Oral History of Takashi Mimura

Interviewed by:
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Fairbairn: Okay, we are here today with Takahashi Mimura.

Mimura: Takashi. (*Translator: Takashi-san*) (*Fairbairn: Taka?)* Takashi. (*Translator: Takashi.)*

Fairbairn: Takashi Mimura? And it is June 20, 2016 and we are at the New Otani Hotel in Tokyo Japan, and we're here to record the story and background of Mimura-san's career. And we are delighted to have you here, thank you. So I see that you have provided some response to our, some written response to our questions that we had sent ahead and I very much appreciate that. But I would like to go through that information and perhaps expand on it as we as we discuss for the video. Okay? So as we talk about the careers of these important engineers and scientists, we often find it helpful to learn something about their early upbringing and family environment and what influences or not those might have had on their career and career direction. So please describe for us where and when you were born and a little bit about your family's situation in terms of your father and mother and their employment or not and so forth.

Mimura: I was born in Osaka in 1944 and grew up at Kobe, and I have two brothers. My father's occupation was designer, designer of women's dresses and he managed a small sewing factory.

Fairbairn: Did either of your brothers pursue a technical career such as yourself?

Mimura: No, no. One is a banker and the other is a tourist company.

Fairbairn: So your mother was, took care of the family is that correct?

{*Mimura: Yeah*}

Fairbairn: Did you ever become interested or help your father in his business?

Mimura: No directly, but my father used to read about fashion related books and he tried to catch up with new trends and new technologies.

Translator: So when I decided to join an engineering company, Fujitsu, and he was very much glad that I selected that company.

Fairbairn: So you grew up in the post war time, was it very difficult childhood? Or was there?

Mimura: I do not remember.

Fairbairn: So you went through a normal Japanese education? *(Mimura: Yes, Yes)* Did your father go to the university or your mother? Had either of them attended university before?

Mimura:Ah. No, they don't.

Fairbairn: So you say in here that you actually didn't become interested in engineering until after school time. So when you were attending school did you always intend to go to university, was that in your mind that you would pursue a higher education?

Mimura: So when I was little I was already interested in science in general.

Translator: So when I was little I was already interested in science in general.

Mimura: My grandmother lived in Okayama Prefecture and during my primary school days every summer I went there. And I spent most of time collecting insects and playing with them. So I was very much interested in natural science.

Translator: My grandfather lived in Okayama City and during my primary school days every summer I went there. And I spent most of time collecting insects and playing with them. So I was very much interested in natural science.

Mimura: I want to be Fabre. Fabre, French.

Translator: French insect scholar who studied.

Fairbairn: What, so you decided to go to University, you went to Osaka?

Mimura: University? So for the bachelor course I went to Kwansei Gakuin University.

Mimura: in Nishinomiya, Hyogo, Japan.

Fairbairn: And what did you study there, did you study science there?

Mimura: Yes, physics.

Fairbairn: Physics. And then you decided to go to graduate school as well?

Mimura: I went to Osaka University graduate course, and then I studied there I studied semiconductors.

Fairbairn: Okay.

Mimura/Translator: Solid state physics.

Fairbairn: Okay, what year did you enter Osaka? What year?

Mimura: 1968.

Mimura: And I graduated in 1970.

Fairbairn: With a PhD?

Mimura: With a master's degree.

Fairbairn: And did you go on to pursue a PhD at that point or that was later?

Mimura: Later.

Fairbairn: Okay. So you were studying metallurgy, what were you studying in your graduate work?

Mimura: Semiconductor, Optical characteristics of semiconductors.

Fairbairn: So you graduated in 1970, and what did you do at that point?

Mimura: I joined a company, Fujitsu in 1970 right after I graduated from the university.

Fairbairn: You joined Fujitsu in 1970? *{Mimura: Yeah}* What were your initial positions there? You said here in 1975 you-

Mimura: Technical stuff, Technical stuff. Yeah.

Fairbairn: I'm sorry? Technical stuff. And you continued to work on semiconductors *{Mimura: Semi-conductors yes.}* Is it research, it was not product focused or?

Mimura: It was research.

Fairbairn: So tell me what was the state of semi-conductor technology and products in Fujitsu at that time? They later became very powerful in the semiconductor industry, were they already well along? What was the, what was the focus of Fujitsu at the time in terms of semiconductors?

Mimura: So of course they had a line for digital LSI, but what I belonged to was the microwave department that is working on the high power transistors.

Fairbairn: Did Fujitsu at the time realize the importance of semiconductors and were they investing heavily in that technology at that time?

