Oral History of Yoshiyuki Kawana

Interviewed by:
Stanley T. Myers

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Stanley T. Myers: Today is the 16th of December, 2014 and I'm Stan Myers. We will be discussing with Kawana-san, his background, his history in his semiconductor related activities during his long career. Kawana-San was born in Chiba Japan in 1932.

Yoshiyuki Kawana: Yes

Myers: After graduating from Tokyo University with a master's degree in metallurgical engineering in1957, Kawana-san joined Sony Semiconductor Division and for the first six years Kawana-san was assigned for development of the silicon diffusion technology, silicon power transistor and the planar epitaxial transistors

Kawana: Yes.

Myers: In 1964 Kawana-san became Engineering Manager for Semiconductor Development and Production at the Sony Atsugi

Kawana: Atsugi

Myers: Atsugi

Kawana: Yes.

Myers: ---plant and led the company's semiconductor manufacturing until 1974

Kawana: Yes

Myers: He served as General Manager and Manager of the CCD, charge coupled device---

Kawana: Yes.

Myers: ---project for Sony's Semiconductor Development Division from 1975 through 1978

Kawana: Yes.

Myers: He served various management positions both in business and research and development at Sony including Assistant General Manager at Sony's Semiconductor Division and Deputy General Manger at Sony's

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Semiconductor Division and Deputy Director of Sony Research. He left Sony in1992 and joined MRC, Materials Research Corporation.

Kawana: Yes, yes.

Myers: ---as senior scientific adviser from 1992 to 1997.

Kawana: Yes.

Myers: He served Nihon Veeco as technical adviser.

Kawana: Yes.

Myers: Kawana San managed Success International Corporation as President 2001 and 2002 and served as board member of Hitachi Systems Corporation from 2004 to 2012.

Kawana: Not Hitachi

Myers: Hitech.

Kawana: Hitech, Yes.

Myers: A board member of Hitech Systems Corporation.

Kawana: Yes, that's right.

Myers: Okay, so let's just start---

Kawana: Just a minute please. At first you said that—I graduated from Tokyo University, you said Toshiba.

Myers: So we'll correct that one.

Kawana: Okay.

Myers: Year, and I'll remember it on my notes

Kawana: Yes.

Myers: So Kawana-san let's just begin about where you born, where did you grow up, what did your parents do and what university should make the

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correction at the point you attended. And through that list of questions then we will pause.

Kawana: Okay

Myers: Then we'll go through the professional years and then the other questions that I will ask towards the end.

Kawana: Oh I understand. Okay. I was born, as you said, in Chiba Prefecture in Japan but it's a very small farmer's village, it's Ichihara In Chiba. And ha grown up there until my entering Tokyo University. There was entirely agricultural field there, yes. And my parents, both my father and mother were school teachers. Yes.

Myers: Did they teach specific course?

Kawana: No, not specific, elementary school teachers, year. And then, I went to Chiba Middle School in 1944. Chiba Middle School was the best middle school in Chiba Prefecture at the time.

Myers: Really?

Kawana: Yeah. It was very rare to enter Chiba Middle School from my village, one student within two or three years. And it was almost end of the time of Second World War. But, I was very delighted to be able to learn new subjects. But very unhappy to say, I couldn't have almost no lesson from the autumn of that year, because we had to work at agricultural field to support increasing food, and sometimes went out to military base to help making big trenches. It was such like turmoil period. In 1945, Japan was conquered by United States and Allied Forces, and MacArthur ruled Japan. Then Korean war happened in 1950. So, therefore this is very---

Myers: Upsetting to a child.

Kawana: ---Upsetting, yes, But I learned metallurgical engineering at Tokyo University.

Myers: Well why did you pick metallurgical engineering?

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Kawana: Really I liked chemistry and material science. Therefore, I decided to pick metallurgical engineering. I decided by myself.

Myers: Oh, you did? Your dad and mom didn't have any influence saying, "You should do this or this?"

Kawana: No, just I decided by myself.

Myers: Good, good for you.

Kawana: I'm going to explain on my entering Sony.

Myers: Yeah, sure.

Kawana: Okay. I went to master's degree of Tokyo University. On some day at the end of 1956, Professor Hashiguchi, my professor, asked me to visit Mr. Iwama who at that time, General Manager of Semiconductor Division of Tohtsuko (former Sony), later president of Sony. The reason was Mr. Iwama asked Hashiguchi to introduce his student for joining the company.

Myers: So that's how you joined Sony.

Kawana: Yeah.

