Oral History of Kunio Uchiyama

Interviewed by:
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Fairbairn: Okay we're at the New Otani Hotel in Tokyo Japan. It is June 22, 2016. I'm Doug Fairbairn and I'm here to interview Kunio Uchiyama, yes? And so we want to explore your career in computers and electronics, and software, and semiconductor and to begin, we'd actually like to hear a little bit about your life growing up, where you were born, what your family life was like. What kind of encouragement or lack there of you might have had from your family or other relatives and so if you would just begin with that. Tell us a little bit about your life growing up, when and where you were born.

Uchiyama: So my family, there are two children, older sister and me. My father was working for trading company in Japan and he was an accounting manager, and after his retirement he ran his own accounting office.

Fairbairn: So he never really retired, he just went from one business to another?

Uchiyama: Yes, he worked till his death.

Fairbairn: In his accounting office, did he work for other small businesses or...?

Uchiyama: Just accounting office. He was checking the account of another company.

Fairbairn: And he just kept working until he passed away?

Uchiyama: Yes. I think he spent a happy life. <laughs>

Fairbairn: And your mother’s side?

Uchiyama: Mother’s side, she’s a-- how you say, housewife, just housewife. Her uncles were engineers, all engineers, and my father was not interested in technology, science at all. But I think I was affected by my mother’s side.

Fairbairn: Did your father encourage you to pursue any particular thing?

Uchiyama: Nothing. He didn’t care about me <laughs>. It was okay.

Fairbairn: Did you have any specific influence from your teachers or people who sort of steered you in a technical direction, or how did you develop your interest in technology? What were some of the things you did as a child?

Uchiyama: Basically I was good at science subjects, for example, mathematics and science, and I think I was junior high school, I started to make crystal radio, vacuum tube radio, transceiver and I took an amateur radio license, and I was so excited about amateur radio, communication.

Fairbairn: Communicating with people around the world?

Uchiyama: Oh, yes. With my very poor English.

Fairbairn: Did they teach English in school? How did you learn English?

Uchiyama: From junior high school in Japan we have a class of English. But I think I got some English tape and tried to learn English conversation.

Fairbairn: So you were teaching yourself?

Uchiyama: Uh huh.

Fairbairn: You went to public schools from junior high and high school?

Uchiyama: Yes, they were public.

Fairbairn: Then what university did you choose and why did you choose that particular university?

Uchiyama: I attended Tokyo Institute of Technology, and it is one of good universities on science and technology in Japan. That is one reason, and my childhood friend's father was a professor at that university, and the most important, there was no entrance examination on liberal arts, like Chinese classics, Japanese classics, Japanese history, world history. I didn't like to study them during my high school.

Fairbairn: You preferred the sciences?

Uchiyama: Yes. I didn't like liberal arts at that time.

Fairbairn: The classes you took there were all technical classes? You didn't have to take humanities studying language or history or whatever once you entered?

Uchiyama: You mean in high school?

Fairbairn: No, once you entered Tokyo Institute of Technology, did you take any classes in history or literature?

Uchiyama: Yes, we could choose such kind of subject, but I didn't.

Fairbairn: You didn't?

Uchiyama: It was mistake <laughs>.

Fairbairn: Did you know from the beginning you wanted to study engineering or you studied electrical engineering?

Uchiyama: I entered information science department.

Fairbairn: What year did you enter the Institute of Technology?

Uchiyama: It was, just a moment, 1972. I entered TIT.

Fairbairn: Then you were studying Information Technology?

Uchiyama: From the second year. First year, that is general. From the second year, we entered some department.

Fairbairn: So you proceeded to Bachelor, Master and PhD, is that correct?

Uchiyama: Only Bachelor's and Master's, and in case of PhD, I got it later, during working time.

Fairbairn: So your Bachelor's and Master's degree were in information technology?

Uchiyama: Information science.

Fairbairn: So did you learn computer programming?

Uchiyama: Yes, I learned assembly program and Fortran at the time, and machine instruction. I was using tape, how do I say, <inaudible> tape, or card reader?

Fairbairn: You were punching cards?

Uchiyama: Yes, that's right.

Fairbairn: And you were programming in Fortran or assembly?

Uchiyama: Mainly assembly.

Fairbairn: Mainly assembly language. Were the computers you were working with, were they Japanese computers?

Uchiyama: It was Japanese computer. One is from NEC and the other is from Fujitsu.

Fairbairn: Did your work with computers get you interested in continuing to work with computers? Is that an area that you found very interesting?

Uchiyama: I think I was in university I was not so interested in computer, so I chose applied mathematics for information theory.

Fairbairn: So you have a technical theoretical background in information theory?

Uchiyama: Mm-hmm.

Fairbairn: So you attained your master's degree in 1978?

Uchiyama: Yes. Mm-hmm.

Fairbairn: Then did you work for Hitachi immediately?

Uchiyama: Yes, immediately.

Fairbairn: Why did you choose Hitachi?