Mimura: Yeah, because Fujitsu was manufacturing microwave connectivity devices so they were very much interested.

Fairbairn: So in 1975 you were assigned to the Fujitsu Laboratories, based in Kawasaki. What was the nature of your assignment and what, what was the task you were given at the time?

Mimura: Back then they were using silicon devices for their LSI. However, Fujitsu had a computing business unit as well and they needed higher performance semiconductors. Using gallium arsenide they wanted to create a compound semiconductor and they wanted to use that so MOSFET and so on. And assignment for me was to study on the possibility in that area.

Fairbairn: What were the technical roadblocks to using gallium arsenide at that time in the computing systems? What problems did you have to overcome?

Mimura: Gallium arsenide MOSFET didn't work back then.

Mimura: So that leads to my research on HEMT FET

Fairbairn: Before we get to the HEMT, can we talk a little about gallium arsenide? I know that wasn't your, but you worked a long time in that. So gallium arsenide was originally pursued because it had potentially some significant speed advantages correct? But it has never become a widespread technology. Can you tell us from your own experience what continued to block gallium arsenide from acceptance and use in any kind of large scale basis?

Mimura: Yeah, yeah.

Mimura: The major or first problem about that was scaling. We couldn't apply scaling rule to gallium arsenide MOSFET and silicon MOSFET, but what was used back then was Schottky barrier of semi-conductor, but it's not good for LSI and for the purpose of the production of LSI. We definitely needed gallium arsenide MOSFET, however, we couldn't scale it.

Fairbairn: So did you move your focus to the HEMT after you realized that gallium arsenide was not a viable long term technology or did others continue to pursue that while you explored the HEMT option?

Mimura: I have been working on gallium arsenide MOSFET for two years.

Translator: I have been working on gallium arsenide MOSFET for two years.

Mimura: The problem is there is a gallium arsenide semiconductor and we applied gate insulation on that. And there is a surface between the gallium arsenide semiconductor and gate interior or insulation. And on the surface there can be many different levels of surface states then with these multiple surface states, the semiconductor doesn't work.

Mimura: In gallium arsenide MOSFET to realize gallium MOSFET, we reduce surface density, surface state means states, energy states between gallium arsenide and oxide. And when we apply the positive gate voltage, metal gate voltage, electron induced goes up to interface state and trapped and no current. So this is very bit difficult to overcome. And we change the course to a new device and that is one that is HMET.

Fairbairn: So Fujitsu abandoned the gallium arsenide program.

Mimura: Gallium arsenide MOSFET program, yeah.

Fairbairn: MOSFET, MOSFET. And did you have, so you were pursuing the need for higher frequency transistors, but not for computer applications, for other applications correct?

Mimura: Yeah, yes.

Fairbairn: So tell me, so the original… the original driving force or customer for the gallium arsenide MOSFET was the computer division. Did some other division come to you and say we need a higher performance transistor? Or did you… did you realize need and saw that may be a way to that and tell me about how it happened.

Mimura: How I should say. As a material, gallium arsenide has a high frequency application potential. However, once it turns to transistor, there is an issue.

Mimura: If we can use gallium arsenide for computer, then we can create a very high speed semiconductor for computing as well.

Mimura: However there were red bricks and it did not succeed easily. Other materials than gallium arsenide MOS FET has the potential using the Schottky technology that I referred to early, you can create microelectronics with Schottky technology and you can implement semiconductor for high speed and higher frequency applications. Many companies were engaged in the development in the world.

Fairbairn: But not in LSI applications but as individual amplifiers, discrete components, right.

Mimura: No. Discrete, discrete amplifier yeah.

Fairbairn: So when you decided to go in that direction did you have a clear idea as to who the customers for that new discrete device might be? Or were you just pursing a higher frequency device assuming that there would be needs for that?

Mimura: I didn't think of any specific application.

Mimura: We just wanted to pursue a highest transistor for highest speed.

Mimura: LSI is more complicated, just speeding up the transistor is not enough, but it's an integrated device so there are so many parasitic factors that we have to consider. I changed the course or the way of thinking and I decided focus upon smaller transistors for specific needs.

Fairbairn: And I understand from your paper and from here that this was not a project that the company was eager to support. Is that, tell me about that. What, is it because there was not a clear application for it or because they didn't believe the technology was viable?

Mimura: No, no clear application. As I mentioned earlier in the case of gallium arsenide MOSFET, there is an oxide layer as well and the interface between the two there can be different surface levels or surface states. However, if it's about the interface between two semiconductors, then semiconductor itself is made of crystal. Then we will not have that problem of different surface levels or surface states. Then I may be able to solve that problem I thought.