Myers: Oh very good.

Kawana: Yeah. At that time, it was 1956 and I joined Sony in 1957. At that time, Sony was not the company name, but Tohtsuko was the name.

Myers: Tohtsuko was.

Kawana: Yeah. And, I joined the company from January of 1957 and from its January to April, I just assigned to support Dr. Leo Esaki's assistant for three months, during the time I enjoyed working with Dr. Leo Esaki for his research on surface phenomenon on germanium crystal. The research theme was thought to be very important. On April 1st, I was assigned to another task to develop silicon transistors. I think it is almost first time to start to develop silicon transistor in Japan. The mission was to develop silicon power transistor for TV use, for transistorizing TV set. Until then, Sony succeeded in developing transistor radio, and sold many of them worldwide. Company president, Ibuka,

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then decided to develop transistorized TV at the time. Generally speaking, people thought that transistorized TV maybe possible, but it's far away.

Myers: Now who is the president of Sony at that time?

Kawana: Mr. Ibuka, you know?

Myers: I've heard the name, yes.

Kawana: Oh Yeah. So, he discussed with Iwama, what kind of device or transistor is needed. So, they decided to develop silicon transistors. It was very clever, I think. Because compared to transistor radio, transistor TV needs high current and high voltage transistor, because deflection of electron beam in Braun Tube [early CRT] require high energy and high power. Also, temperature in its cabinet becomes high. Therefore, germanium transistor may not be applicable for TV.

Myers: At that time, did you dream of the LED TVs?

Kawana: No.

Myers: Not in your dreams.

Kawana: It's impossible to think. But, it is very interesting they decided to go to develop silicon transistor, Mr. Ibuka and Iwama. The reason of their decision seems to come from BTL, Bell Telephone Laboratories. Iwama attended BTL seminar in January 1956 in that BTL reported newly developed technologies to licensees in the world. The main theme was impurity diffusion into semiconductor, germanium and silicon. And also, diffused germanium and silicon transistors and silicon diode were reported. Iwama attended the seminar with his follower Iwata. BTL's belief was silicon will be the future main transistor, because of low leakage current and high temperature capability. Iwama was convinced by them, but other people were not so, because it is difficult and they were busy in developing high frequency germanium transistor.

Myers: It was unknown at that time.

Kawana: Yeah. Unknown technologies. And many people attended the seminar from the world including Japan. But, Mr. Iwama might be the only person within

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Japanese attended who really decided to develop silicon transistor right after then. Because, Japanese semiconductor companies were busy to develop high frequency germanium transistor for radio. They could not consider silicon was so important. Sony was volume manufacturing transistor radio already. Others were not. There might be some difference between them.

Myers: Oh great.

Kawana: With myself only, development of silicon transistor was impossible. BTL had concentrated in it by many scientists. Therefore, I worked with my partner and also my boss Dr. Misawa who was just hired from Panasonic Research Center. He is two or three years older than me. He, at that time, was an experienced engineer in semiconductor engineering and development. I learned from him very much. I did not know anything about silicon transistor or semiconductors at that time. Because I learned metallurgy.

<laughter>

Kawana: I learned very much from Misawa. He, after Sony, joined BTL and did a very good job. But, at that time, I didn't know transistor technology. Misawa and myself made a team to develop silicon transistors. Learning from BTL's articles and documents, we followed the experiment of silicon diffusion technology. And then, in September 1957, BTL unclassified oxide diffusion masking technology. So, we followed quickly its technology and found it a great technology to be used for silicon transistor. We decided to use it for our power transistor development. I think there were no activities to utilize it.

Myers: Bell Lab was one of the first, there's no doubt.

Kawana: Yeah, I know but they have only done small signal transistors but not power transistors. The power transistor was developed, I think, first by General Electric Company, I guess. And some other United State companies have developed silicon power transistors. But, I got some samples of GE's silicon power transistor. I examined their performance and structure. I found it not matured and unsatisfactory for our application. Then, we decided to go completely different way with our original thought that is using oxide diffusion mask technology. It was very interesting.

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Myers: Trial and error, huh?

Kawana: Yeah, Trial and error. You may understand that at that time silicon crystal was not good.

Myers: I know, I made some of it.

Kawana: Ah so.

Kawana: First we bought silicon crystal from Dupont in France. Its diameter was 20mm or so.

