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Shigeki Sugano

An interview conducted by
Peter Asaro

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Peter Asaro: Our first question is, where were you born? Where did you grow up and go to school?

Shigeki Sugano: Yeah, I was born... September 29th, 1958. I'm born in Tokyo and I lived in Tokyo Chiba, I've been near the Tokyo area from being born to now. In 1993 to 1994, I lived in Stanford. I was a research visitor in Stanford University in the mechanical engineering department. So first I want to say that my interest in robotics began in the – when I was in junior high school. So at that time in Japan, there are two famous professors; there are only two professors in Japan in robotics area. One is professor Ichiro Kato, my mentor at Waseda University, and the other is professor Masahiro Mori at the Tokyo Institute of Technology. I and my friends in junior high school are very interested in technology, advanced technologies including robotics and the rocket in space and computers, so that's kind of high technology. It's say, 1970s... and Professor Kato was interested in humanoid type robot and Professor Mori was interested in some biologically inspired robotics. So I am very interested in humanoid type robot, so I want one day to enter the Waseda University to study with Professor Ichiro Kato and fortunately I could pass the entrance exam to Waseda University and when I was freshman I visited Kato Laboratory, his office. Yeah it's 1977, and at the time there's no email and safe. We're using the telephone and things so I couldn't call the Kato Laboratory. So suddenly I visited directly to Kato Laboratories. Unfortunately, he visited China at that time so his secretary told me: when professor comes back to the university they will let me know that. So about two weeks I go to phone the secretary and I visit the Kato Laboratory. So Professor Kato was very busy at that time but he guided me and my friend all around the laboratories to see robots and also the hand prosthesis and leg prosthesis. It was very interesting and in Japan, Waseda University, I was assistant to enter the laboratory as a senior and write a thesis. So but... Kato Laboratory, many students want to enter so it is high competition but successfully I could enter the Kato Laboratory and first my research was about prosthesis, about the knee, under-knee. When I entered – after I entered the Master course, the new project started. It's a piano playing robot. So we called that robot WABOT-2, musician robot and I can play piano and so there are several master course students but Professor Kato asked me to engage in this new project. So, I was a Master student but I composed some project team in Kato Laboratory and also joined the civil laboratories in searching about vision system and speech sensor system and computer system. When I entered the master course, now Intel and Ziro and Motorola announced the 16 bit microcomputers. So before that, we could only use 8 bit microcomputers so Professor Kato was thinking that we should introduce 16 bit microcomputers and intelligence of the robot is very important, very important. So we have many meetings and decide to develop the piano playing robot, so it was WABOT-2. And my Master thesis and Ph.D. thesis was about the piano playing robot. And then hand coordination and also the autonomous system, those are piano playing, music playing. Then the robot can use the normal musical score and the timing, the fingering and the motion, the body motions, everything, autonomously. So successfully we could display the WABOT-2 system in the Tsukuba Exposition in 1985 so it continued six months but every day the robot, WABOT-2 system could play the electronic organ for six months. So there is my Ph.D. thesis. So in the Kato Laboratory, we considered this a huge

robot. The very important point for the future robot is a human robot communication and dexterity and intelligence. So we introduce and design all kinds of such functions to the WABOT-2 system. Such experience was very, very important for me to my present research contents and everything. So... unfortunately my mentor, Professor Ichiro Kato died when I was in Stanford University as a visiting scholar. But just before that, I and Professor Kato studied the new project about what is a mind? What is a mind of the robot? What is a mind of human? We say kokoro in Japanese. Kokoro is a kind of mind, our affection, my emotion and intelligence, everything is combined, we call kokoro in Japanese. So I decide to try to realize such kind of kokoro in robot, that's a new project. At that time, before Stanford University I began the tenure of professors Waseda University, fortunately. I set my research thing, human robot interaction and human type robot which has some kokoro, or mind or intelligence or emotion. There are two big projects in my laboratory, it continues for about 20 years or something. So I developed a TWENTY-ONE system; you can see that in the website on my laboratories of the human symbiotic robot and with human robot interaction functions. Also we developed WAMOEBE – WASEDA Amoeba. It's a typical example of a robot that has a mind or engage in some functions. So... these two things are very interesting. So many high school students of course including students at the university are interested in such kind of robot and many students visit my laboratory and discuss about such kind of robots. It's very fun for me to discuss with young students to develop the next generation robot. So... now, in my laboratory I have about 30 students and 10 Ph.D. and assistant professors on my staff in my laboratory and we try to realize the real human symbiotic robot and also the robot that has mind, kokoro. That is now my present situation. I want to say that discussion with other country's people, they have different culture to discuss kokoro, mind and human robot interaction. So probably the culture is different than the sense of value is also different, but the robot is kind of copy or some say... that artificial machine but... very resemble oriented to the human. Then the discussion is very important about mind or usually – most of the researchers interested in intelligence, not emotion. The difference come from the difference of the culture but many Japanese people want to discuss as kind of kokoro mind emotion in the robot in the artificial things. Because I think it is very important because that intelligence, only thing knows their intelligence will be emotion or kokoro because there are many studies about learning system, but it needs some evaluation criteria. It's based under some survivor or some benefit for the robot itself. It's the same as the humans. So I'm very interesting in the what is the origin of living things, or the origin of the intelligence, then we should study about emotion more. Emotion is a kind of origin of the living things. So now... just now I am very interested in those kind of functions, original functions in our robotic system. It's from the point of view like meaning that's artificial machine or artificial things or everything that we can call it alive.