Uchiyama: Maybe my nephew was there. So I know the name of Hitachi. So I didn't consider deeply to choose companies, but I like some electric company. So I chose Hitachi, by chance.

Fairbairn: When you chose a company, did you know what your job would be?

Uchiyama: Basically I'd like to become a researcher there. So I enter with the company, I told interviewers that I like to be in a laboratory.

Fairbairn: So is that what you did, you enter the central research laboratory is that correct?

Uchiyama: Yes.

Fairbairn: So, in your college work, did you learn anything about electronic design work or chip design or anything like that or was it all mathematics theory?

Uchiyama: No, nothing. Just applied mathematics.

Fairbairn: So when you entered the central research laboratory, what were some of the first things you were involved in?

Uchiyama: First two years, I was developing CAD software, it's a fault simulator, and I developed some algorithms for fault simulator.

Fairbairn: So that was in 1978?

Uchiyama: 1978 to 1980.

Fairbairn: So that was relatively leading edge technology, there was not good fault simulation technology available?

Uchiyama: Yes, there was a big project to develop fault simulator in Hitachi.

Fairbairn: Do you know what was driving that from a commercial point of view, had there been problems or they're worried about test coverage or whatever? Why had that become a big project at Hitachi?

Uchiyama: Because at the time we were making chips and board. That fault simulator was for checking a board, a computer board. So in order to keep reliability, checking fault coverage is very important.

Fairbairn: Do you know if there had been any programs in which, where there had been a major problem because of poor fault coverage, a product had some problems or were they just trying to improve the quality overall?

Uchiyama: Yes. We have to increase the fault coverage. In order to increase the fault coverage, we had to make good test patterns. It was very important.

Fairbairn: Did your project help create the actual test factors to give the appropriate fault coverage?

Uchiyama: There are two teams. One is our team and that is for fault simulator team, and the other team is generating test patterns automatically. That was another team.

Fairbairn: So you identified where the problems were and they worked on finding test patterns which would then test for those faults?

Uchiyama: Yes, we collaborated each other.

Fairbairn: Did you find that work interesting?

Uchiyama: It was interesting to develop a new algorithm.

Fairbairn: You had only programmed in Fortran before. What language were you using to program this?

Uchiyama: At the time I used assembly language, of mainframe and also Fortran.

Fairbairn: So you were developing these, or running this fault simulation on some of the chips that were in design at Hitachi at the time or where they..?

Uchiyama: At the time, that fault simulator is for board testing. So at the time I think the integration of LSI is very low. So we bought LSI's and put those on the board and test it.

Fairbairn: What was your next project or activity?

Uchiyama: After that I'd like to design hardware. So, I asked my boss to change my work from software to hardware. So it was easily accepted.

Fairbairn: But you had never designed hardware before?

Uchiyama: No <laughs>. Yes, I like a new job <laughs>.

Fairbairn: At what level did you do your design?

Uchiyama: Mainly logic design, and my target machine was small size mainframe computer.

Fairbairn: Was this a project where there were many engineers working on it?

Uchiyama: It was a very small team and I joined one team and I studied. At the time I didn't know about computer hardware so mainly I studied and after that we tried to make single chip, small size, mainframe computer.

Fairbairn: The architecture of the machine and the instructions that was defined…

Uchiyama: Instructions is compatible with IBM.

Fairbairn: So you were designing a chip that would implement a predefined instruction set?

Uchiyama: So I designed micro architecture and I designed logic and simulate them.

Fairbairn: Was the simulation tools you were using, were those internal Hitachi?

Uchiyama: At that time, I think in house logic simulator, using mainframe. It was very slow.

Fairbairn: By this time, it was early 80s?

Uchiyama: Early ‘80s, yes. ’82 to maybe ’83.

Fairbairn: So that was a very aggressive time to be trying to put a mainframe on a chip.

Uchiyama: Precisely speaking it was not one chip, maybe two or three chip.

Fairbairn: What technology were you targeting?

Uchiyama: We were using two-micron CMOS technology. It was an in-house Hitachi’s technology.

Fairbairn: Were you able to get that chip set working?

Uchiyama: That project was stopped.

Fairbairn: Before you actually made the chips?

Uchiyama: Mm-hmm, yeah. Just logic design.

Fairbairn: So you at least learned the whole process of logic design.

Uchiyama: Yeah. It was a good experience.

Fairbairn: Something about computer architecture and so forth. Did that spark further interest in that area? What did you ask to be involved in after that?

Uchiyama: After that, I belonged to 32-bit microprocessor team, and we developed Hitachi’s first 32-bit microprocessor, and it was fabricated in the Central Research Laboratory's fab and the chip was made but it was not commercialized. It was just a prototype chip. The instruction set was original. It is like Motorola's 68000. At the time we licensed from Motorola.

Fairbairn: So you said that that work helped Hitachi in the legal dispute with Motorola later on?

Uchiyama: After that, around 1999, there was patent lawsuit between Motorola and Hitachi.