Myers: Yeah, about that timeframe it was. Now it's---

Kawana: <laughs> Yeah. At that time, the price would maybe higher than gold, I guess. And, after the diffusion for PN junction, the leakage current was very high depending on the wafer site. Therefore, the large area chip of power transistor had a very large leakage current. That was unusable. It was the most serious problem for us. And, we could not solve this, because metallic impurities in the crystal might have precipitated during processing that caused leakage current. Therefore, we decided to make the chip as small as possible. Larger chip size deteriorated yield. Then, the current capability was lost. We had to find compromise. Then, we devised many kind of chip structure to increase current capability. We decided to use multiple electrode structure. Another difficulty was masking technology. There was no photolithography at that time. We had to develop oxide masking and mesa masking method without photolithography. It was very interesting time.

Myers: Right.

<laughter>

Kawana: Anyway, I was almost a project manager in 1959 for development of silicon power transistor. After many structure modifications and new process introductions, the transistor was put into production in 1960. And, transistorized 8 inch TV set was put into market in the spring of 1960.

Myers: Were you given any specific training at this time or just on the job training?

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Kawana: I had no specific training, only on the job training, Yeah.

Myers: It's a different world, isn't it?

Kawana: Yeah. And one point I should say is that, how to make low leakage current and high current capability were very opposite requirements.

Myers: Right

Kawana: Therefore I could not do both completely. Then, I considered and considered. Finally, I decided to engrave the backside center portion of the silicon chip to make very thin. But the edge remained thicker to make mechanical strength of the chip strong in order not to break by handling. By this method, we could achieve both low leakage and high current capability.

Myers: Did you do that on epitaxial wafers or just---

Kawana: No, just on the single crystal wafer.

Myers: Single.

Kawana: There was no epitaxial technology at that time. Also, Triple diffusion technology appeared some years later. So, I think it was Japan's first silicon power transistor and also it was viable silicon power transistor in the world at that time. I guess. Because of that, Sony had manufactured transistor TV, from 8 inch first and then, 5 inch. Sony's black and white TVs are 4 inch to 19 inch ones. Within them, that power transistor was utilized from 4inch to 12inch TVs during about 10 years. That was my first good memory.

Myers: Was that your key job at Sony?

Kawana: Yeah, at that time, yes.

Myers: ---in that period time?

Kawana: It was the first job of mine, 1957 to 1960. Should I continue?

Myers: Sure. Well I just wanted to get into the writing that you spent ten years focusing on that particular subject.

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Kawana: No, no, no. I just finished my development and sent it to the manufacturing department. And after that, I developed other transistors, planar transistors, epitaxial planar, transistors, ICs and related technologies. So, I don't know anything about power transistor development after then. And epitaxial planar transistors were also my development theme. We learned from BTL on epitaxial transistors. And, we developed it for also TV application (vertical deflection use). After it was developed, our boss visited BTL and showed our developed transistor to them. It is reported that BTL people was very surprised to see the performance of the transistor. Optimization of epitaxial layer thickness and resistivity was so good that BTL had not seen the performance before. Compatibility between breakdown voltage and epitaxial layer parameters were very good. That made its saturation resistance and current handing capability was excellent. I would like to finish my story on transistor development and go to another story.

In 1975, I was assigned as a Project Manager of CCD development of CCD development from 1975 to 1978. Mr. Iwama, ex president of Sony, decided to set up CCD project. He returned Tokyo from President of Sony America in 1973 and had both roles of Deputy President of Sony and Director of Sony Research Center. He established the project for the future success of Sony's VCR business that was Sony's big target.

Myers: Mm-hm

Kawana: Therefore, the camera is one of the most important equipment for VCR. At that time, tube camera was used, but the performance was not good. Vibration resistance and lag of image etc were unsatisfactory. Iwama once visited BTL before and met CCD inventers who explained him the device. He found CCD development activity at Sony research center. Then, he took this and established CCD project. But the project did not go well through 1974. He wanted to reform the project by changing the development management and engineers by participation from Sony Atsugi, head quarter of Sony Semiconductor. That's the background of my involvement.

Myers: Yeah

Kawana: Yeah

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Myers: One of the questions I was going to ask you, you're a company, Sony, like Japan

Kawana: Yeah.

Myers: Why they go into semiconductors?

Kawana: Oh yeah. <laughs> That's a very good question.

Myers: Yeah. Because, you know, one, it'd maybe serve free market, but was Sony more a captured market, internal?

Kawana: Yes. Sony decided to involve semiconductor in 1952, I guess.

Myers: Mm-hm.

Kawana: When Mr. Ibuka, president of Sony, visited New York and heard that BTL was allowing license, transistor patent for any company. So he was very interested in transistor. He had no detail knowledge or opinion on transistor. But his thought was "How to give his people good jobs, exciting jobs to the people."

