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Yoshiaki Shirai

An interview conducted by
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with
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Q: So if we could start with your name and where you were born, and when?

Yoshiaki Shirai: My name is Yoshiaki Shirai. I was born in 1941 in Toyota.

Q: And where did you go to start going to school? What were some of the things in school?

Yoshiaki Shirai: School. University, or –

Q: Even when you were younger.

Yoshiaki Shirai: High school. Tokai High School in Nagoya. Nagoya University, because I was living in Nagoya. And then I moved to Tokyo University for graduate course. And then spent five years and finished master course and Ph.D course.

Q: And what did you study? What department in Nagoya University?

Yoshiaki Shirai: Mechanical engineering. Laboratory is control.

Q: And how did you get interested in mechanical engineering?

Yoshiaki Shirai: I was born in Toyota, and so there is a Toyota factory. So I was interested in car. And many people in that area would like to go to mechanical engineering. So, -- <laughs>

Q: It was just popular. <laughs>

Yoshiaki Shirai: Yeah, it was popular. I guess so. I think so, deeply.

Q: So when – Did your family work for Toyota?

Yoshiaki Shirai: Yes, once my father worked for Toyota, and then he moved to another company, Denso, also adjacent to Toyota car.

Q: And that's when you went to Nagoya.

Yoshiaki Shirai: Yes, it is.

Q: So in your undergraduate, umm did you have any – Did you know about robots then at all?
or

Yoshiaki Shirai: Only by comic book language.

Q: Which comic?

Yoshiaki Shirai: Atom.

Q: Did you enjoy reading it?

Yoshiaki Shirai: Yes, yes really.

Q: And so how did you decide then which university to go to for Ph.D?

Yoshiaki Shirai: Because I stayed in Nagoya for many years, and for undergraduate and in high school and music school and private school, so I wanted to change the place. I think at that time, Tokyo University was called to be the best place for.

Q: So which – And you were in mechanical engineering. In Tokyo University.

Yoshiaki Shirai: Yes.

Q: Did you go into a lab when you went to Tokyo University?

Yoshiaki Shirai: In Tokyo University – In every university we have lectures. Also, we belong to laboratory. And my laboratory in the master course were Mori, Masahiro Mori who is very famous for robotics. When I entered his laboratory, he demonstrated his first robot. He said, this is the first robot in the world. That has three fingers and manipulate object by pneumatic actuator.

Q: And what was some of the research that Professor Mori was interested at the time?

Yoshiaki Shirai: Because my field is control, so he has interest in control of the plant, especially he was eager to automatic production line for the cigar maker near the laboratory. So he stayed outside than stay in.

Q: Oh, and he was more – And so you worked with him on that project?

Yoshiaki Shirai: No, no, no. He said please choose – you find your own thing. And I don't need him so often -- Maybe several times a year.

Q: So how did you choose your theme?

Yoshiaki Shirai: Because he showed me the three finger robot, I, at first, decided to continue to make better fingers. And at that time, also the very famous professor Ichiro Kato at Waseda University was associate professor. And I look at the newspaper, and it says Kato Ichiro makes a sensor, tactile sensor. So, I called Ichiro, and I'm a student, but could he show me that tactile sensor, and I visited his laboratory, and he himself showed me the tactile sensor. It consisted of a small micro switch and looking at this, this is not a good tactile sensor. Then, I tried to make better sensors, first.

Q: So what kinds of different sensors did you develop? What did you try?

Yoshiaki Shirai: I tried rubber and carbon powder. And I made it, but it was not successful because its characteristics of that conductivity changes with time. And then I gave up, and do many things on fingers, and at last, I had more interest in vision. And then I started to work on vision because we have sensors, and we have very small degree of freedom compared with the this retina. It's very large degree of freedom in vision. So I think that is more promising.

Q: Was there anybody else who was working on vision?

Yoshiaki Shirai: No one in my field.

Q: So you had to kind of find everything yourself.

Yoshiaki Shirai: Yes, yes, yes.

Q: How did you do that?

Yoshiaki Shirai: I read books on that.

Q: Was it easy to find books at the time?

Yoshiaki Shirai: No, no, no. I must go to the library.

Q: And were they – Do you remember who – What were the books or who were they? Were they Japanese authors?

Yoshiaki Shirai: Mostly American. <inaudible 00:07:10> it's a Japanese Diet Library that is a biggest one, and I sometimes visit there and find. And also, there is some organization which introduce the foreign journals very quickly. And that gives us summary of the journals. And together with the original, okay. And that asked – and I applied to make the summary when I was a student. I earned some money by reading the, yes, foreign journals and make the summary in Japanese. And I also registered my field was maybe vision. And then, I can get those information very quickly, and get some money by writing the summary in Japanese.

Q: That's very clever.

Yoshiaki Shirai: That organization, if I visit that organization, of course we can read more summaries which was made by other researchers.

Q: So what kinds of questions did you start working on in vision while you were doing your masters?

Yoshiaki Shirai: How it can recognize object.

Q: So what were some of the early studies or early experiments?

Yoshiaki Shirai: At that time, there is handwritten numbering. Numerical character reading was just established by Toshiba company for postcard classification. We have a postcard with numbers on Japan. But, maybe in United States, it is automatically read and then classified. And it was already complete. And also, in United States there is a system which analyze trace of the high-speed particles, half automatic. It's interactive. So later, when I visited in the United States and went to some laboratory, I look up that machine. And it was mostly automatic, but if they made a mistake, this should come here then pointing them and find it. Such kind of machine already completed.

Q: And what kind of experiment did you do during your masters?

Yoshiaki Shirai: During master, to finding the theme, it takes one year. And then, not so much time, so I have at that time I found a very interesting book that is Perceptron. 1964, I found that is interesting. And then I tried to apply or improve the performance of the perceptron.

Q: And you were still working by yourself.

Yoshiaki Shirai: No, no, no.

Q: No. Who did you work with then?

Yoshiaki Shirai: After I worked one year, I found that perceptron has a limitation. And then while reading many other books, that approach is not so good, and it changed my direction.

Q: So what did you work on? How did you decide to work on vision then?