Fairbairn: How did your work help resolve that or help strengthen Hitachi's position?

Uchiyama: I was developing that microprocessor, I submit the patent on memory management unit. It is related to content addressable memory. It was by chance but that patent was used in the lawsuit <laughs>.

Fairbairn: So even though your chip did not get commercialized, you still had a positive impact on Hitachi?

Uchiyama: Uh huh. So there was 4 patents from Motorola and only 1 patent from Hitachi and that was my patent, and finally that lawsuit was settled.

Fairbairn: Did you just exchange patent licenses?

Uchiyama: Yes. The judgment was we infringed each side's patent, each other. So stopped commercialize microprocessor. But it was very damaged on both sides so we settled.

Fairbairn: You'd now worked on a couple of different chip designs?

Uchiyama: I made a lot of chip design.

Fairbairn: You said you'd come back and gotten PhD. Was your PhD related to your work in computer design?

Uchiyama: Yes, microprocessor design, low power microprocessor design. It was my doctorate degree's theme.

Fairbairn: When did you actually get your PhD then?

Uchiyama: PhD, It was when I was 47 years old <laughs>. It was 2001.

Fairbairn: So did you have to write a separate thesis to get your PhD or did your work at Hitachi qualify you for the degree?

Uchiyama: I got the theme. I did in the company.

Fairbairn: So after you did the work on this 32-bit processor, you then took one year to go to the United States to do research at Carnegie Mellon, is that correct? Tell me about that experience.

Uchiyama: I went to Carnegie Mellon University and I belonged to the laboratory of Professor H.T. Kung, and his team was developing systolic array processor. It was like a data flow chip and to accelerate I think image recognition. It is the origin of autonomous driving. Autonomous vehicle. They are testing autonomous vehicle, elementary autonomous vehicle on the campus and we are developing the chip for image recognition.

Fairbairn: Were you doing actual chip design or developing architecture?

Uchiyama: I designed part of it, part of the systolic array I forgot the name. It was Logician, something like that.

Fairbairn: Daisy Logician?

Uchiyama: Yeah, Daisy Logician. Yes. I think I used it for logic design.

Fairbairn: This is during 1985 to 1986, correct?

Uchiyama: Yes.

Fairbairn: What did you find most interesting from both a sort of personal point of view, and also a technical or career point of view about Carnegie Mellon? Maybe first from a personal point of view, how did you find working there to be the same or different than working at a Japanese university?

Uchiyama: I think first there were a variety of nationalities. Professor Kung, his origin was from Taiwan and other people are from Hong Kong, Monica Lam she was a famous compiler researcher.

Fairbairn: Who was that?

Uchiyama: Monica Lam, and other researchers mainly from France and others from Germany and so on, and Japanese.

Fairbairn: Was there anybody else there from Hitachi or were you the only one?

Uchiyama: Only me at the time, at that team.

Fairbairn: Besides the different nationalities, what about from the technical point of view? How did you find it different than doing research at a Japanese…?

Uchiyama: I think it was a big team.

Fairbairn: A big team?

Uchiyama: And I think we couldn't see that kind of big team in a Japanese university. Maybe 30 or 40 researchers.

Fairbairn: All working on the same program?

Uchiyama: Yes, same systolic array. From hardware to software, compiler and so on.

Fairbairn: What about from a personal point of view did you enjoy your time there and how did you find living in the United States versus Japan?

Uchiyama: Yes, in 1985 I just married. So I went with my wife. It's like a kind of honeymoon. Long honeymoon.

Fairbairn: Was she happy being there in the United States?

Uchiyama: I don't know <laughs>.

Fairbairn: You were working too much?

Uchiyama: Not so much. I traveled a lot in the United States and in summer vacation I went to Europe. We went to Europe. It was a good time.

Fairbairn: So you enjoyed your time there?

Uchiyama: Yeah.

Fairbairn: Did the work there influence your work in a specific way when you returned to Hitachi?

Uchiyama: I think I have to study more from the world. Not only Japan, but there are a wider world.

Fairbairn: Before we go further, I'd like to reflect back on the design work you were doing and one of the major issues I'm sure came up in doing your processor design, Chip design. Whether to copy an existing instruction set and be software compatible or create a unique architecture and instruction set. You said early on you had done some work that was IBM compatible and some of the later work was compatible with the 68000 but later on you created your own architecture and instruction set. Can you tell me what the driving forces and tradeoffs were for those choices and what role you played in sort of making the decision as to which path to take? Is that question clear?

Uchiyama: I think original instructions or architecture is important when we create new market. Customers opinion is very important and according to customer opinions we redefine our architecture instructions sometimes.

Fairbairn: You redefined it?

Uchiyama: For adding instruction set and so on, and it's important I think. So it's important to have original architecture.

Fairbairn: So you had worked on this 32-bit processor before going to study at Carnegie Mellon. That was one that was one that was compatible or largely compatible with the 68000 family from Motorola. When you came back, somebody chose to take a new path, is that right? So tell me about that choice and what the goals of that were and how that came to be the program that you were then involved in.