Myers: Right

Kawana: He had been using vacuum tube for many years. He heard that transistor has very small size and low power consumption and high reliability. He only heard these three things. <laugh> So he decided to go into transistor business. Not for getting money, but only to get the exciting job to the people.

Myers: Right.

Kawana: After discussion in the company, he decided to go to transistor radio business.

Myers: Yeah

Kawana: At that time, BTL said "Please do not do that, because high frequency characteristic of transistor is not good for transistor radio."

Myers: Yeah.

Kawana: Transistor radio

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Myers: <laugh>

Kawana: <laugh> just transistor radio.

Myers: Yeah. Yeah.

Kawana: It's a very long story but yes anyway, that's a first of the history.

Myers: It was interesting how things developed in those days.

Kawana: Yeah, Yeah, Yeah, Yeah.

Myers: And the reason or the focus of one, getting into that, Sony, to make a better radio or whatever, to somebody else to do something else.

Kawana: Yeah, that's right. Yeah, uh-huh. But many people at that time wanted to make transistor radios only. But, they could not develop, manufacture, transistor radio, because of poor high frequency characteristic. And, Sony used grown transistors.

Myers: Mm-hm.

Kawana: Other companies all used alloy transistor. Both were very difficult to get good high frequency characteristic for radio.

Myers: Right

Kawana: But Sony finally developed a new technology for grown transistor. you may know that.

Myers: Yes.

Kawana: It is Phosphorus doping for emitter in crystal growing stage. It's a very interesting story, yeah. I think it's a Sony's first important invention on transistor. Sony could get into transistor radio business successfully with this. That was in 1957.

Myers: Right.

Kawana: Yeah.

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Myers: So how many years were you with Sony before you went to MRC?

Kawana: It was 35 years.

Myers: Thirty-five.

Kawana: Yeah

Myers: Long time.

Kawana: Very long time. Yeah. <laughs> Because 60 years old is , you know, the age of retirement.

Myers: Right

Kawana: So, therefore after 60 I went to MRC.

Myers: Who'd you work for there?

Kawana: Huh?

Myers: Who was running MRC then?

Kawana: At that time? Sheldon Weinig.

Myers: Yeah.

Kawana: You know?

Myers: <laughs> Oh Yeah. Everybody knows Shelly.

Kawana: <laughs>

Myers: Haven't seen him for a long time. I talked to him on the phone a few times, but I figured it was Sheldon Weinig.

Kawana: I see.

Myers: Crazy guy.

Kawana: Crazy guy. Yeah, that's right.

<laughter>

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Kawana: That's interesting. Yeah.

Myers: Yeah. He is a lot of fun.

Kawana: Yeah, yeah. He's, you know, a Jew. I think.

Myers: I don't know. I don't know.

Kawana: Yeah. That's related to my story. I was born in March 1932. So, I retired Sony in March 1992.

Myers: Mm-hm.

Kawana: In 1991, I didn't decide where to go after Sony. Then, at Sony's internal meeting, I met Mr. Kaneda who was former deputy president of Sony.

Myers: Mm-hm.

Kawana: He is also my friend. He asked me. "Would you mind to join MRC to support us? <laughs> I didn't decide to go there at the time. I answered "That's a good idea. I'll consider it. Then he introduced Dr. Sheldon Weinig to me. Sheldon Weinig at that time just entered Sony's umbrella. Then, Israel country contacted Dr. Weinig, who has relation to Israel, and asked him to introduce some engineer of Sony and wanted to take him to Israel to look for any collaboration possibility. Then I agreed to go Israel. Dr. Weinig was pleased to hear that. Then, I met him in Jerusalem Israel.

Myers: <laughs>

Kawana: And, I visited Jerusalem University with Dr. Weinig. We visited several professors and discussed their research subject. And after then, I visited several places in Israel to find out any good chance of collaboration. So, after returning to Japan, I said to Mr. Kaneda, I'd like to join MRC. So, He told Dr. Weinig that Kawana-san wanted to join MRC. So, I met Dr. Weinig and he decided to allow me to join MRC. <laughs> So I went to New York then. Yeah.

Myers: Did you live there for long time or--.

Kawana: Only one year and a half.

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Myers: Uh-huh

Kawana: Yeah. And I lived in Fort Lee, New Jersey, just opposite of Hudson River. And I commuted to the company in New York by car. Mm, yeah.