Fairbairn: So did the company give you some short amount of time or some small budget to pursue this or did you, how did you…

Mimura: No…, under the table research.

Translator: Under the table research.

Fairbairn: Oh, under the table research okay.

Translator: Without official permission.

Fairbairn: And so you did this on your own with the help of a couple of other people or is it purely something

Mimura: Oh yes, I tried to meet people who can grow the crystals that can be the material for my semiconductor.

Mimura: And I talked about my idea and I have this new idea so why don't we work together to create a new semiconductor.

Fairbairn: So you had a pretty clear idea in your head how to go about this. You thought you had a, you had something in your mind that you thought would work.

Mimura: Yes, I had an idea.

Mimura: I had a very clear idea, but what was missing was just the idea for any application because I had to go to that company or people who have the capability to grow pure crystal. And the equipment for the crystal growth was very expensive, so as a result if they come up with a new pure crystal it would be very expensive again. Although it should be a very high performance crystal or semiconductor, but it is quite costly and I couldn't imagine who can use that in actual real world application. So engineering wise and from the viewpoint of technology I was confident and I thought it was a good idea, but no idea for application or who can be the user.

Mimura: When I talked to the people who could grow the crystal, maybe even if we can create a transistor, one transistor might cost one million yen and who could use that? We were saying.

Mimura: Our most popular application of my HEMT device is BS, satellite broadcasting receiver and when it was used for the BS receiver the cost of HEMT was maybe ten yen or several dozens of yen so the first price we imagined was one million yen, but it became very very cheap very rapidly. The cost was significantly lower than expected.

Mimura: Several ten, several ten.

Fairbairn: So you say few tens like less than a hundred yen, less than a dollar.

Translator: Yes, less than a hundred yen.

Fairbairn: As you pursued this idea, did some people tell you to stop doing it or did you just do it secretly or?

Mimura: Nobody tried to tell me to stop.

Mimura: No one tried to stop me and the supervisors, my supervisors in the lab and the people that I talked to were quite much interested in that plan and said, "please do that".

Fairbairn: So what year, when was it that you started on this project?

Mimura: 1979.

Fairbairn: 1979.

Mimura: 1979.

Fairbairn: And when in this period did you get your PhD and how did that?

Mimura: No, no PhD.

Fairbairn: No? No PhD, okay. So how long did this project take before you had a-. You started in 1979? You started this project in 1979?

Mimura: The inception of the idea was in July of 1979. I tried to implement the theory and we created the first prototype in December by the end of that year.

Fairbairn: Very quickly.

Mimura: Very quickly.

Fairbairn: So can you identify when you had this idea or when you decided to pursue it, in capturing these oral histories one of the things we like to understand is where do these ideas come from? What triggers them or what you know what does it just came to you one day or was it in a conversation with somebody or did somebody something say or what?

Mimura: No…, I presented my research on gallium arsenide MOSFET at an international conference and I talked to a researcher from IBM and while I was talking with him or after I talked to him the idea or new direction, I started thinking about new direction and the idea just came to me.

Mimura: In three weeks after then I completed, I sophisticated my idea about the device.

Fairbairn: When did you publish your results, when did you make them public as the development of this device?

Mimura: In 1980.

Fairbairn: In June?

Mimura: May.

Fairbairn: So when you announced it did you become aware of anyone else who was working on a similar technology or anybody else with a similar idea or?
Mimura: So I published my article in May.

Mimura: In June I went to another international conference again and I think it was at Cornell University or somewhere. And after my presentation I was sitting there and someone at my back tapped my shoulder and he was trying to write a same type of article, but I was faster than he did. He was mortified at me.

Mimura: French researcher.

Fairbairn: Once you publish your results how long was it before people started coming to you with applications or did by the time you published it did you then have an idea as to how it might be used? Or what applications it might be used in?

Mimura: Not yet, no application.

Mimura: Application just happened to follow incidentally. Three years later maybe, my company created a telecommunication amplifier using that device and one member of my group who was in charge of the production of telecommunication amplifier presented the work in a conference. And that directed people's attention and from the United States. One person who is related in astronomical observatory contacted our company and he wanted to use that amplifier for his observatory. And we didn't know about this at the radio wave based observation system so long since it's a totally different area from my specialty. And also our national observatory in Nobeyama in Japan, the people there came to us and they also wanted to use our device in the observatory. That was the start of commercialization in 1983.