Yoshiaki Shirai: Then, I went to the Ph.D course. At that time, I was working quite different field, operation research. But while I was working for Ph.D. –Ahh at that time I was working for Ph.D. that is operation research for forestry operations, okay? So I visited the laboratory for forestry. And there they were <inaudible 00:11:35> paper that is in the analyzer -- aerial photograph analyzer was installed inside of laboratory in that – yes, laboratory. So, I visited that laboratory and asked by related person to introduce me and let me use that one, okay? And I had some dream to analyze this X-ray picture. When I -- it's a mechanical engineering course, I went to the ship building company. They said they take many pictures for the welding part if there is some defects or not. But human beings are now analyze this. But I thought that should be analyzed by machine. And then, I asked, and that's okay. So I leave that X-ray picture by that machine, and then some curves comes. Then I went to the seismic laboratory earthquake in Tokyo University, that is analyze this curve into the tape – a digital tape. And I then I bring this to the computer center in my university, then that make the tape to card, and the dividing card is the main input. Then that result card, I work on recognition is a defects of X-ray picture alone. It's quite different from Ph.D work. And, when I finished the Ph.D., there I – before that I contributed to the Pattern Recognition, Volume I, and it was published.

Q: Congratulations. <laughs>

Yoshiaki Shirai: Yes, yes, yes. So my Ph.D. work, it is not related to the vision. Then, I enter the Electro Technical Laboratory as Inoue, and then I started robotics again.

Q: So which year – So which year – When did you entered the electrotechnical laboratory?

Yoshiaki Shirai: Just after Ph.D. I finished in Tokyo University.

Q: So '69?

Yoshiaki Shirai: Yes, it was '69.

Q: And what kind of work were they doing in ETL?

Yoshiaki Shirai: ETL? Myself?

Q: When you went there, what was some of the –

Yoshiaki Shirai: In ETL, yes?

Q: Mm hm. In the projects.

Yoshiaki Shirai: The related field -- there are two related fields, okay? One is robot, okay, mainly interested in manipulation. And, the other is related to vision. That laboratory, main work is robot vision and cat vision.

Q: Why cat?

Yoshiaki Shirai: Cat is used for analysis of visual processing, okay? But you know Hubel -- Hubel and Wiesel in United States who received -- Hubel in Massachusetts. I met him, and he received the Nobel prize in analysis of cat retina, and visual activity of cat. And so in many place, not only Harvard but many place, cat is typical subject for analysis because the shape of this head is almost fixed for cat. It's easy to just analyze. So, I belong to that laboratory and also robot vision group.

Q: Oh, so you were working both on the cat and the robot.

Yoshiaki Shirai: My laboratory, yes, yes, yes. But I belong to the robot vision group.

Q: Ummm mmm So what was the aim of the robot vision group? What were they doing?

Yoshiaki Shirai: Maybe the same as United States. Because when I entered the Tokyo University, my professor, okay, showed me the movie of the Salford, robot, okay? This blocks, pick up and put this and like this with --taped TV camera.

Q: So the blocks world was record.

Yoshiaki Shirai: Yes yes. So when we are students, we know there is such kind of intelligent robot. Of course, industrial robot is also important in Japan, 1964, maybe, it's important already. So because of – and also, my boss in that Electro Technical Laboratory, in my section, visited the United States and MIT, and also he brought some picture of MIT's work, also block world. So we know approach <inaudible 00:17:27> what to do. So it is similar I think.

Q: So you were also doing block and kind of pick and place?

Yoshiaki Shirai: Yes, yes. The vision for pick and place. Pick and place, another section.

Q: Oh, the manipulation section.

Yoshiaki Shirai: Inoue was in that section.

Q: So what were some of the questions or problems that you worked on in the lab?

Yoshiaki Shirai: In the lab? At first, we work on how to make the line drawing of the block world, okay. And then I found that it is impossible because it depends on the lighting condition. So in principle, there's no difference of light intensity. And then impossible to find this <inaudible 00:18:19>. Then I think of a way to make better drawings. That use four different light. First, front light, then upper light, then left/right right/left. Then we make the top light each line drawings. So some line drawings -- some part is missing and also some part is shadow cast because there are many -- <inaudible 00:18:52 > with blocks. And this way, also some part is not known, is seen, but also another shadow casted. But combining four line drawings, we can make the perfect one. At first I worked for that. And also – but I think that is not enough, because at that time, line drawing is okay, but after we get the line drawings, how do you interpret as a 3D object? That is another issues. So also I was graduated from mechanical engineering, I thought how about measure the distance. Then I think of a better way because we are using intelligent camera. So just project straps and then scan and we can get some 3D data of all the view field, field of view. <inaudible 00:18:52 >. And then my purpose was not make that device. My purpose was used that three data to interpret the scene. And then we just succeeded, okay. At that time, my boss's boss told me that this is a good chance to go abroad, and spend

one year in some laboratory and because my friend is at MIT, I decided to go to MIT. And I wrote letter to Minsky with the paper, two papers, that is for light -- illuminations paper and also rangefinders paper, those are submitted to each guy, 1971 in London. Then Minsky accepted me. And later I know that Minsky receives many letters from the world. It's not easy to be accepted, and I was very lucky. Then, I just **make** the good rangefinder and we can take data. Now it's my time to use that data. It's very good timing, but I must leave this, and I must go to MIT, so--..

Q: Who was your boss at ETL?

Yoshiaki Shirai: My direct boss was Saburo Tsuji. Later he became the professor of Osaka University and also the president of the faculty. He, last year, he received an award from the government, and he's also was president of Artificial Intelligence Society in Japan, and the vice president of the Robotics Society of Japan. That history is just the same as me.

Q: So you had to leave your work with the rangefinder, and other people were working on it, and you went to MIT.

Yoshiaki Shirai: Yes, yes, yes.

Q: What did – What was happening at MIT when you got there?

Yoshiaki Shirai: At MIT? Also, Minsky, for the first time, he showed the laboratory, and this was my room, and after that no relation. And I must find myself the theme. But one day, I find some camera, **<inaudible 00:22:59>** camera, image dissector, and asked the students what is this, student or staff. And he showed me how to use this, and also he showed me the performance of Horn-Binford line finder. Horn and Binford is very famous in field of vision. And I found that performance was not so good, it's poor. So, looking at this, I can make better with line drawings. And then, that's the start of my work at MIT.

Q: Did you work by yourself or with somebody – Was there any collaborator?

Yoshiaki Shirai: Yeah. No, alone.

Q: And Inoue-Sensei was there too at the time?

Yoshiaki Shirai: No, no, no. At that time, he was a student at Tokyo University.

Q: Ah, okay. So he had been there and went back, and then you went – Or, how did it work?