Myers: He was a very, very bright man.

Kawana: Yeah, I think so.

Myers: Yeah

Kawana: He used to be a professor of Columbia University.

Myers: Right

Kawana: Yeah. Yeah. I met many doctors there. There were many doctors at that time in MRC.

Myers: Right.

Kawana: Yeah. And it was very interesting for me to discuss technological things with many people there. But very unhappy things happened at the company. The performance of the company was not good. So--.

Myers: Yeah. Technically they did very good, but I think business-wise it was a problem.

Kawana: Yeah, very bad. Uh-huh.

Myers: Yeah.

Kawana: So the reason for Sony's involvement was that Dr. Weinig asked Sony to support his company.

Myers: yeah.

Kawana: So finally in 1997, Sony decided to terminate the company.

Myers: Mm-hm.

Kawana: Well, then I have to return to Tokyo. No, not return, but anyway. I got out of the business. And many MRC people went out to other companies. Some

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of them joined Veeco <laugh> to develop another kind of technology on manufacturing equipment. One of the people who joined Veeco asked me to join Veeco. So, I decided to join Veeco. But it was not in the United States, but in Tokyo to establish a new subsidiary company.

Myers: Right

Kawana: I started with only four or five people in Tokyo. And, at my retirement time from Nihon Veeco in 2000, the number of workers of the company was about 80. It had very rapidly grown.

Myers: Yes.

Kawana: Yeah.

Myers: You had some good technology.

Kawana: Thank you.

Myers: And still do.

Kawana: Thank you again. I learned much technology and also I acquainted many people. That's very interesting and fruitful for me.

Myers: Mm-hm.

Kawana: Yes.

Myers: Mm-hm.

Kawana: I didn't speak with Dr. Ed Braun so much. But I think he's a rather small, not tall person.

Myers: Right

Kawana: Yeah

Myers: Yeah. He's retired from Veeco now too. I think.

Kawana: I see. Uh-huh.

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Myers: Yeah. Well, starting to wrap up our discussion with you, Kawana-san, in your opinion, what's the appropriate role for the Japanese companies in the semiconductor business today and the environment today and the future.

Kawana: Uh-huh

Myers: Kind of what do you think about it?

Kawana: Ah, I see. Okay. Hm. You know, Japanese semiconductor industry, has grown up very rapidly because they are only engaged in consumer electronics, micro computers transistor radio, transistor TV and VCR.

Myers: Mm-hm.

Kawana: And desktop calculators and such kind of consumer electronics. They prevailed in the wide world.

Myers: Right.

Kawana: And therefore many, many semiconductor devices were needed in Japan. So they could have produced many semiconductor devices. And then, calculator was a good chance to get into MOS LSI business for Japanese.

Myers: Right.

Kawana: Japanese semiconductor industry went into DRAM manufacturing. And, in the end of 1980's, Japanese DRAM prevailed over the world.

Myers: Then, Japanese semiconductor companies had fallen into bad situation. The big companies all became worse.

Myers: Right.

Kawana: Japanese semiconductor manufacturers are not independent company, but divisions of large electric companies.

Myers: Yeah. You mean totally integrated.

Kawana: Integrated. Yeah.

Myers: I understand.

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Kawana: Therefore they had much money to invest. DRAM was a very good Japanese target, simple structure and small number of devices that was ideal mass production form. They invested much money to make plants. Another point was good reliability of their DRAM that was a heritage from consumer electronics.

Myers: Right

Kawana: Japanese weakness was in low-price manufacturing. Japan pursued good quality and good reliability device that required complicated processes and many masks. That's the main causes of defeat of Japan by Asian companies and some of United State companies.

Myers: Really got populated.

Kawana: Yeah.

Myers: So many companies making DRAMs.

Kawana: Ah, that's right.

Myers: Right. And now so many companies going out of it and---

<laughter>

Kawana: Yes.

Myers: So what do you see the future in semiconductors for Japan? Where do they go from now?

Kawana: Uh-huh. Okay. Mm. Japanese semiconductors currently have some strength, I guess. They are weak in some area of LSIs, particularly for ASSP, application-specific standard products. They are very weak. United States and Asian companies, of collaboration, they are very successful. Japan still is difficult get into that business. However, Japan has some expertise in some field, such as image sensors of Sony and NAND memories of Toshiba.

Myers: Yeah.

Kawana: And---

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Myers: Good examples, yes.