Peter Asaro: And so do you think this Japanese perspective of kokoro and the integration of intelligence and emotion is also part of why they've developed many more humanoid robots as well?

Shigeki Sugano: Yeah, yeah, yeah.

Peter Asaro: Waseda in particular has developed a number of humanoids.

Shigeki Sugano: Yeah there is several meanings with humanoid. Some researchers says the style of the robot is like human, so then it's humanoid but in my opinion, it's a very wide meaning. So humanoid, yeah, of course head, two arms, and two legs, or something; that is a kind of humanoid but yeah so... Not only the style, but also the functions is very important for the humanoid, so we call that, yeah there are very – there's no leg and no arms, but there is only a head and body... but it's... activity resembles a human or some intelligence or some so facial expression or something, we can call such kind of robot humanoids; because it's close to the human or living things. So I try to focus on the function; the living functions, arriving functions of the robot. So it means as a – we believe we are living, right? Then, in the case of the robot, what happens when we consider that alive, living things? So it means that we regard architecture machines as a human, then we can call humanoid, a kind of humanoid. Can you understand that?

Peter Asaro: Yeah, yeah definitely. So you said in the 1970s there were just these two professors working and –

Shigeki Sugano: In Japan, yeah.

Peter Asaro: So I wonder what the sort of broader context of robotics in Japan were and why there were so few people then and how it grew over the span of your career and also the relationship between the kind of manufacturing robotics and the research robotics and then the academics.

Shigeki Sugano: Ah, probably at that time, it is separated; the industrial field and the academic field. Also the in 1960s there are few robot researchers all over the world, in Japan also and then the Professor Kato told me once that he couldn't use the title robot in his research because it's a field of science fiction, not academic research. Most of the researchers regard robots as a kind of science fiction, most of research thing. So then the Professor Ichiro Kato uses a word, artificial hand or artificial rake and applications is the medical field; some hand prosthesis or something. But, 1970s so the 8 bit microcomputers and such kind of computing system is developing was developing and so we could use such kind of intelligent functions. Then many researchers in the world start robotics, so there's no problem to use the word robot. But 1960s, it is a bit difficult to use robot in the research area. Probably in the US and Europe, the same situations and in 1970s so industrial, yeah of course industrial robot had started in the US, the patent of Devol and after that, there are many industrial robots developed. And in Japan in 1980s, many robots introduced to the factories. So but we did not concern – did not have the relation to the industrial robot in the States. Of course there is kinematics, dynamics, and theoretical field, there are many researchers in the academic field, but the industrial robot did not require such kind of say advanced kinematics or the dynamics so that the industry robot could move and contribute to the

automation. The interesting thing is that in Japan, industrial robot in the number of industrial robots, it's high compared to other countries. That means that the very type relation that I do, the research about the mind and the kokoro. Many Japanese or most of Japanese accept to consider the mind and kokoro in the robot artificial of things. But in America and Europe, it is very difficult to introduce such kind of philosophy or concept because... you know that there is a kind of toy. If the figure is human or the animals and small child throw away or breaks such kind of toy, then in Japan we are upset. Oh, she's crying. She means a doll, or animals. But probably in US, Europe, you... you tell your children don't do that. It's broke. So it's a sympathy with such kind of artificial things. We are easily sympathize with such kind of dolls or the artificial things, but resemble to the animal or the humans. Robot is for it's come from the difference of the culture or the religion. So... about industrial robot, it is the same situations. In Europe I heard from some professors in Europe, he said that the European people, first the company tries to enter the industrial robot, they refused because a robot replace a human. But in Japan, the laborer in the factory welcomes the robot; they are friend. So they called such industrial robots, <inaudible, Japanese>. It's a yeah... idol in Japan; very beautiful lady actor. So they are welcome to introduce industrial robot. People that they are sympathize with such industrial robot as a human friend. That's a big difference, difference with the culture and concept. That's a very interesting point, the difference, the research in Japan and other countries.