Yoshiaki Shirai: Sorry, Sorry. He – No, he entered U.S. one year later. And then, I moved to MIT. So he was not student, but he was at ATTI, okay. He's another section, okay. So – And my – Yes, idea is that the line drawing is to connect the point where the light intensity changes. So if we take a picture of the blocks, some part light intensity changes not so large, and or some part there is a small shadow light intensity <inaudible 00:24:39> large. If you point that intensity and then you just connect, you cannot get good better good line drawing. So when we look at something, some part is very clear and something is not clear. At first, human beings find the clear part, and using that as a clue, we find the obscure parts as well in detail. So that idea I used findings the line drawings.

Q: And this was at MIT with the new – the dissector, image dissector camera.

Yoshiaki Shirai: Yes. Yes yes

Q: And did you – Did you publish that anywhere? or

Yoshiaki Shirai: Yes, yes, yes. I published the Journal of Artificial Intelligence.

Q: Mm hm. And you were in MIT for one year?

Yoshiaki Shirai: Yes.

Q: Did you do any – Was that the project that you mainly focused on?

Yoshiaki Shirai: After MIT?

Q: At MIT?

Yoshiaki Shirai: Yes, yes. I work alone. So in autumn I -- my first version succeeded, okay. And then I asked Minsky to come here and look, and he look at me. He was admired me and then he said, "Please come to my house to take dinner."

Q: Oh, good.

Yoshiaki Shirai: I was surprised. And I used to use bicycle, so I just followed his car, his Ford. So, and also at Winston, I has some interest in vision, so he also impressed -- We are very -- Since then we are very good relation with Minsky and Pat. Winston and other members. Till that time, so I'm alone.

Q: And then after, did they -- Were they more interested in working with you? or

Yoshiaki Shirai: Oh, yes, yes. They asked me to stay more, but at that time the new project in Japan is a big project that is patten information processing start the next year. Main person in that project in my laboratory, ETL, called me directly to come back to contribute to that project. So my plan didn't succeed.

Q: You had to go back.

Yoshiaki Shirai: Yes, yes.

Q: How was Minsky, like when you went to dinner or talked to him, what -- How was he to work with or talk to? What kind of things did you discuss or what kinds of things were interesting?

Yoshiaki Shirai: I don't think interesting.

Q: Do you okay, that's why?

Yoshiaki Shirai: But sometimes we talk about robot -- robotics. For example, I say the human being is quite different from the robotics. We point somewhere not by calculation, but by memory, I said. And he understands. Also like vision, human beings look at things and are interpret things, but it's not only by the line drawing and not with the stereo but with many knowledge about the thing.

Q: Right, and you mentioned yesterday when you were giving the talk, you showed the pictures, experience. Just experience of the world and the body. So you were already thinking about those things in the 70s.

Yoshiaki Shirai: So Minsky's way of thinking is very close. Minsky just denies the perceptron very theoretically but myself it's experimentally. And I read his paper, "Steps toward Artificial Intelligence," when I was in master course <inaudible 00:29:19>, and I was much impressed by

that journal article. I read many articles, but I remember that article very well. Also, Minsky was also told me and he has much interest in I said. I was very happy.

Q: And so did this kind of thinking about human perception, did that – Did you use that in developing any of your vision projects?

Yoshiaki Shirai: Ahh Human vision. We don't know that is human vision or not, but when we reflect myself by the frontal part of my face and brain, then we may interpret results line drawing as this, or we may make the line drawing as this. But we don't -- I don't care for that mechanism of the brain itself.

Q: So it was more kind of just understanding the functions and then interpreting for the machine rather than trying to replicate human cognition.

Yoshiaki Shirai: Yes.

Q: So when you went back to Japan, the big pattern information processing project. What was that about?

Yoshiaki Shirai: That big pattern consists of the 3D image, image of 3d, and 2d character and speech. So I was in charge of the 3D object.

Q: So was this basically for reading like kanji or something?

Yoshiaki Shirai: Yes, yes. Kanji, yes. The big project -- the contractor consisted of many industries, companies and laboratory because it's a MITI's project -- Ministry of International Trade and Industry. So we are <inaudible 00:31:23> the MITI, so our MITI laboratories and many industries.

Q: What were some of the industries that were involved?

Yoshiaki Shirai: Most famous electric company like Hitachi, NEC, Toshiba, Mitsubishi, Oki --.

Q: And what were they – Why were they interested in this system?

Yoshiaki Shirai: What Why interested?

Q: Why did they want to make this system of pattern recognition?

Yoshiaki Shirai: Oh, that project was established while I was at MIT. So I didn't –

Q: You're not sure why. I mean, was there an application?

Yoshiaki Shirai: I was asked to come back, because I was away at this time.

Q: I mean, was there an application that they were developing?

Yoshiaki Shirai: Yes, yes.

Q: What was the application?

Yoshiaki Shirai: For speech and character recognition, that's clear. For 2D image, that is automatic analysis one, maybe, map and maybe human face like this. And for 3D, that is like robotic vision, so maybe object <inaudible 00:33:05>. So, so the object for handling has no direct application, but if it is successful, it can be used for many areas. The project itself has no direct application. The technology is most important. So, there are criticism that is this spend much money but no product. But the company is very glad to develop their own technologies and utilize them to make the products.

Q: Because then, I mean, this kind of thing could go then into the industrial robots or manufacturing or something like that. And so did you work on all parts, or you just worked on the –

Yoshiaki Shirai: Only 3D.

Q: Only the 3D. So what were some of the interesting problems that you had to deal with.

Yoshiaki Shirai: At that time in my laboratory I thought that we'll have to work with on mainly two things, but one is to take picture of the 3D object and understand the scene. The other one is to take 3D data using rangefinder and interpret it, okay. Because when I come back here there is some researchers who is looking for themes, so I gave that theme to this researcher, and he's working on rangefinder. So, but I myself cannot work <inaudible 00:34:46>, but I work with

together. And no one is working on these pictures. So I changed my mind to myself recognition of desk scene, usual desk.

Q: Who was the researcher you were working with on that?

Yoshiaki Shirai: Oshima. He received the Takayanagi prize. Takayanagi is an inventor of the television in Japan. Brown is the inventor in United States, but independently Takayanagi invented the television, and he became a -- maybe a vice president the president of Victor company, and then there is a Takayanagi prize. And Oshima received the Takayanagi prize after I left ETL.

Q: So that's in the 80s right? And so you were working on the picture recognition. So what kinds of questions or what kind of approaches were you using?