Fairbairn: Okay, so it took some time from the time it was developed before the application. What was the, can you roughly say what the performance advantage of this device over existing technology? How much better you know, was it twice as fast or hundred times as fast what was the?

Mimura: Noise is very important criteria, Low noise characteristic is very important for such device. Our device had very very low noise level. In the case of radio wave astronomical observatory they needed to continue the monitoring for a week or so. The device stability becomes very important because the vibration or oscillation occurs and it has to stay in the same state and the vibration characteristic was very good in our case.

Fairbairn: So when you were developing it, it sounded like performance was the major goal in terms of higher speed device. Were you also aware of the low noise or stability capability? Do you recognize those as important characteristics?

Mimura: Low noise characteristics are come from the high speed. So if you can create a very high speed device, then the noise level goes down.

Fairbairn: But speed was the thing you were most or that you thought was most interesting, most valuable.

Mimura: High frequency, highest frequency spectrum is required for such observation. So what they were using was 20x GHz. This is a very important key.

Mimura: Gigahertz.

Fairbairn: They needed speed, they needed performance and noise and stability.

Fairbairn: So did you continue to refine that device? Once you found an application did you then pass it off to others in terms of manufacturing? Did you continue to do research in that area to refine and improve it? What was, what did you do following that time, 1980.

Mimura: In 1985 our device was finally implemented in the observatory. And around in 1987 it was used for BS antennas. It contributed to making BS antenna in smaller conductor and because we use of HEMT you can make antenna very small. And it led to the fall of Berlin Wall because East Berlin citizens could watch the TV program from the West very secretly because the antenna became so small. Then they knew about how rich life in the West was and it motivated to the fall the Berlin Wall. The export of BS antenna grew very actively around 1987.

Mimura: I kept working on HEMT, widening the selection of materials. So originally it was made of gallium arsenide, but to seek or to pursue a higher performance, we started using indium phosphide and gallium nitride, that is material for blue LED with high power. Currently the majority of mobile phone stations use gallium nitride HEMT. So different materials are used for various type of applications.

Fairbairn: So did other companies pick up this technology or license this technology from Fujitsu or is Fujitsu the only source of?

Mimura: Talking about now, we are not selling HEMT to any other companies outside the group.

Mimura: Fujitsu had a factory that produced HEMT, however, we spin it out and it became an independent company.

Fairbairn: Oh I see.

Fairbairn: So Fujitsu is the only source of HEMT devices, is that?

Mimura: Umm. Well. Other US companies.

Fairbairn: So yes or no?

Mimura: No. There are other companies.

Fairbairn: There are other companies. So did they, did the. I mean you have a patent of the device yes?

Mimura: It expired many years ago.

Fairbairn: It expired, okay alright okay.

Fairbairn: So you, you are still doing research today it that correct? *{Mimura: Yeah}* What technologies have you pursued since your work on the HEMT or have you continued to refine that technology?

Mimura: That's difficult.

Mimura: I'm always interested in the improvement of HEMT and for more energy savings the greater expectations on the gallium nitride. I think it has very much potential to save energy.

Fairbairn: So in this last section, we ask people what are some of the newer technologies or new ideas that if you were entering a university or leaving a university today, what areas sort of catch your attention as being ones that you might pursue if you were to be starting your career today?

Mimura: So under this, it is numbered as five number, question number five in Japanese, but in the second bullet point you're asking about how do I think about the technology development these days.

Mimura: Currently this industry is too much competitive and it's very hard to have a long term vision.

Mimura: that's I'm worried about.

Fairbairn: Everything is short term focused.

Mimura: Yeah, short term. And about your original question in being a college student now. It seems to me that I'm more interested in the fusion type of area, merger of science and engineering.

Mimura: In that sense, medicine, medical science or brain science.

Mimura: if I were a student right now then I might be interested in that kind of area.

Fairbairn: Do you have children?

Mimura: Yes, two.

Fairbairn: Have they pursued anything in the technical area or?

Mimura: One is medical doctor and one is a wife.

Fairbairn: Hardest job of all.

Fairbairn: Is there anything that you would like to tell us about your career or your life that we have not discussed at this point?

Mimura: Nothing special.

Fairbairn: Well I think it's always very interesting to talk with people such as yourself who have come up with brand new ideas that other people are not pursuing, and how did those happen and what was the environment. Cause we're always looking for ways to make continuing advancements and to understand the context and environment in ways in which things have happened in the past are important lessons for the future. So we appreciate, complement you on your significant breakthrough and your ongoing contributions. And also for spending the afternoon with us to tell us your story, thank you very much.

Mimura: Thank you.

END OF INTERVIEW