Peter Asaro: And I guess related to that, so where does your research funding come from; is it mostly from the government, or do you also work with industries?

Shigeki Sugano: Both. Of course Japan has governmental funding, like NSF in US. We call NEXT <inaudible Japanese> has a big fund for the research field, all of the research field and those about the robotics, several companies are very interested in developing the future robot, then some companies ask me to collaboration to develop the new robot. So I want to mention about the TWENDY-ONE robot system, it's a human symbiotic robot. It was also a result of the cooperation with companies; all the fund from the companies. Also it's a company do not ask me to develop the robot, they ask me to collaborate to build a new robot, so there are many steps involved, many staff in the industry, the companies joined my laboratory and many students joined also laboratory... project in my laboratory. So there are about 10 to 20 researchers involved for 10 or... for 7 years to develop TWENDY-ONE system. So... it is, it was confidential project for 7 years, I couldn't report anything in the conference, <laughs> or research papers. So three or four years, I couldn't do... I couldn't report the research result, so before starting the TWENDY-ONE system development but three or four years, the number of reports reduced <laugh>. Then my friends in Japan asked me, what I was going on... For what research you did. So there are huge reports in the confidence, but I couldn't say anything. I couldn't say anything about new project. But yeah that's project to study during 2000 and completed 2007... and I press released the TWENDY-ONE system. So probably at that time it's... a top human symbiotic robot in the world; I believe that. Yeah so many people – researchers know the TWENDY-ONE system, also visit many with many, many researchers in my laboratories to see the – check the TWENDY-ONE system. Interesting is that I press

released in December and – in November, and just after two days or something, the people in the Willow Garage in the U.S. telephoned me. They want to visit my laboratory to see the TWENDY-ONE system. On that time, it not famous, the Willow Garage, but after that, you know, it's a very big company, and now it's split to other companies. So the president and some technical operators visit my laboratory. Yeah, accepted their visiting. So they checked a TWENDY-ONE system like that so that we had many useful discussions, yeah. I remember that. It's just after the announcement of the TWENDY-ONE system. Just two days after.

Peter Asaro: What were some of the Japanese companies that you worked with?

Shigeki Sugano: Hm?

Peter Asaro: Which Japanese companies did you work with?

Shigeki Sugano: Yeah, many companies involved with that project, but there is a main company, but it is confidential now. It's continuous. But you can know that, too. It's in my report, because in Japan, we had several presentation in conference. And it includes the company's name. But officially, it is confidential. But big companies, and also the big company in the robotic field actuators, sensors field involved many industries involved that project. Yeah, one company supervised everything, but many companies, probably you know all the companies names that are involved with the TWENDY-ONE project.

Peter Asaro: And were you also working with other university researchers and roboticists on this project or other projects, other operators?

Shigeki Sugano: Yeah, in Waseda University the very good point is that we can easily cooperate. So usually, one laboratory has one professor and he or she manage everything. And there are many laboratories in universities and they are independent. So it's almost same situation that U.S., Europe, and also in Japan. But in Waseda University, it is easy to collaborate with similar laboratories to the one robot or two robot. So for example, I already mentioned about the WABOT-2 system, musician robot. It's four laboratories collaborations. So Kato laboratory, developing the hand and arm and leg and also the intelligent motion generation system. And other laboratories, develop the vision system and speech recognition, and speech sensor system and also the computer system. So it is – Robotics has very wide feet from the materials to computer program. The mechanical engineering, the informatics and electronics, everything. It is kind of impossible to cover all the area of the robotics. Then generally, each laboratory has some topics, for example, the frame or the hardware for the hand, so it's a special topics each laboratory has. But if we try to realize a system over all the robots, we have to introduce many kinds of advanced technologies, materials, computers, electrical circuits

everything. So we should cooperate with laboratories and companies that have very special technologies or know-how about that electronics and computers, everything – in the field. So in Waseda University, now in Waseda University it is very easy to cooperate with main laboratories. So we communicate, always communicate and gather information or advice. Also, the students communicate with each other. It's very good for the students to run everything about the robotics area. So it's probably very good point in Waseda. We have advantage of it.