Yoshiaki Shirai: I worked, at first block world especially at MIT. The background is black and white blocks, and I think that is not so good because it is special case. So, I use just gray desk. And something is brighter than grey, and something is darker than desk. Then the objects are usually for telephone and books and pen and eraser or cup or like this. So, usual object.

Q: And this was, generally, it was just recognizing the object. Was it related to any work that was still being done by the robot or by the manipulation group, or no?

Yoshiaki Shirai: I don't know, because I developed how to find the edge of the curved object and how to the represent the curve by second <inaudible 00:37:18> -- curve, okay. It's not easy. So that kind of basic idea is used, but because there is especially no applications for analyzing desk scene, because I belonged to the laboratory and I start from block world to the usual object that is my -- yes, I did it. But after that I realized that that's not so good. Because it is very difficult, okay. It takes five years. But even if it succeeded, no direct applications. I should have work better.

Q: But now HRP2 can pick up the cup from the desk.

Yoshiaki Shirai: Yes yes. And for 3D group, definitely consists of me and co-workers, Oshima. We work on the analysis, recognition of the mechanical parts, mainly parts of the automobile and stuck it together and -- try to recognize.

Q: So more closely can be applied to the automotive industry.

Yoshiaki Shirai: That was successful. That's why he received the Takayanagi prize.

Q: Oh, that's the project he received the prize for

Q2: That's Rangefinder, right?

Yoshiaki Shirai: And also he received an award, best paper award from the Society of Electronic communication – Institute of Electronic Communication. That was successful. And I think that the method is not very new. New but if good people think maybe for some days maybe think of this, but fortunately, we have rangefinder and good data, and we could start earlier so that's why we can make very good work. <inaudible 00:39:35> Lucky.

Q: So in the beginning, when you said it took five years working with the desk object recognition. Were you – Is the – What other projects did you do after that?

Yoshiaki Shirai: After that I work on automatic selection -- screen of stomach x-ray picture -- X-ray image of stomach. That is very difficult. At that time, chest analysis was already famous, and that is also of course -- the difficulty is many organs are overlap, okay. And for the stomach, because when you take an x-ray picture, we drink barium then we can get the auto line a little bit easier. But the problem is the shape is different from person to person. And the, of course, the thickness or the condensation of the barium is different, so the contrast is sometimes very clear, and sometimes not. And sometimes, the barium go to some other organs, then the boundaries not clear. Also, that kind of problem. So we work with doctor in Tokyo University.

Q: Was this – How did this project start? Do you know? How did they become – ETL become interested?

Yoshiaki Shirai: No, that is myself. ETL at that time very free. Here I think I would like to work on that.

Q: So how did you find out about this problem?

Yoshiaki Shirai: I thought that vision is a little easy, okay, most of the reason, so I must find a very difficult one which cannot be completed for a long time, then I selected. And of course, before – during that time I get acquainted some researcher in the hospital who is working on the CT tomograph of brain, and I worked with her to find the main part of the brain using the CT

tomograph <inaudible 00:42:36> how to make the 3D volume like this. But that is not my the – my main work.

Q: And when was this? What year?

Yoshiaki Shirai: What year? For what? For stomach? This one? For that, yes. CT two years and for stomach, many years. But in the middle, I became the director, then I give this work to the successor. <laughs> So difficult. So I wrote papers, okay. And also we also collaborated with a doctor in Tsukuba University - A medical course. Because we moved to Tsukuba from Tokyo to Tsukuba.

Q: Were you in – Did it go to AIST or no?

Yoshiaki Shirai: No, our laboratory moved -- whole my laboratory. ETL moved from Tokyo to Tsukuba in 1979. After that, so it's far from Tokyo then <inaudible 00:43:55>. So, that doctor wrote their our own papers, and we take a lot of papers but the real useful system was not build, unfortunately.

Q: Why was it not built?

Yoshiaki Shirai: Its cost much, and we cannot expect a special case. But mostly, mostly cost.

Q: What kinds of places were you publishing papers then?

Yoshiaki Shirai: Information related society or electronics related society that is Information Society of Japan or Institute of Electronic Communication. But recently it change the name -- Electro -- Information and Communication.

Q: Even longer.

Yoshiaki Shirai: It include Information.

Q: But was there a lot of communication with researchers from other countries.

Yoshiaki Shirai: Sorry, IEICE, Institute of Electronics, Information and Communication, sorry. It abbreviated as IEICE. (NOTE: IEICE actually stands for *Institute of Electronics, Information and Communication Engineers*.)

Q: IEICE. I got it.

Yoshiaki Shirai: One of the biggest society in Japan.

Q: And did you mostly publish in Japanese circles or also outside of the country?

Yoshiaki Shirai: Mostly Japanese, and I contributed to international conference. But very less to publish in English.

Q: What kinds of conferences were out there? There was probably no vision.

Yoshiaki Shirai: Ichikai [ph?]

Q: Ichikai, okay.

Yoshiaki Shirai: We, yes, contributed Ichikai many times, and ICPR.

Q: Okay, so there was a computer vision conference. So when did you become director of ETL?

Yoshiaki Shirai: Not director of ETL. At first I became the section chief of my –yes, Section chief in 1979. Section chief in computer vision. Then, 1985 I became the director of the control division. Control division. Director of control division. At that time I gave my work to successor.

Q: And so in the control division, what kind of other work besides vision was happening?

Yoshiaki Shirai: That is very large. Very large, because it includes another section -- manipulator.

Q: Okay, so then you – The robot came back.

Yoshiaki Shirai: Yes, yes, yes. At that time I was involved in the advanced robot for hazardous environments.

Q: So what kind of projects were they working on in the division?

Yoshiaki Shirai: The whole project is very large, and involved many companies, and -- big companies -- Hitachi for locomotion and Mitsubishi Heavy Industry for teleoperation and Toshiba for vision for recognizing the valve or the piping, and MITI laboratories -- there are the two laboratories, one is ETL, one is MEL -- Mechanical Engineering Laboratory. So for ETL mainly we are working on planning on this assembly and assembly of the valve. And also sensor planning to execute that task, what kind of sensor is useful and where we should look like this.

Q: And what was -- So there was a big application. What was the application?

Yoshiaki Shirai: Application. It is said maintenance in nuclear plant, because name is advanced robot for hazardous environment. But we don't think of that it's not inside a plant. Because if it's inside a plant, we must think of the radioactivity. Then, must we think of the camera also, bit different, but we don't think. That is usual plant. No difference. We have interest in robot technology, not nuclear. <laughs>

Q: So it wasn't really put in the field. It was still more of a lab project.