Uchiyama: So after returning to Japan, there was an atmosphere to make original architecture or instruction set. Japanese original instructions set. That was a TRON project, and professor Sakamura who was in Keio University at that time, he proposed TRON instruction set and we cooperate with him to make new instruction set.

Fairbairn: We mean Hitachi?

Uchiyama: Hitachi and Mitsubishi, Toshiba, Fujitsu. Maybe all Japanese company joined that TRON project and started to make their 32-bit microprocessor using TRON instruction set and I belonged to that project.

Fairbairn: What was the target market or application for TRON was it in computing or embedded processor, or…?

Uchiyama: Basically computing for workstation or communication system and so on.

Fairbairn: So it was meant to compete with the biggest processors from Intel or Motorola? Is that right?

Uchiyama: Right. So there was a B-TRON project that was operating system.

Fairbairn: So you were going to build the operating system, the processor? Everything.

Uchiyama: Yeah, from operating software to processing, yeah. But that action was failed basically.

Fairbairn: Why did it fail?

Uchiyama: It's pressure from United States at that time.

Fairbairn: From customers or the government or what kind of pressure?

Uchiyama: Maybe from government, from the United States government. At the time, Japanese semiconductor was very strong, and I think U.S. government was worrying about that <laughs>. So we tried to make B-TRON that was operating system for business or education. It is like Windows. But that project was stopped. I think by the pressure of United States.

Fairbairn: TRON and B-TRON were both stopped?

Uchiyama: Yeah, B-TRON was stopped but there was C-TRON. It was for communication. I think C-TRON was used in communication system. It is led by NTT, and the chip I developed was used in that communication system.

Fairbairn: What were the most important or unique characteristics of the TRON project? You weren't trying to just do something that was different, but something that was better than what was already out there, right? What was the biggest target you were competing against? Was it Intel's microprocessor family, Motorola, or…?

Uchiyama: We consider our competitors are Intel's 86 or Motorola's 68 series. That was not embedded processor.

Fairbairn: Where did you feel you could make a contribution? Where did you think you could make your program better than what was already available?

Uchiyama: For example, that instruction set was CISC but we developed super scalar micro architecture and also very complicated branch prediction mechanics in the chip. I think those technologies were very latest at the time.

Fairbairn: These are things that had been used in super computers or mainframe computers before, but not applied in the chip, is that correct? Were these things that had never been applied in computing?

Uchiyama: I think it's first time to apply those kind of technology in a chip. Our designers of mainframe computer were usually conservative. So they didn't like very new aggressive micro architecture, I think.

Fairbairn: So the TRON project you think was just stopped. Was there a point at which you said "No, we aren't going to do this—"?

Uchiyama: That was not stopped but from the commercial point of view it was not successful. Our chip was sold only to communication system. The volume was very low.

Fairbairn: Now obviously, you said that there was pressure from the United States. Were you able to develop a chip which met the original goals? Or the reason for the lack of acceptance, was that mainly political or mainly technical or a combination of the two?

Uchiyama: I think the fail over B-TRON project was big, I think, because B-TRON is an operating system. If B-TRON was accepted, I think there was a huge market. It is like a personal computer.

Fairbairn: So you think the chip design itself was successful. You met your goals...

Uchiyama: Oh, yes.

Fairbairn: ...but without the operating system and so forth, you couldn't really...

Uchiyama: Circumstances around chip was problem.

Fairbairn: So how long did you work on the TRON program?

Uchiyama: I think after returning to Japan, so three or four years.

Fairbairn: From ’87-- you came back in ’87?

Uchiyama: Uh-huh.

Fairbairn: Uh-huh, so maybe until 1990 or so?

Uchiyama: Uh-huh. Yeah.

Fairbairn: So what was the-- so you’d now worked on three major processor developments, right...

Uchiyama: Uh-huh.

Fairbairn: ...and this is all in Central Research Laboratory, correct?

Uchiyama: Collaboration with not only Central Research Laboratory, but with another laboratories and also of course semiconductor division. Usually semiconductor division led all projects.

Fairbairn: And so the division includes the laboratory as well as the product design people and so forth and they worked together to develop...

Uchiyama: Yes, yes, we made a project team.

Fairbairn: And was this the common way for at least Hitachi to work was to combine people from different groups to work on a project team?

Uchiyama: Yes, in Hitachi, there was a system to make a project from gathering from different divisions, laboratories to develop high important chip and so on.

Fairbairn: So you said there were many companies involved in the TRON project. Were there other teams developing other chips to implement the TRON instruction set or was your...

Uchiyama: Yes, yes, for example, Mitsubishi developed low end TRON chip and Fujitsu developed high end TRON microprocessor and Hitachi developed mid range and high end, two microprocessors.

Fairbairn: And were all of those chips completed?

Uchiyama: They're completed. They were commercialized, but they were not sold well.

