I agreed to join his

effort. That's the first time I helped a venture capital company form. So, it took him three and a half years to raise the first 45 million Euro. The person is incredibly consistent-- intense and persistent is what I wanted to say. And mostly, very interestingly-- he got money from what's called family offices, and the beauty of family offices is that you do not have to go through all the checklists of the pension funds and the institutional sources of money. Basically, you meet some people who are rich, and if you can appeal to their interest, whether it's clean tech or something like that-- they may have some very special interest—then they decide very quickly, you have a 50-50 chance to get five million or ten million. That's how he raised his first fund and the second fund. So, he first wanted to do that in Switzerland, but we could see that the number of deals in Switzerland, and Europe in general, is not that great. So pretty soon, we started to look for deals in California, and then it turned out that Aymeric met his current wife in California, and so now is living in Woodside, and the headquarters moved to California. And, as that happened, and also the second fund-- so now, we just finished a second fund at 150 million-- then it was felt that it was better that I would move back to California to help with-- so this represent about 50 percent of my activities at this time. Again, looking at deals, analyzing deals, and, I think, spending a lot more time than I did when I did my own startup on the product aspect, the IP-- I became a specialist of IP-- the marketing aspect; really see what's unique with this product, how is it gonna be, and, naturally, how is it gonna be ramped up.

Kapoor: So these are still in the nanotechnology domain?

Bauer: Yeah. We have several startups, like Crocus Technology is one, which is local, doing magnetic memories and magnetic sensors. The biggest segment of our product line is gonna be different kind of magnetic sensors and also switches to replace reed relays, among other things. We have a company named SBA Materials, which is also a local company which is doing low-K dielectric material, which is becoming critical at the seven nanometer node. There are several issues with the seven nanometer node. The RC constant is not good, because of the R, 'cause there is a lot of problem with the single damascene and dual damascene processes. But we don't have time to go through the processes, but you need to improve the R, so the company can do that, and also the C by just low-K dielectric. So this is a dielectric, basically SiO2, but there is a template creation which makes holes in it very, very uniformly, two nanometers diameter spread all over, which has very good mechanical property. So this is something that I'm on the board of, and we have now corporate investors. We have Samsung and Intel and Air Liquide just recently. So this afternoon, in fact, I'm going to see a board member there. So this is one, and in life science, we have a series of startups, mostly starting with nanoparticles in delivery of well-known chemicals that you use to kill cancer cells. But you encapsulate them, and you put ligand on it, which will attach to cancer cells, and the capsule only opens when it's inside the cancer cell. So you have much less side effects, and you can use, effectively, smaller dose, and it's going where the cancer is. There are several startups there, and we invested in a couple.

Kapoor: Recently, while I was driving, I heard an interview with somebody in Israel about NanoDimension. Was it a different company or--

Bauer: Which company?

Kapoor: They call themselves NanoDimension, actually, and it's an Israeli company. So it has no relationship <inaudible>

Bauer: Our name is NanoDimension. So again, there are many applications in life science. We're involved, for instance, with Twist. I don't know if you heard about Twist. Twist Bioscience, they are producing oligo-DNA-- part of DNA chains, and they have a process now that's really fast. And so, the idea is to-- for instance, you have people developing bacterias to make beers or to make all kind of chemicals, and so you can-- now with CRISPR CAS9, you can cut the bacteria genome where you want to very accurately and take some of these special DNA elements made by companies like Twist and insert them and see what's the impact is of it. But you can do it now in a way that's-- there is another company that we founded named Muse who can put something like hundreds of different DNA in the same bacteria-- bits to accelerate the optimization of this bacteria. So there are tremendous things happening in this world, which for me is completely new but very interesting.

<crew talk>

Bauer: So this is fascinating work, and I'm not even sure-- I come every two weeks here, and so, it's either to talk to companies, and then, when we eventually invest in them, then I'm on the board of these companies.

Kapoor: So, as you mentioned, 50 percent of your activity is involved with NanoDimension.

Bauer: Yep.

Kapoor: Venture capital, but you also mentioned that you spend a lot of time mentoring new people, young people, the startups.