Yoshiaki Shirai: Most of the research, not only the research in national laboratories but also in the companies. The name is for nuclear plant, but actually it's a factory. So that gap had some problems later.

Q: So why did they become interested in nuclear plant?

Yoshiaki Shirai: Hazardous condition consist of nuclear plant and underwater and also the fire for the petroleum plant. And for the fire our technology no relation. It's quite different from industrial robot. And also, under sea, there is a company, for example, Mitsubishi ship company making the ship which can move very freely. That is not useful for industry. So, we have interest in nuclear plant, because it very similar to usual plant.

Q: And so what were some of the challenges that you were looking at in terms of technology?

Yoshiaki Shirai: In my laboratory, there was a very good researcher. He's called Katsushi Ikeuchi. He working also with recognition of 3D objects. It's stacking <inaudible 00:51:17>

each other using stereo or what he called Photometric Stereo. When I was chief of computer vision, he entered. Mostly he himself works about to. I am supervising him in literally. And he left to at first MIT and come back again and left for CMU. Also, there is some other guy, we call Sugihara, entered here after finishing the master course, and he – I give him the theme that is use my rangefinder to make the line drawing. Using the rangefinder that much easier, but took very complicated scene and very effective. So, the idea is similar to what I did before the line drawing just picture <inaudible 00:52:23>. And also he got best paper award. But we are close – loosely related. ETL -- boss and the researcher for both directors was very loosely coupled. So when I was a researcher, if I find very interesting thing, I don't ask him if I can do. Myself can do this myself like this, so work freely.

Q: And the funding was very open. Did that change at all?

Yoshiaki Shirai: The funding? Yes. Funding come from some project. But once we get the computer and the camera and some peripheral devices, that can be used anywhere.

Q: And they didn't mind in terms of your time? So you could use your – Was there – Well, maybe this is complicated, but Google lets people use 15 percent of their time on personal projects. Was there something like that?

Yoshiaki Shirai: No restriction.

Q: No restriction.

Yoshiaki Shirai: Nothing. If somebody's working here or he want hobby, but no one complains. So long as he's working good in the main project.

Q: So how long did this maintenance project last?

Yoshiaki Shirai: Oh Yes, I forgot to -- while we are working with the task planning like this. Also for example, Takase, at that time in manipulator group, developed the direct drive manipulator and performs very complicated task. And while our -- 1955 when Expo held in Tsukuba and that – a little before that time – many visitors came. The prime minister of France and Thatcher and also the I don't know the head of the European Community, and we showed many things. I remember that direct drive manipulator was broke while the EC directors were looking at it. <Makes noise of machine malfunctioning>

Q: The curse of the demo.

Yoshiaki Shirai: So that has never happened only once. So very rare case while very important people looking at it.

Q: Bad luck.

Yoshiaki Shirai: Yes, bad luck.

Q: So did you work –

Yoshiaki Shirai: French – Mitterrand. When Thatcher came, we gave her the portrait of her face.

Q: From the robot's point of view?

Yoshiaki Shirai: Yes yes. The vision group made this.

Q: And did you work closely with the manipulation group, still?

Yoshiaki Shirai: Still – what do you mean still? At that time I was director.

Q: Right, I mean I'm just trying to understand how the groups – So do the groups work together a lot? or

Yoshiaki Shirai: Not a lot. But sometimes we work together. Maybe – you know I told you the vision feedback. At that time we must demonstrate some new things, and Professor Tsuji and Inoue's boss asked us to perform the visual feedback. And then we cooperate with each other.

Q: And so this was – Which year was this in?

Yoshiaki Shirai: Seventy -- 1970. Just after he entered you know he entered ETL. And after that wrote English paper and then some comment come, and rewrite. At that time I was at MIT asked Minsky to check my English. <laughs> I remember.

Q: So umm when did the – When did the plant project end?

Yoshiaki Shirai: Uh it's about seven years -- 98? I don't remember well. I'm not sure if it's right.

Q: Was it in the 90s or no? Oh wait, well, it's Thatcher so --

Yoshiaki Shirai: Yes. If I see this and look at it on the computer, yes.

Q: Okay, it's no problem. So what -- Were you there -- When did you -- How long did you stay in ETL, 'cause then -- Till '88, right?

Yoshiaki Shirai: Yes.

Q: Did you do any more projects at ETL while you were there?

Yoshiaki Shirai: Myself?

Q: Or with the group?

Yoshiaki Shirai: Not too big project, but small research we did. So One which related to robot -- myself at that time I was a little far -- a little separated from robotics, but I am interested in the vision itself. And also because I am interested in some robotics, I made comments, for example, for the obstacle avoidance of manipulator like this or sensor planning. I remember that there was a German visitors, and he's working sensor planning, and I discussed and made some comments. They wrote papers, and at that time the Japanese co-workers include myself in there's the author, and the German said, "Oh, it's necessary to include me," he said. <laughs> I remember very well.

Q: Who was the German? Do you remember?

Yoshiaki Shirai: Yes, I know. Usually, I remember.

Q: It's hard sometimes. If you remember later, you can just email me. It's no problem.

Yoshiaki Shirai: Ah, he came from Karlsruhe I think, and come back and spent some times and went to Brussels by European -- there is some European organization as a scientific attaché, yes.

Q: So you ... you kept working on some of these robotics related projects as an advisor.

Yoshiaki Shirai: So many work possibilities. The other section is working on mainly hardware for computer. Also, I sometimes discussed that. So many directors and so many researchers, so I don't remember. <inaudible 01:00:55>

Q: No problem. How many – How big was the –

Yoshiaki Shirai: Oh, Niepold. N-I-E-P-O-L-D.

Q: Ok How many people were – researchers were in your group? How big was it?

Yoshiaki Shirai: About 40.

Q: And when you were a director, did you have to –

Yoshiaki Shirai: Forty, but that is regular member. And we also accept students and the visiting researchers from the companies, so working more people working.

Q: That's a very big group to manage. So did you have to help choose projects or communicate with METI in anyway about what to do.

Yoshiaki Shirai: One things is that we are a little famous in Japan, so many companies come to look at us. And also there are many – some companies who ask to solve their own program. At that time, we accept researcher from the companies and we worked together. I worked together with many such companies. For example, Denso or Matsushita, at that time Matsushita Electric Works. And we complete some method and get patent. That's why there are many researchers. So at that time they gave us some problems and if I think that is interesting, and then work together using the computers.