Fairbairn: Since you didn't have B-TRON, did you port Unix to the machine or did you have C or...

Uchiyama: Well, at that time there was no-- there wasn't Unix. I don't know where about that. I think Unix is not ported, only in our microprocessor, C-TRON, that is a communication operating system, is ported by NTT.

Fairbairn: So clearly, if you had a chip that was aimed at sort of workstations or general computing, it had to have an operating system working with it. Otherwise it was not going to be successful.

Uchiyama: No.

Fairbairn: So you moved on from that project. What was the next thing you became involved in?

Uchiyama: Next from the beginning of 1990, at that time digitalization of consumer products started, for example, digital camera, PDA, game console, television and so on, so we discussed and we tried to make some new microprocessor for that application. So we changed our market from workstation or computer to embedded system for digital consumer.

Fairbairn: And was that a new program that got kicked off at that time or was that redirecting...

Uchiyama: At that time it's...

Fairbairn: ...something that was already going on?

Uchiyama: It was not top down; it was bottom up. First small start, I think.

Fairbairn: What was the-- was there an existing processor that you-- or instruction set that you focused on or did you create a new architecture at that point?

Uchiyama: We had-- there are several embedded type processors in semiconductor division, but the performance was low, so they couldn't satisfy the requirements of digital consumer appliances, so we have to make a more high performance microprocessor, but also low power.

Fairbairn: So low power was a design goal from the beginning?

Uchiyama: Yeah.

Fairbairn: And what was that program? What processor first came out of that effort?

Uchiyama: We made a SH, Super H microprocessor. We call it SH and it's a RISC type. It has a RISC type instruction set and we optimize instruction set for digital consumer products.

Fairbairn: So was the SH-- it was 16 bit or 32 bit or what was it?

Uchiyama: It's a 32-bit architecture, but the instruction-- the length of instruction set is 16 bit. It was very unique. So using 16-bit fixed instruction set, the size of program could be small. It was one of features.

Fairbairn: So code size was very important?

Uchiyama: Yes, yes, at that time code size was very important for embedded applications.

Fairbairn: So was the SH program based on or extension of the H8? Wasn't there an 8 bit processor before?

Uchiyama: No, it is different.

Fairbairn: Totally different?

Uchiyama: Totally different. We started from scratch.

Fairbairn: And what influenced you to go towards a RISC-type instruction set?

Uchiyama: RISC, because we believe that a RISC type instruction set can make the chip size smaller compared with CISC and cost effective, and also can get high performance.

Fairbairn: So did you study the work that was being done at Stanford or MIPS or SPARC or Berkeley or I mean, in...

Uchiyama: Oh, yes, at that time there are already-- later 80s, there are MIPS-- there were MIPS and SPARC and so on, so we studied them. The problem is the length of instruction set. The length of instruction was 32 bit, so using 32-bit instruction set, 32-bit fixed length instruction, the code size increased. That was a problem, so we decided to adapt 16-bit fixed length instruction set.

Fairbairn: Did you also look at the ARM architecture at the time or were you not looking at that?

Uchiyama: Oh, at that time, we didn't care about ARM so much.

Fairbairn: Were you aware of it?

Uchiyama: Of course we knew.

Fairbairn: But that was not a-- so there-- you sort of liked the RISC model, but none of the existing RISC processors really satisfied-- none of them were a good model or a good example of the direction you wanted to take; is that correct?

Uchiyama: You mean...

Fairbairn: You didn't see in any of the existing ones something that says, "Okay, we want to build something like that." You say maybe there was some inherent advantage in the RISC concept, but the implementations that existed at that time were not representative of what you wanted to do. Is that correct?

Uchiyama: At that time, MIPS or SPARC, they are for workstation.

Fairbairn: Yes.

Uchiyama: Uh-huh. So they were pursuing high performance basically, so they were not suitable for embedded system.

Fairbairn: So did you meet with those designers or with people from Berkeley or other places where they were doing research in this space or did you just do...

Uchiyama: No, I didn't see-- meet them. But I don't know other people met them or not.

Fairbairn: So Hitachi embarked on-- started on a program to build a high performance embedded processor that had high code density, high speed, and low power.

Uchiyama: Yes, and low price.

Fairbairn: And low price <chuckles>.

Uchiyama: That is very important.

Fairbairn: So it had to be a small chip, it had to be able to go in a plastic package, and...

Uchiyama: Uh-huh. Yes.

Fairbairn: ...all the other characteristics.

Uchiyama: Uh-huh. Uh-huh. Natural cooling.

Fairbairn: I'm sorry?

Uchiyama: Natural cooling. We don't put fan.

Fairbairn: Pardon?

Uchiyama: We don't put fan in the system.

Fairbairn: No fan. Had to be...

Uchiyama: No fan.

Fairbairn: ...natural cooling, yeah. Okay, so that program, when did you fix the design goals and kick off the actual design program itself?

Uchiyama: The first chip of SH was commercialized in 1992. It was used for digital camera.