Peter Asaro: Yeah. Who are some of the roboticist professors that you've collaborated with?

Shigeki Sugano: At Waseda University? Now, there are professors related to Kato, Ichiro Kato laboratories. Professor Fujita, Professor Takanishi, and Professor Fujimoto and I. And also, there are very famous professors, but in the field of vision and speech recognition sciences and there are Professor Hashimoto and Professor Kobayashi. And Professor Iwata who graduated my laboratory, now became the full professor. And about seven or eight professors involved with the robotics laboratory we call the Human Robotics Institute in Waseda University. So each professor has special topics, but sometimes we collaborate and build one robot based on the funds from the government. So about five years or ten years maybe, we developed a kind of say, collaborate result in the new robot. Now, you know, the 311. It's a Fukushima Nuclear Power Plant accident. So the Japanese government are the big one to develop how to combat, recover power plant. Also, how to assist the residents, humans in the Fukushima some area. So we are now cooperating with some companies and also the cooperate with several laboratories to develop a new robot. It's a directly not relation to the Fukushima Nuclear Power Plant, but it's a relation to the humans that live around the Fukushima area or something to assist those so that say, keep the safety and it's a new field to develop the robot in Waseda University's team.

Peter Asaro: They have a safety – robot safety institute in Tokyo, right? Is that with Waseda?

Shigeki Sugano: Safety institute? Probably it's by Japanese government and AIST and TSUKUBA. But it's a little bit different. Safety has many meanings. So one is checking system of the – that this robot is safe or not. It's a – AIST has an institute for such robotics. I don't know the exact name, but probably the Dr. Yokoi-san knows where about that. In my case, the safety means safe human robot interaction. So the robot works around the human. The robot has safety functions. So the industrial robot, there are many kinds of robot. There are some say, isolate by the fence or something. But the human symbiotic robot as a safety function, it means that the soft function was given some recognition function to touch and have the physical interaction. The safe robot means that a robot can have the physical interaction with human. That means safe. Safety. So the Fukushima Nuclear Plant or a mobile robot safety it has different meanings.

Peter Asaro: What's the biggest challenge for human robot interaction and really getting this sort of emotional recognition into the robots? What's the technical challenge?

Shigeki Sugano: Technical, yeah. Important thing is how to recognize individuals. So in the way we have field or that such a system that something the human lady like. So the robot has to have the function to recognize human individuals and adapt to individuals. So we human can assist other person easily, because that we can understand themselves. We can understand them, what are the conditions or some feelings. Then, for example, in the hospital, so the nursing care requires adaptation to each patient. So they understand that individuals' conditions the same way. The robot have to understand the differences of individuals. So very difficult. But it is very important to realize and introduce a practical field of the humans and symbiotic robot. It's a challenge about topics.

Peter Asaro: And that allows them to prioritize the goals and perceive the world according to the – what the people around them might need.

Shigeki Sugano: That means that priority?

Peter Asaro: Yeah, well, I just – So once you recognize somebody, then you can adapt to their particular needs, but that would change your goals as a robot, right, to adapt to the needs of who you're working with?

Shigeki Sugano: Yeah, the important things are how to – Important thing is to collaborate with hospital and real world facilities and all kinds of touching and nursing care system, peoples and we have to collaborate with them and what is the essence of the technology the robot adapt to human. So now it is very difficult problems. So now we are looking for what is important things to proceed this project. So that is the first stage. Of course, the conversation and human speech system and speech recognition system and that kind tool, not the real functions. The real function is that how to recognize individuals. That is a new topics. There is no presentation, no research. For example, the IRSO conference, please check the proceedings. Overall, it's very difficult and there is no such thing or titles in the proceedings.

Peter Asaro: And the applications that you're looking at are primarily personal care and healthcare?

Shigeki Sugano: Yeah, yeah. It's very important. You know, Japan has an aging society, so now I am 55. So in next 20 years, the young – the population—the young are aged and I'm very worried about the future Japan. So it's very serious problem, and now already aging society brings a big problem in the area. It depends on the area. Total area is there are many people, but

some of the other areas, some areas are only there are elderly people. That's a big problem. So we should introduce and we should develop such human symbiotic robot as soon as possible to introduce to such area or hospital that would help field. But such kind of robots I've already mentioned that they have to have the function to recognize another, to individuals. So it's a very important thing.

Peter Asaro: So tell me about your year visiting at Stanford. Who did you work with there and what sort of projects?