Q: And what kind of problems did you choose?

Yoshiaki Shirai: Of course, vision related. For example, the inspection for solder joint or inspection of the maybe the surface if there is some cracks or similar like this.

Q: Any other project that you want to mention or that are important?

Yoshiaki Shirai: Not my main directorate, but in my division, of course, there are some robot company who would like to make some planning and force control like this, so that robot companies researcher comes and work together.

Q: Which robot company?

Yoshiaki Shirai: Ah, Kobe Seiko and some others which I don't remember well, because it's manipulator group.

Q: They were working more closely.

Yoshiaki Shirai: Ah, maybe – once a year, the manipulator group meet, and I sometimes attend them at the end of the year. So, sometimes the researcher from that company joined.

Q: And then they kind of exchange ideas and maybe brainstorm new projects?

Yoshiaki Shirai: No, just very good days we spend, so we remember that days. And we what are you doing now. There's an exchange. A current, yes, conditions.

Q: So why did you choose to leave ETL in 1988?

Yoshiaki Shirai: I myself like ETL very much, but the number of the members of ETL is limited. I think if we stayed on, so not many people can enter. So, when I entered ETL, my boss' boss told me that don't think you can stay here for long time. You must quit. So you must work very hard so that you can go anywhere. That is the first day. The first day he told me. So I think always it's almost time. At that time there is proposal for Osaka university – before that there are some proposals, but it's too early. And I became the director, then I am not directly related to the work of research, so I don't think that – I cannot continue, 'cause I might be spoiled. It's a very good position. I don't money so well, but they work very good. I not to earn money so much, but I think that I cannot continue for a long time. That is.

Q: So how was the university different from working at ETL?

Yoshiaki Shirai: Not free universities. Lack of money. And the most important thing is that at ETL there are many researchers in the same field and which I discuss. But in universities they are still mostly professor, associate professor, assistant researcher and the students. This is

“vertical relation”. In ETL, it’s “horizontal relations,” it mean equal; so we can discuss very freely. But in this lab the discussion is not so equal. That’s the big difference.

Q: So did you enter as assistant or enter higher?

Yoshiaki Shirai: Yes, yes, as a professor.

Q: As a full professor.

Yoshiaki Shirai: Yes. Maybe if I enter as associate professor, I cannot be a full professor.

Q: So umm were there people already there who were doing computer vision before you?

Yoshiaki Shirai: No. No. I entered in globally mechanical engineering but that is called – it’s control, okay, electric control. So it’s more near to information, but basically mechanical engineering. So no one is working on vision.

Q: So you were the first.

Yoshiaki Shirai: Yes.

Q: And how did you develop?

Yoshiaki Shirai: I’m the first in that course. But there’s some other part which are working on vision.

Q: So did you work with them?

Yoshiaki Shirai: Yes. Laboratories in electronic course. There’s some special laboratory. In some laboratories, they work on vision.

Q: So how did you start your lab?

Yoshiaki Shirai: How do you?

Q: Yes. What students and money?

Yoshiaki Shirai: I decided not to continue my research in ETL, so quite different. So, I started from -- at first we must prepare the basic tool and then for because just students not researchers. So, start from very easy scene -- so the recognition of the outdoor scene or stereovision for indoor scene because stereovision not so quick. So, rangefinder is suited for industrial application. Stereovision at that time is not -- still not far from the real application. So stereovision and outdoor scene understanding, ok. Not useful for industry and motion picture analysis, for tracking human beings.

Q: Why did you decide to do that? Why change?

Yoshiaki Shirai: Yes, later -- of course I was working from robot which -- okay later I will talk. At first the while that is if I work, we compete with ETL. So it's not so good because we know each other. And also that is good for industry and that means these not good for students, that is the motivation. And at first, I was working with Professor Asada, Minoru Asada, he's also famous, and he moved to another laboratories as a professor. Then I worked with Kuno, Yoshinori Kuno, who spent maybe one year or two years in CMU and come back to Toshiba, and we worked together in a big project. So I know he's very good so I asked him to come. And he's interested in human beings, so the interface with human beings, and even in his philosophy is not possible for the computer to recognize everything. So if we don't know, the computer doesn't know. We asked human beings. I think that is a very good idea. After he left, I decided to work similar one. That is to bring things for the handicapped person or elderly persons. That is very useful because at that time my father, already died, at that time he was -- sometimes he asked me please bring something, and people say, oh, for the meal can only one time. For meal human beings can come and eat, and that's okay, but please bring me something. Must be prepared for every time. So I think that's a very good application, and then at that time already there was a demonstration, for example in Tsukuba Expo 1985, there was a demonstration that is by Tokyo University, one person is in pain and robot comes here and take the bottle on the table, and bring here. But I think usually bottle is not on the table, okay, that is in the refrigerator. The difficulty is how to pick up the -- yes, the bottle from the refrigerator. Instead of -- yes, how do you put this -- **<inaudible01:13:29>**. So then take some drinks from refrigerator and take off and bring, that kind of work I started. So I did part of the vision part and my -- at that time my assistant professor is working on motion -- automatic vehicle, and he is now professor at the university and he is working. Now famous in Japan. So, at that time when the robot cannot understand what is the object then he ask this object or this object. I can't recognize that object witch you ordered, then save picture to him and then he break up -- just behind the Coke, then robot understand, oh behind the Coke I understand, this must be the object which he like. Like interaction is also useful. So our laboratory includes speech recognition, and how to interact. Speech recognition itself is not my work, our work but a way of interaction, and precisely but very quickly.

Q: So did you start working on this immediately in the late eighties, or was this in the nineties?

Yoshiaki Shirai: '88, Start from the very basic themes and outdoor scene and stereovision and then tracking people, and then robot which bring things.

Q: So then you had to do some studies with people, actually.

Yoshiaki Shirai: Yes. Yes.

Q: So kind of like human robot interaction study, and developing some of the interface?

Yoshiaki Shirai: No. Just, at that time interaction. For example, if robot is certain this is object, so he shows this is object so I bring this. If this object or this object. <taps table> I don't know whether this is a object or this but I think this is one. Is that okay? Then they say, oh, another one, and if it unclear then I found these objects I found, but I don't think this is one which you order, then human beings says, oh, next to this object. That is easier. But if without the saying, oh, I cannot find the object itself, what shall I do? Then the person <inaudible01:16:54>, because he don't know.

Q: Right, how to explain.