Fairbairn: So the development time was relatively short, it sounds like.

Uchiyama: Yeah, maybe two years.

Fairbairn: And did you-- when you began the development, did you work with potential customers so the...

Uchiyama: Yes, usually. Our development style was customer oriented, so we discussed with customers about specifications of chip. That was very important.

Fairbairn: So what companies did you work with for the digital camera application?

Uchiyama: Digital camera application, that was a camera from Casio. It was very successful using our chip. I think that camera was the first successful digital camera in the world. The resolution's very low comparing with today's. This was only 25-- 250,000 pixels.

Fairbairn: Did Hitachi have a good long term relationship with Casio? Was that...

Uchiyama: Yeah, Casio was a good customer of Hitachi's semiconductor division.

Fairbairn: Did Hitachi also develop other parts of the camera, like the image sensor or other elements?

Uchiyama: Yes, we tried to make-- we made sensor also, but I think our image sensor was not successful. There were more strong image sensor makers.

Fairbairn: So your major contribution was on the SH processor.

Uchiyama: Uh-huh.

Fairbairn: So did you develop a special operating system for use in embedded products to go with the...

Uchiyama: Operating-- I don't know the operating system, but just-- there's a operating system right now called I-TRON that is part of TRON Project.

Fairbairn: So spun out of the...

Uchiyama: Yes, I-TRON is for embedded...

Fairbairn: Embedded, okay.

Uchiyama: ...operating system. Very tiny operating system.

Fairbairn: So that was a-- the first product was very successful. Were you designing multiple chips or the first goal was to get a single chip out and then build on that to get higher performance or whatever?

Uchiyama: I think it was a single chip solution, so it includes CPU and memory on a chip.

Fairbairn: And what were the next applications that you were able to address with that chip?

Uchiyama: Next chip based on that SH-1 design, we developed a microprocessor for a game console. That was the Sega's game console. The name was Sega Saturn.

Fairbairn: Saturn?

Uchiyama: Yes, we made-- we developed SH-2 for that game console. It was very successful at that time. So it was 1994 or 3.

Fairbairn: And by this time, I forget. Had ARM emerged as a competitive embedded product at that time?

Uchiyama: Not yet. So 1994 and 1995, the shipment of SH was-- SH achieved number one share in RISC processor market. Yeah, I think.

Fairbairn: Big volume.

Uchiyama: Because of, yeah, because of game machine

Fairbairn: Forget what I was going to ask. Okay, so you now had a very successful product. You must've felt very good. The previous chips you had worked on were not commercially successful, but now you had a product that was doing very well, it sounds like.

Uchiyama: Yes, yes.

Fairbairn: So it sounds like that was a pretty unique product on the market at that time, if ARM had not yet sort of emerged. There were not-- Intel and Motorola were not pursuing that market either, right?

Uchiyama: Uh-huh. But MIPS tried to enter that market.

Fairbairn: That's right, MIPS did go after an embedded...

Uchiyama: Yeah, and also Power PC after that. And also Japanese NEC, they had an embedded RISC-type microprocessor.

Fairbairn: Your product must've been much lower power than these other products, though; is that correct?

Uchiyama: Yes, we were pursuing our performance product figure or MIPS product. We tried to achieve number one position at that figure.

Fairbairn: So you continued to create new generations of the SH processor in new semiconductor technologies, but also spinning off different chips to target different markets; is that correct?

Uchiyama: Yes, and after SH-2, we developed SH-3. That representative consumer product was PDA, Personal Digital Assistant.

Fairbairn: Did you continue to be personally involved in all of these programs?

Uchiyama: Oh, yes, at that time.

Fairbairn: And what was your-- where did you focus your efforts, defining new chips or doing design or what was your...

Uchiyama: Yeah, defining chip and the development team. And achieve the performance power and so…

Fairbairn: Were you addressing the power performance at sort of all levels, both the architecture as well as the detailed design level, sort of minimizing power at every step? Is that the way you approached it?

Uchiyama: We developed a variety of techniques to minimize power and also achieve high performance. So it's many-- there are a lot of efforts.

Fairbairn: And at some point, it looks like you pursued one that was focused on digital signal processing, DSP.

Uchiyama: Ah, yes.

Fairbairn: Tell me about that program and what the goals of that was.

Uchiyama: We have original DSP, but it was not successful, I think, so...

Fairbairn: A single chip processor?

Uchiyama: Yeah, single chip, only DSP chip. So I think a manager of semiconductor division considered the DSP architecture should be merged to SH, because SH was successful at that time, so we defined SH-DSP. We merged DSP instruction set to original SH instruction set.

Fairbairn: And you put in special hardware to enhance the performance for certain DSP applications; is that correct?

Uchiyama: Yes, we're trying to that DSP—SH-DSP for baseband application, baseband processing application for mobile phone.

Fairbairn: Did you also target the handset market as well or was it not suitable for that?

Uchiyama: Handset means?