Bauer: Yeah, so the one which is most interesting now is a company named Invenios, which is in Santa Barbara, or Optilux-- that's part of the same company. And this company is completely-- that I never knew about, but they have a unique capability of using lasers to attach any kind of glass or any kind of metal to glass, or different materials also to different metals which usually are not welded together by some various-- either UV or infrared laser with very selected pulse repetition rates. And they have a bonding that's not-- it's where you have part of the material of one side goes inside the other. It's really a cross-diffusion, and they can do that [at low temperature]. So, the application that I'm working on is liquid lens, which I started some time ago in France, which was a company named Varioptic, and Varioptic gave a license to this Optilux company, which is also Invenios. And for the liquids-- so the general concept of the liquid lens, and whereby Varioptic was doing one element at a time, like the small VARTA or batteries for hearing aid, which is made not batch-wise. This company in Santa Barbara can take 300 millimeter glass wafers and do hundreds of liquid lens at once. So that's a project that I'm involved with, and again, you are talking about-- and the liquid lens is a huge advantage. One, it's not just the way Optilux is doing it. If you look at the cost of each unit, it's 20 cents, and the selling price can be three dollars or something like that. It has the ability to do autofocus, because basically, you have a cone, and then the liquid moves up and down the cone, depending on the voltage. So either in the cone the polar fluid moves like this or like this, so you can do autofocus, and then, depending on what voltage-- the cone

is divided in four quarters, and so you can tilt the bubble this way or that way, and so you can do what's called optical image stabilization. When people have hands which tremble a little bit, you can have gyros which detect the movements and feedback a correction, and so the bubble will countermove compared to what your hands are doing. So you can take pictures with relatively long exposure-- in dark areas, because of this motion compensation-- and then you can also do zoom. The element is seven millimeter or six millimeter diameter, one point two millimeter thick or something like that. So it has applications in-- you spend hundreds of dollars for it if it's for inspection of the body [endoscopy], you can go through all the price ranges for camera modules. It has application for automotive, because it's also very vibration resistant. The way the people have been doing it now is to move, for instance, two lens with voice-coil systems, but the voice-coil is a mechanical part, and when you have vibration, they break, so it's not reliable. So, for many applications, this system is gonna be successful, so we have all kind of customers: automobile, big Asian companies for mobile phone and so forth. And so it's, again, a situation in which-- it's like an old book, going in and seeing some bright, young guys, who don't know how to produce. And it's very easy. There are ten steps of production. If you talk about semiconductor, there's 600 steps, and this-- so, it's incredibly simple. But still, people stumble on-- and it's just common sense, some of it.

Kapoor: This is really fascinating. We wanted to transition to the next set of questions. What do you think is the next big challenge for the technology industry? This can encompass anything from macroelectronics--

Bauer: Yeah, I said about that-- I think it was excellent. This exercise that I had to go through to come here was really good to start thinking a little bit longterm and in new ways. I think the biggest thing I see is mobility, especially, naturally-- but at Tesla, because I was fascinated by the concept. And I have solar panels on my house, so the whole thing to me appeals a lot, but then you hear that this company like Tesla or Google is doing in this--

Kapoor: Or Apple.

Bauer: These cars which are now independent from drivers, and I think this has enormous consequences-- even difficult to understand all of the consequences. But it starts with-- okay, if you're getting older, then okay, this not gonna be a big problem to continue to have a car, because it's gonna be able to drive. That's one selfish aspect. The other aspect is: do you need to own a car? Or maybe you are just gonna ask for a car to come in front of your house <inaudible>

Kapoor: Like Uber or something.

Bauer: But then, if you don't own the car, how are insurance companies going to be impacted, and are they gonna insure the driver? No, there is no driver. This, as I said, open all kind of doors to do new things, including rapid transit system. Do you need really big rapid transit system if you can have that? Do you need to do very, very expensive infrastructure or not, and what for? So I think this is incredible challenge. I think--

Kapoor: In that sense, also, service with the drones, with the degree of privacy--

Bauer: Yeah, I think there's all kind of aspects that's gonna impact life of people in ways that we still don't understand.

Kapoor: And that's only talking about within the Earth. We're not even talking about space travel.

Bauer: Naturally, space travel would be another thing. I was always fascinated with that, but then you have-- the only issue is enormous amount of energy that you still need to do. So until we have energy efficiency, that's gonna be a problem. But the enormous amount of energy we're wasting on the ground could be remedied by some clever evolution in the area of automated mobility, which means you also don't lose that much freedom. We are not tied to very rigid rapid transit systems, so to me, that's a fascinating thing. And then, maybe the other-- but I think that's the biggest new thing I see. As far as computers, I think it's clear that it's becoming completely decentralized, attached with application which is close to each person and spread out, if we could just be everywhere, but not centralized and in which more and more computer resources are going to be trying to find out what you need and what you want. But I think the profound transformation is-- I did not see that right away, but after thinking about it, I think the automated ability to move is something that's very significant.