Yoshiaki Shirai: Yes, yes. Like this – what is easy? Also, he extends the object from the bottle to the fruits, many kinds of fruits. At that time there are many fruits, and look at this, and so human beings think, oh, that fruit I like. They're seeing an object. How to profile good information which is easy to specify the object humans beings like.

Q: And were you working with any – you mentioned you were working with somebody who had a robot who was implementing.

Yoshiaki Shirai: Yes, in my laboratory I had a robot.

Q: It was a little mobile. What kind of robot?

Yoshiaki Shirai: Yes, rather vehicle because it must open the refrigerator.

Q: Oh, so it had an arm, and was a mobile robot with an arm.

Yoshiaki Shirai: Yes. It moved in front of the refrigerator open and take –it requires rather large arm. So it's heavy. So large, vehicle. <laughs> But the manipulator itself we don't make much progress. That we follow the current technology.

Q: And what other projects did you do in your lab with your students?

Yoshiaki Shirai: With my students? It's application of the human tracking. And that is analysis of soccer game. Soccer and ball. You ask that goal scene <inaudible01:18:46> -- and the success of long pass then it shows desk scene.

Q: Any other projects you want to mention?

Yoshiaki Shirai: Yes, many projects. <laughs>

Q: Whichever ones you think are important.

Yoshiaki Shirai: Yes. After that – many people working in gesture. Gesture is very easy, I think, because gesture cannot express so many things. But -- do you know that hands – sign language for deafness? Sign language is very difficult because it overlaps with each other like this, and also over with face, same color. So, I found it very difficult. So, I – we moved to this recognition with handshake. So, one person find how to find 3D structure from the contents. He works his students, he's now working with me at Ritsumeikan University, but after that there are several – few Ph.D. students who work on how to find the 3D shape of human face hand posture by overlapping with each other or <inaudible01:20:19> background. Some parts is very similar to the current <inaudible01:20:27>. That is one of the big subject. Maybe I forget one other subject. <laughs>

Q: So how do you think the challenges of computer vision have changed through the years since you've been in the field for such a long time?

Yoshiaki Shirai: Oh, in general?

Q: Yes.

Yoshiaki Shirai: In general. I think the one – there are two things, okay. One is that the information which can we use – we can use increase the monochrome picture and color picture, motion picture, and from motion picture from many cameras like this. Another is the speed of

the computers increased. So and memory increased, hardware. So we can may take method which cannot be taken in old days, especially for motion picture analysis. You can use that online.

Q: And what about the connection between computer vision and robotics? In your work you've had some times when the robotics – having the robot do something helped come up with problems for computers, and so how do you think those are connected?

Yoshiaki Shirai: Because manipulation and motion – locomotion itself is developing and also the vision developing. So, at first, they're in primitive stage and they're working together, but as they develop – then it's not easy to work together. So the current situation is that for manipulation group or locomotion group they make use of the current technology, and for us, the vision group, we make vision, but sometimes we need manipulator for locomotion. So we use the current technology, but this is -- in the old days both are advanced together. Together.

Q: So it's not so easy any more to work together.

Yoshiaki Shirai: Yes. Sometime we integrate it, but at that integrate don't – not both team, okay. one team which make importance of vision group would like to integrate to ask the manipulator <inaudible01:23:01>like this, vice versa.

Q: What about in your group – in your work. How have the kind of questions and challenges – what are some of the challenges you're interested in now? How have they changed?

Yoshiaki Shirai: So I left to Ritsumeikan University about six years ago. I – mostly I continue hand gesture analysis and also service robot, I continue. Still get difficults.

Q: So where are you now after Ritsumeikan?

Yoshiaki Shirai: Now I'm in last stage of Ritsumeikan.

Q: Oh. Last. <laughs>

Yoshiaki Shirai: I'm still professor at Ritsumeikan university. Six years ago.

Q: And Ritsumeikan, is the funding situation still the same as in Osaka kind of difficult, or where do you find funding for some of your work?

Yoshiaki Shirai: When I moved to Ritsumeikan university, I have much money that ten million Yen. We can use freely. So we bought manipulator and computer mainframes. So after that funding not very ruled as Osaka University, but because we have very good money, so -- we are not suffered from the funding.

Q: And in Osaka. Osaka has a lot of robotics activity happening, especially with some of the humanoids and androids and all kinds of –

Yoshiaki Shirai: Yes.

Q: Yes, Ishiguro Sensei. <laughs> Did you have any connection with some of those people?

Yoshiaki Shirai: In research, no. But Ishiguro – Asada is still <inaudible01:24:56> Tsuji, Professor Tsuji, and I know he is still -- and also Ishiguro is still <inaudible01:25:02> Tsuji, so while he was student, I really know each other, and they moved to Osaka University, my campus. They go another campus, he moved to this campus. So we know each other. We discuss very often, especially with Asada once we have a team, so --. But after we separated, we have no direct relation in the research, quite different. For example, Asada has research interest in baby – how the intelligence of baby start, and also Ishiguro has interest in human beings itself and the robot is used as a tool to analyze human beings. So, we are interested in the robot which is useful for human beings, so I think different.

Q: What are some or the challenges you think in computer vision coming up, or robotics?

Yoshiaki Shirai: In my laboratory?

Q: In your lab and then also in general?

Yoshiaki Shirai: Oh.

Q: But first in your lab.

Yoshiaki Shirai: In my lab. Yes, I continue and another one is to work with the analysis of human motion by just with one camera. We start resample especially for golf swing we started when I am in Osaka university working together with some company which produced golf equipment. Then one system we completed that consists of two cameras use in indoor. So we can -- it's easy because we can take background and human being comes here and we can make subtraction. But now more difficult with only one camera without background image.

Q: So outside basically.

Yoshiaki Shirai: Yes, outside. Daytime and night. Yes, it's very difficult. So we are working.

Q: So this is to kind of help people learn how to do the right golf move?

Yoshiaki Shirai: Yes. Advise -- You are this part is wrong, like this. So yeah, and my co-worker, Shimada, once work on this, still working very quickly using many computers <inaudible01:27:38> very precise also <inaudible01:27:44>. So most of the work is for gesture, gesture is easy because these discrete -- and hand sign language a little difficult because there are many kinds of shape. But Shimada interest in without any application. Very small difference they can <inaudible01:28:10>. Maybe more about medium kinds of shape. <laughs> That is also a challenge because it's a 3D shape.

Q: And for computer vision, in general, what do you think some of the future problems are?