Fairbairn: Actually in the phone itself.

Uchiyama: Oh, phone itself. Yes, I think so, uh-huh. So I think that architecture instruction set was suitable for processing handset application.

Fairbairn: So were you able to penetrate that part of the market? Did you...

Uchiyama: Other team-- there was another team for SH-DSP. Was a SH3-DSP.

Fairbairn: So they were spinning off different...

Uchiyama: Uh-huh. Yeah, uh-huh.

Fairbairn: So does the SH processor development continue now or has that been spun off in Renesas or...

Uchiyama: Spin off to Renesas.

Fairbairn: So when it was spun off, when did Renesas-- when did that...

Uchiyama: Renesas was created in 2003, so all semiconductor division at Hitachi went to Renesas.

Fairbairn: So did you go with that or did you stay with Hitachi?

Uchiyama: I stayed in Hitachi, and-- but some colleagues went to Renesas. And we are now-- we're also collaborating with them sometimes.

Fairbairn: So until it was spun off, was your major focus on continuing enhancement of the SH processor?

Uchiyama: Yes.

Fairbairn: Was that the major focus of your work?

Uchiyama: Uh-huh. We're-- yes, we're collaborating with them. For example, we developed SH Mobile with them.

Fairbairn: I see.

Uchiyama: It is for-- application processor for mobile phone.

Fairbairn: So you're still part of the Central Research Laboratory?

Uchiyama: Yes.

Fairbairn: So you continued to work on the SH processor, even after it was spun out; is that correct?

Uchiyama: Now, I'm not involved with the...

Fairbairn: Okay.

Uchiyama: But maybe till 2010, I collaborated with them.

Fairbairn: So for several years, five or seven years afterwards...

Uchiyama: Uh-huh. Uh-huh.

Fairbairn: ...it was-- so you worked on the SH processor for a long time, from...

Uchiyama: Yeah.

Fairbairn: ...1990 to 2010, for 20 years.

Uchiyama: Yes, uh-huh.

Fairbairn: <chuckles>

Uchiyama: Too long.

Fairbairn: Too long.

<general laughter>

Uchiyama: Yeah.

Fairbairn: So after you sort of stopped doing that, what other-- what was the next program you got involved in?

Uchiyama: After the mid-2000, around 2004 and 2005, I started multicore project. It is kind of a national project.

Fairbairn: Multiprocessor?

Uchiyama: Yeah, multiprocessor. Multi CPUs on the chip, and I carried out three projects related to heterogeneous multicore. And we cooperate-- I cooperated with Renesas Technology and universities.

Fairbairn: So that was very a important area. People were not able to continue to increase the clock speed of the processors, right...

Uchiyama: Yes.

Fairbairn: ...mainly because of the power problem; is that correct?

Uchiyama: Yes, right, uh-huh.

Fairbairn: So you were looking for ways to increase the performance of the processors by doing multiple cores. And so what was the focus of that work? Were you mainly looking at sort of general purpose computing applications or were you also thinking about even embedded kinds of applications for these multicore projects? What was the...

Uchiyama: That is for embedded system, very advanced embedded system, like cell phone, smartphone, and advanced digital consumer, and also autonomous driving. It needs a lot of computing performance.

Fairbairn: So were there particular customers that you were working with to help define what the...

Uchiyama: But there were no customers.

Fairbairn: No customers.

Uchiyama: That's a fundamental technology project. So we just developed prototype chips. We made three prototype chips using heterogeneous multicore application.

Fairbairn: And what were the differences between those? What different things were you exploring?

Uchiyama: The first thing-- we improve a little for each processor. The first chip was-- there was four CPUs and two accelerators. That was-- the architecture was heterogeneous and the second chip was eight CPU cores. CPUs were SH. And we developed not only CPU, but also the chip, so parallelizing compiler.

Fairbairn: It's as big of a software problem as a computing-- as a hardware problem, right...

Uchiyama: Uh-huh.

Fairbairn: ...to figure out how to take a task and divide it between multiple processors?

Uchiyama: Yes. So Waseda University has a specialty of parallelizing compiler, so they developed it.

Fairbairn: And did that parallelizing compiler-- did it apply to any application? I mean, could you take any program and run it through this?

Uchiyama: Oh, it can apply any applications if the application is written by Fortran or C program. Only language restriction, limitation.

Fairbairn: Still writing in Fortran after all this time.

Uchiyama: Uh-huh.

Fairbairn: <chuckles>

Uchiyama: But, you know, in a supercomputer idea, more high-end simulation, they're using-- they're still using Fortran.

Fairbairn: I didn't realize that.

<general laughter>

Uchiyama: Yeah.

Fairbairn: So what kind of performance-- you know, if you have four processors or eight processors, what was the typical performance gain? You couldn't get eight X with eight processors. You got something less than the number of processors, correct?

Uchiyama: But in our case, we can get, for example, X8 times, eight times using 8 CPU cores.

Fairbairn: Oh, you could?

Uchiyama: Automatically.