Kapoor: Looking at it as a challenge, what problem do you think that tech industry can solve for society in the future?

Bauer: What problem can science solve? I think all that I can see, as I mentioned before-- I think health is a big, big issue, both the quality of life, improved health, and also the cost of-- how do you improve the cost of health? But in all the startups that are happening now, there are explosion, really, of startups in that area. That's one of the big areas. Energy efficiency-- the biggest problem you have now is, I think, storage of energy, because in Europe, you have all of the wind power now and solar power. Sometime in Bavaria it's more than 50 percent; sixty percent of the power is now generated clean. And so they have to shut down the gas or oil [electricity generating plant], and then they are constructing a new power generation system, which is a gas based system that's preheated, ready to go from zero to a thousand megawatts in 15 minutes [when the sun or wind die down]. But this is hugely-- or so-- wasteful, just because we do not have energy storage. So now, in Europe, you have part of this storage is taken care of, because some of the German electricity goes through Switzerland, and then it pumps water up the mountain dams. So it's not a solution that's valid for-- so I think the storage of energy is huge-- large amount and also small amount for-- when you have solar panels, you may want to optimize your cost of power, or you may want to be-- as a back-up, or you may want to be completely independent of the net. We are looking also, at Nanodimension, at several solutions for home storage, and Tesla is making a big push in this area. It's not clear that lithium ion batteries are best, because it's pretty high resistance, but then the other solution is lead-acid batteries. You need to have exhaust in your garage to get the gas out of-- so that's not very good. But energy storage is a big one.

Kapoor: So related to the future, how do you think the technology jobs will change in the future? We're used to graduating from college, going to the job and, so there's a certain change already on social media, the jobs are very different than what we were used to.

Bauer: I think the big difference is that, I think, you and me started when technology meant technology. You were gonna work in specific areas and work only on that. I think, if you are now getting in technology, you really have to understand, as I said before, not only the technology, but what product you are going to make; so the product engineering part, the product marketing part, and I think lately, I see more and more that the design part is becoming very big. And in a way, it was a weakness in the United States, and I think now it's changing-- with people like Apple and others, people like Tesla-- the car is beautiful-- and people need that. You're not gonna buy a product only on technology; you have to buy it on something else. So it's functionality, which are the attractions of the product-- why you need the product-- and also the design. I think that's where the young engineer has to be both trained, but also, he has to understand, then if you are advising him-- we have to advise them that, okay, they have to follow their dream. They should always do that, but at least understand that the dream maybe can be done-- if it's a product like a software product, can be done in Silicon Valley, but maybe not so well. So, you have to go to the areas where you can find people who are gonna help you and seize that as a whole thing, just not technology only. Not like, oh, if you like manufacturing, then you have to be ready to go to Taiwan or go to China, and you cannot say, "I'm gonna do in Alabama some mechanical manufacturing." You have to understand. That's something that, when I was young, I did not accept. I would say, "Okay, that's my dream; I'm gonna do it any way I want," but that doesn't make any sense, right? Now, certainly, it doesn't make any sense.

Kapoor: Of course, you've already answered a part of the question: what advice would you give to a young person just starting out on their career?

Bauer: Again, I think you have to realize the competition in the world is intense, and it's getting even more intense, so you have to be intense. That means you have to learn all the time. You have to work enormously, but work smart. Decide that, if you like cheap, high-volume manufacturing, then you can't stay here. You have to go somewhere else, and you have to accept that. In Singapore, well, that's-- if it's creative new products, then probably Silicon Valley is one. You also have to realize that Silicon Valley's really unique. Everybody has been trying to do the same thing, and with mixed success, and so again, if you want to do something made in Silicon Valley, maybe you have to be in Silicon Valley. So it's not compromising on your dream; it's making sure that you prepare a plan-- that your dream can succeed with the most chances-- and then work a lot and all the other things. Learn a lot and so forth.

Kapoor: Thank you very much. Any other closing comments you'd like to make?

Bauer: No, I think this idea, as I said in the middle of the talk, I think, is very good. I like the idea to be able to talk about one's experience, and it forces me a little bit to recap what I did and what I want to do in the years I still have. So I thank you very much for the opportunity to do that. I think it's wonderful that I was able to recall some old friends and some exciting times in California.

Kapoor: It was our privilege to have you here. Thank you very much.

Bauer: Thank you.

END OF INTERVIEW