Yoshiaki Shirai: Future problems. Before that I was -- not now, popular thing is to use many pictures collected from the Internet as training, and try to recognize all of it. And that approach is so popular and I avoid it. But three years ago, some students from Vietnam came here as a master course, tried to work that thing, and there is no one who can take care of him. So, then I have to take care of him, and we work together and make a system which can recognize a car, bicycle, airplane, horse. <laughs> And sheep like this using very -- yes, samples, and I found that it's possible for a certain extent. Maybe 90 percent is successful, but the problem is if it is not successful we don't know how to change the algorithm, okay, because we don't analyze logically but just gives many examples. So, that's very popular. So, still I continues because it's easy, because there are many selected features of images. Using that features for giving <inaudible01:30:56> select the many features. So which kind of features are available and extracted. Then this is a horse, okay. Another horse coming, so many pictures and this is a not horse, and then just scribbles this automatic way then there are some system, mostly correctly recognize horse. But that a little different from human beings. So that is not the tendency, but many people are realized that is because recently in Japan, the Japan Information Society in Japan, Information Processing Society in Japan had a special issue on vision and they something

ask what is not done and it says only use one picture, without many retrieving picture how to understand the picture, that is the challenge, it says. So, that is what I thought from the first, I use only the pictures. So, if – the difficulty not easy so but I think that person who knows very well, you think that is **track** vision. But not many people would track because it's difficult, it's not easy to write papers. So for a moment the current technology of machine learning is very popular. And they succeeded in face because they have many sample of face and many researchers work together. So face recognition **<inaudible01:32:17>**. So if the killer application is found then that vision system will be made in a few years.

Q: But nobody knows the killer application quite yet.

Yoshiaki Shirai: Without the killer application they cannot concentrate on the program.

Q: So we have one final question that we ask everyone, and it's kind of for education. So if there were – if you could talk to some young students who are interested in robotics or who are interested in computer vision what would tell them as advice for how to start?

Yoshiaki Shirai: At first they must have much interest. So if – it it solve the problem then they have no interest. When I was young student at that time the Eiichi Goto, who is famous for the – he is very famous for Parametron Computer, is interested in vision. He said he himself is not working on vision, he's a physicist. There are many picture taken in physical experiment, but to analyze this, it take a year. To take pictures, maybe a week. So please you – I cannot do but please you help us for analyzing – the vision people analyzing this. So I listened to this. Oh, vision is very useful. That not solved, that's very important. So we must not tell them that this is complete, this is complete, this is – oh, very interesting. Then it's not interesting <laughs>. This is not solved. This is so **<inaudible01:34:16>**, please help us. That is very important. So students also try to find what is lucky, and if it is helpful please come in, analyze – no, apply the current tool and just conventional way, and just small different applications, that can be done by everyone. So that's interesting. And also I graduated from mechanical engineering and moved to the vision. That's why I can do many things which cannot be done in different field. So robotics include many fields, so even if they think I am not related to robotics, no problem. Someone comes to robotic field there are many things to do.

Q: Thank you. Is there anything you wanted to add that we didn't cover?

Yoshiaki Shirai: I don't know exactly the purpose of this, the history?

Q: Yes.

Yoshiaki Shirai: So about 1980, in our group in ETL, there is also this hand -- hand manipulation that is fingers working, this is tele advanced. When maybe Mitteral <phonetic 01:36:20> comes then shake hand and show -- and at that time I think ETL is very advance in field of robotics, and also how to -- carpenters, robot carpenters.

Q: What were they doing?

Yoshiaki Shirai: Yes. Robot carpenter that is just -- saw, the wood, and then like hammers, yes, use those things, carpenter who make some object. In block's world they said put and <inaudible01:36:59> but in actually make this using the force control. So I think ETL's robotic groups advanced in that time -- at that time.

Q: Why did they stop being more advanced?

Yoshiaki Shirai: One reasons is that some person who is very eager left. The other is that once it is demonstrated, they're done. Many other laboratories can easily follow. No secret. We very open, so --.

Q: And I was just curious but how is -- you said you worked with Masahiro Mori. How is he to work with? What kind of -- I know you said you didn't see him very often?

Yoshiaki Shirai: Oh.

Q: He's also very famous.

Yoshiaki Shirai: Yes, he is.

Q: Young kind of.

Yoshiaki Shirai: He likes the peculiar things. So because I'm a little orthodox. For example he -- I received -- he gave one lecture for us only one lecture because he belongs to the laboratory not the school so -- and I attended and I write report and then the evaluation not so good, and I asked him why my evaluation is not so good, not the best one, the second. I think I have the best score in my field, so --. He said, "you are the like a sample." "Nothing's special," he said. "So, you should have said some before that." <laughs> In that way, so he accepts everything but he doesn't teach any. That's the way they teach, but usually when we enter school, the course, maybe the professor give him there are kind of things, or do you like some of them, but he said

when he comes, “This is laboratory, not the university.” So university here, this is the laboratory. “So, you are not the customer.” Most of <inaudible01:39:48> industry. From industry they can money, and you cannot use much money and you must select the theme himself like this and I work – I make something simulator, electric simulator when I was working. And one day, <inaudible01:40:17> he came here. Oh, you have made these kind of things. Oh, soldering is very bad. You Pench <Phonetic 01:40:29> (Note: “Pench” is a Japanese word that means “plier”), you cut cut cut cut. You mustn’t do it again. He left. <laughs> So very strict in this, but he knows that I can continue even if --. So someone is working on some mechanical <inaudible01:40:54>, it is not a success but professor says nothing. Like this. So, very good days, even that situations someone is good, someone is bad, but not all bad. So, and after that, at that time, Masahiro Mori is very young, but after that he get a little old very well in Tokyo Institute of Technology, and then I met him. He’s like a gentleman. He changes very much because it’s a school, he must teach students. These are undergraduate students. He knows what the students are. <laughs> And then but he’s very creative himself, he started new project, robotics project, that is contribution.

Q: I heard you also had a research institute for Mukuta or something. Have you ever – maybe not.

Yoshiaki Shirai: It’s an research institute for manufacturing, yes.

Q: Kind of like Buddhist principles of manufacturing.

Yoshiaki Shirai: You know. Yes. The name of the laboratory is manufacturing industrial -- manufacturing laboratory like this. He has an interest in Buddha. So, he sometimes attends assembly of Buddhists. Not this kind of academic conference. <laughs>

Q: Great, thank you. Those are all our questions.

Yoshiaki Shirai: Okay.

End of YoshiakiShirai.mp3