Fairbairn: For certain applications?

Uchiyama: Uh-huh.

Fairbairn: Some applications were more...

Uchiyama: More or less.

Fairbairn: ...were easier to get performance; others were more difficult.

Uchiyama: Yes, of course. It depends on applications.

Fairbairn: So the things where you have image processing or algorithms that could be done in parallel, then the multiple processors was very powerful?

Uchiyama: Uh-huh.

Fairbairn: Is that correct?

Uchiyama: Yes, for example, image processing, they have inherent parallelism in their algorithm.

Fairbairn: So there are many other companies trying to do the same thing? Intel has multiple processors.

Uchiyama: Yes.

Fairbairn: Oracle has multiple processors. Everybody doing processors is trying to figure-- did you work with anybody else? Was there any cooperative program with anybody, either in Japan or in other parts of the world? What was your-- or were you working mainly just Hitachi and...

Uchiyama: We have many in cooperation with, of course, Renesas Technology and also National Laboratory.

Fairbairn: So mainly in Japan?

Uchiyama: Mainly in Japan, yeah.

Fairbairn: You kept track of what other people were doing, but-- so did you feel that you had some unique technology that was better than what you saw in terms of your competition?

Uchiyama: Uh-huh. Basically our target is embedded system, like-- I think the promising application is autonomous driving. They need very huge power, but power consumption is limited. So we are trying to pursue that application.

Fairbairn: What other companies are pursuing the same application?

Uchiyama: A lot of companies, I think. Autonomous driving is a very hot topic...

Fairbairn: Yes.

Uchiyama: ...these days.

Fairbairn: What other semiconductor or chip companies are...

Uchiyama: For example...

Fairbairn: ...trying to develop a similar product?

Uchiyama: ...nVidia.

Fairbairn: Nvidia?

Uchiyama: Nvidia, they're trying to make a chip for autonomous driving, and of course many semiconductor company. Of course, Renesas and other semiconductor companies trying to make chip for that application, I think.

Fairbairn: It's a long payoff. It'd be quite some time before you have volume in this area. Is there-- what about if you had more processors, 16 or 32? Could you continue to scale the performance with that or do you reach some plateau?

Uchiyama: Oh, yes, I think my recent interest has been when Moore's Law ends.

Fairbairn: Is what?

Uchiyama: Moore's Law? Do you know Moore's Law?

Fairbairn: No.

Uchiyama: No, it's a semiconductor Law. <Inaudible>.

<crew talk>

Fairbairn: Moore's Law?

Uchiyama: Moore's Law.

Fairbairn: Oh, Moore's Law, okay.

Uchiyama: Moore's Law.

Fairbairn: Yes, yes, yes. I'm sorry.

Uchiyama: I think it will end around 2025.

Fairbairn: Yes.

Uchiyama: So maybe, the number of cores can be implemented on the chip will be stopped.

Fairbairn: But if you could put 32 cores on a chip, could you get 32 times the performance or how...

Uchiyama: Oh, I see. I think the architecture become heterogeneous, not only CPU, but also accelerators. I think the role of accelerator is very important. CP's not efficient, for example, image processing, so in that special application, we need excellent accelerator.

Fairbairn: So are you doing research in that area as well, in, like, imaging processing accelerator?

Uchiyama: I used to be doing that, but now I'm just watching the trend.

Fairbairn: I presume Nvidia is very focused on that?

Uchiyama: Oh, yes, uh-huh.

Fairbairn: And what do you think the other important trends for complex processors is? There's multiple cores and then accelerators. Are there other things that you're looking at?

Uchiyama: Other things, for example, three dimensional stacking objects. I think that is mandatory after beyond Moore's Law.

Fairbairn: And that's-- these are the areas that you're currently active in today; is that correct? Looking at all of these new technologies and helping...

Uchiyama: Yeah.

Fairbairn: Is there anything that you've been involved in or that you're currently involved in that is beyond what we've talked about? Are there other things you'd like to tell us about?

Uchiyama: Now, we are-- I'm carrying out small collaboration project with university.

Fairbairn: So you're-- so previously you were involved in actually product design and now you're involved in more long term research and...

Uchiyama: Yeah.

Fairbairn: ...looking at future trends and that kind of thing, right?

Uchiyama: Yes, and the new applications and so on.

Fairbairn: What is the optimum number of processors, cores per chip today? Is it four or eight? Is that...

Uchiyama: Recently, for example, using 16-nm technology, we can find the chip-- there are 15 cores on the chip. So the number is a lot.

Fairbairn: And you have to have the software to keep all of them busy at the same time.

Uchiyama: Yeah, yeah, the software program is very big, I think.

Fairbairn: Okay, is there anything else you'd like to conclude or discuss? Have we covered all of the important things?

Uchiyama: I'm very glad to have this interview. Thank you very much.

Fairbairn: Okay, thank you very much. Appreciate your taking the time to do that.

Uchiyama: Thank you.

END OF INTERVIEW