Kawana: And power transistors, power devices of Mitsubishi, Toshiba, Fuji Denki and Hitachi are very strong. And another thing is microcomputers in Renesas. Such devices are not like ASSP. They can devise technology improvement and the device performance improvement on their devices that are related each other. Such devices including NAND and image sensors are Japanese favorite ones, and will still go ahead.

Myers: Right.

Kawana: Japan should search further strength in those devices and technologies.

Myers: That's probably in the future, I think.

Kawana: Yeah.

Myers: Yeah.

Kawana: I think Japan should also consider design house strengthening ways, because Japan has expertise in the design of consumer electronic equipment like TVs, smart phones and so on. United States and Asian companies are superior now in this field with the collaboration between big foundries.

Myers: Big foundries, Yeah.

Kawana: Big foundries. Yeah. Those foundries do not exist in Japan.

Myers: Yeah.

Kawana: Japan should start to create such new design house or strengthen existing design house utilizing Japanese design expertise.

Myers: Yeah. It's an open-ended question.

Kawana: Yeah.

Myers: Because it can go several different ways.

Kawana: Yeah.

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Myers: I'm going to give you the easiest question in the world.

Kawana: Okay.

Myers: What advice would you give to young students going into college, just beginning to get into semiconductors or whatever they're going into?

Kawana: Yes.

Myers: And what's the most opportunities in technology do you see.

Kawana: Yeah.

Myers: I mean, there's all kinds of medical devices and smartphones. So I'd just like to hear what you think at this point.

Kawana: Ah, I see.

Myers: About technology in general.

Kawana: Okay. From my reflections of my career, I would like to advice young students to study science, basic understanding of science and engineering. I think it's very important. I'm not good at explaining that. But if people who are very good at understanding the science and, for example, are working in semiconductor field, he would become a very good engineer by applying the science he learned.

Myers: I think that's actually---you know, in the U.S. now there's a program in high school areas. It's called the STEM program.

Kawana: Oh.

Myers: Science, Technology, Engineering and Mathematics.

Kawana: Oh, right, right. Ah.

Myers: And that's basically what you said.

Kawana: Oh, yeah. Oh. I did not know that. But it's good.

Myers: Yeah, yeah.

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Kawana: I think that's very important.

Myers: Yeah.

Kawana: Yeah.

Myers: I do too.

Kawana: Uh-huh. And after entering the company, if that kind of understanding that engineer has, then he can design or develop or create many things from that kind of understanding also with current information.

Myers: yeah.

Kawana: Yeah. And what the question is?

Myers: Well, the follow on the question to that is what do you see as the opportunities in the technology room?

Kawana: Yeah.

Myers: And that can be any, I mean, biomedical or energy.

Kawana: I see.

Myers: Whatever. Just what's on your mind today.

Kawana: Oh I see. One thing I am interested is IoT, yeah. The reason is that there would so many devices are needed. And not only the number of the device but also the kind of device be so many. So many kind of sensors, for example be needed. Also, many kind of application devices. That may be good at for Japanese, because it is, unlike to ASSP, has more room for devices.

Myers: Why don't you, like CCD, charge coupled devices.

Kawana: Oh, Yeah. That's right.

Myers: Tell your people that's reading this, what does IoT mean?

Kawana; (I didn't catch his words. The answer is created later.) IoT is abbreviation of Internet of Things, and things each has its property that is

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collected to internet through sensors, and after analysis of the large volume of data, we could get valuable information on our life or industry, like medical, agricultural and industrial information.)

Myers: Mm, hm.

Kawana: Yeah. But CCD is now succeeded by CMOS sensor.

Myers: Mm-hm.

Kawana: So its process is very much complicated. And the performance is also related to that.

Myers: Right.

Kawana: So for that kind of things, Japan is very good at doing, also same for NAND memory.

Myers: Yeah.

Kawana: The same reason may be applied for the IoT. That's my guess.

Myers: Right.

Kawana: Yeah.

Myers: So any other words you'd like toad at the end of your---

Kawana: Oh, oh, I see. Well, related to IoT, there are many device sensors, biomedical sensors, agricultural sensors and machine sensors. It is told that trillion sensors may be necessary.

Myers: Right.

Kawana: If that is right. Japan has very good chance to do that. Yeah.

Myers: I totally agree. Well, thank you very much, Kawana-san.

Kawana: Yeah.

Myers: I'm glad you're feeling better.

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Kawana: I am. Very much, thank you.

Myers: And I think you did a great job.

Kawana: Thank you very much.

<applause>

Myers: We'll give him a---

Kawana: Thank you very much for all the talk.

END OF INTERVIEW

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