Shigeki Sugano: Oh, I did not belong with some project, but so I was in the laboratory of Professor Bernie Roth. He had the post of the professor also Ossama Khatib and I also talked to – discussed for a full summer. And I am very I was very interesting discussing with Bernie, Bernie Roth about such human robot collaboration or what is essence of the human. What are the essence of the robot. The differences and also the emotion and intelligence. Yeah, one episode I had that I, once I explained Bernie about my project of the robot mind. So I understand that there is a big difference between the English language people and Japanese language people. Of course, we experience so many ways about the mind, but I explained that mind is always – A mind supervise every – all the behaviors of the human. Later Bernie told me, “There is a word out of mind in English.” Out of mind means there is no mind. Mind cannot supervise or monitor the human behavior. But kokoro in Japanese, I believe that kokoro controls everything. Then, I understood that there is a difference between kokoro and mind. So such kind of conversation is very interesting and very good for me to proceed my research. So I enjoyed the conversation with Bernie and Khatib Ossama all summer in U.S. and also other students, professors. So also the educational system in U.S. I'm very interested in, in fact. I now, about seven years ago, the Waseda University, my department changed the curricula. So I introduced visual thinking, the course. I know that in some university the mechanical engineering department at Stanford University introduced a course of visual thinking. It's a very interesting course. So the students make some artificial things by paper. Only papers, and also they're using the Lego in a robot contest. Very interesting also the students involved are very exciting. So I introduced such kind of course to my department. So the experience in Stanford University is very, very good for me to proceed in my career and also research and education.

Peter Asaro: And have you also discussed this the kokoro with philosophers or psychologists?

Shigeki Sugano: Yeah, sometimes. But it is very difficult to discuss kokoro with – from the point of view of psychology, because they don't know the technology. They don't know the computers. They don't know the robots. So it is very difficult to explain that. So I read many books, but I avoid the conversation with such researchers. But because it is very difficult to say, proceed if we have that conversation with psychologist or something. So they – They cannot they cannot explain the essence of the mind from the point of view of the engineering or science.

It is very difficult point, and some psychologist says, “We should not discuss such things.” It is all the same situation in the overseas and other countries. Once I attended international conference in Europe, and there is some discussion about robot mind, but there is a roundtable discussion or something, so there are many audiences. So then after discussion the chairman asked to the audience, the floor, “Do you have some questions?” One of the audience raise a hand and had a long speech about that we should not have research about robot mind or something. So many say, panelists were able then to hear that. But after that I found that the question was from – He belonged the church, so religion. So it is very difficult to have a mind. So it depends on that position of the researchers. Here also, research, but they join the church, and so in the same situation about psychologists. They have a different field, different positions, and it’s very difficult. So we should discuss from the point of pure science and engineering first. Of course, we should consider ethics, but before that, we should have some research and want to have the result. So then we discussed more with such scientists or the psychologists and also the another people from the church and the religion. So now it is not a stage at present to discuss with them.

Peter Asaro: All right. Is there anything that we didn’t cover that you wanted to talk about in your career?

Shigeki Sugano: That’s okay.

Peter Asaro: That’s good. And then we have a question we always wind up with which is, what’s your advice to young people who are interested in a career in robotics?

Shigeki Sugano: So in my case, I’m interested in robotics in junior high school. So the young people interested in the science fiction is very good. But about the robotics, I already mentioned that the robotics covers many kind of fields. So there is big difference. For example, the research on materials, research on computer program, but roboticist needs everything. Then the first stage the young people who wanted to have research on robotics, first they should run about some topics. So in the department of mechanical engineering, run a design, materials and control and if they, in the computer science and the computer program architecture network, and after that, learn more about wide field. So we have some university in Japan has the name of robotics department or something. I don’t like that, because it’s a kind of – There is many fields, but they can very narrow, not deep. But they run everything. But it is not good for them. First, there is a deep learning about something, and widen that field. Then, yeah, we cannot – We cannot become the specialist of the materials and the computers and the mechanism and everything, not like that, no. But I am a specialist of the mechanics. He is a specialist of the computer science. And collaborate and widen our field their field using this collaboration. Then, the young people can develop the very good robot. So robot is a very special field that covers many functions and much wider field. So always I talk to students. First, you must run about something in that deep

about some subject. Then, widen that knowledge and experience. Or, they cannot develop a good robot. But I believe that is very important.

Peter Asaro: All right. Well, thank you very much.

Shigeki Sugano: You're welcome.