Oral-History: Nobutoshi Kihara

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About Nobutoshi Kihara

Nobutoshi Kihara is a mechanical engineer employed by Sony. He is best known for his development of video tape recording technology. He was educated at Waseda University and went to work at Sony in 1947 after his graduation. At Sony, he worked on a variety of recording technologies until he began work on video tape recorders in the late 1950s, a process which culminated in Sony's production of Betamax technology in 1975.
The interview begins with Kihara's education and early experience with radio mechanics. He discusses his involvement in a variety of projects at Sony, including his work on the Hellschreiber, wire recorders, tape recording, the portable tape recorder, stereo tape recording, and transistorized television and tape recorders. He emphasizes the advantages and disadvantages of the Japanese patent systems; he also mentions the effect transistorization and miniaturization processes had on parts supplying companies. Finally, he discusses the development of the video recorder from the late 1950s into the 1960s, describing the joint agreement between Ampex and Japan around 1959, which brought together Sony's transistor technology and mass production capacity and Ampex's FM recording technology. He outlines the key elements of VTR development, describes the various technical challenges involved, and notes that the larger goal was production for the consumer market. The interview concludes with Kihara's assessment of Sony's ability to develop new products as an extension of a traditional engineering way of thinking, and his strong belief in the need for engineers to make the impossible possible and to rely on their own ideas rather on building off of someone else's ideas.

About the Interview

NOBUTOSHI KIHARA: An Interview Conducted by William Aspray, Center for the History of Electrical Engineering, May 24, 1994
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Interview

INTERVIEW: Nobutoshi Kihara
INTERVIEWER: William Aspray
DATE: 24th May 1994
PLACE: Sony-Kihara Research Center, Gotanda, Tokyo
[NOTE: Kihara's words were translated.]

Family Background and Childhood

Aspray:
Can you please tell me about when and where you were born and what your parents did for a career?
Kihara:
I was born in October 1926. Within my family there were a number of people who worked in production facilities or in connection with engineering. My father also intended to go into the same line of work, but ill health prevented him from doing so, and he eventually joined the Faculty of Commerce at Waseda University.

Aspray:
Is that how you decided to attend that university?
Kihara:
Yes, I suppose it was at my father's suggestion that I entered Waseda University. Another relative ran a foundry, and indeed I had some experience of helping out there myself as a youngster. So I eventually ended up entering Waseda, and at that time there was a quite famous research center for foundry work, the Iron-casting Research Center, and I studied there.
Aspray:
Were you interested in mechanical things as a boy? Building radios? Chemicals? Repairing motors?
Kihara:
Yes, indeed. When I was a youngster, probably eight or nine years old, I was very interested in making things and putting things together. Frankly, I think I was quite good at it. One of the projects I did at that time was to make a pottery bowl. Within the ward I was living as a child, the Nakano Ward, there was a competition for elementary school children in making things. My bowl was entered and won a prize. When I was in junior high school, my father, who also took an interest in the mechanical side of things, bought me several different items. I remember particularly a model railway and a DC motor; I enjoyed putting the motor on the train and making the railway run.
Aspray:
When you were growing up, what did you want to be as an adult?
Kihara:
A mechanical engineer. After the end of the war, when I graduated from university, I had to pay back the cost of my education. I took on a lot of part-time work to do this. Down near Kanda and Akihabara, where all the electronics shops are now, I used to pick up lots of radios that people had thrown away. I repaired them and made my own radios as well. I think I must have made twenty radios or more. So I do feel that outside of formal

study, I learned a lot from my own personal interest and efforts about engineering and about piecing things together.

Waseda University and Sony

Aspray:
I see. What was a typical career for students who studied in your program at Waseda University?
Kihara:
Obviously it was a very different time from now. It was wartime, and students who studied engineering were able to avoid military service. I think that was one of the big factors there; entering the engineering school at Waseda was very highly competitive. Not just for those students who had an interest in that particular field of study, but for those students who wanted to avoid military service if possible. As a result the examinations were extremely competitive, and something like forty times as many students were applying to enter the course as could be accepted. From among my classmates at that time there are only four people who are still involved in a career that has some link to technology and engineering. Many of them went to work in banks or in commerce. One of the four is at Waseda; Professor Hasegawa, and the other three worked for engineering-related companies.
Aspray:
How did you come to work for Sony right after your education was complete?
Kihara:
At that time Sony's founder, Masaru Ibuka, was a lecturer at Waseda University. (Tokyo Telecommunications Engineering Corporation was renamed Sony Corporation in 1958.) He lectured about what Sony was doing as a company and about the kind of research and development that Sony conducted. I heard those lectures while I was at Waseda. About the time we were preparing to graduate, a lot of the companies had "applications welcomed" posted around the university. Among those, I saw one for the Sony Company of Masaru Ibuka. I knew of Sony because when I was making and repairing radios in the Kanda and Akihabara area and buying components, such as radio dials, pickups, and turntables for record players, and all of the best components, with the most attractive and newest looking designs, came from Sony. That was why I was already aware of the company and had a favorable impression of the company. When I saw the posting I realized that this was Professor Ibuka's company, and I made the link. That's why I decided to apply to that company.
Aspray:
So you didn't apply to any other companies for employment?
Kihara:
Yes, I did go through the entrance procedure with some of the other companies, some of the big names such as Toshiba and Japan Radio. But it turned out that the kind of job that they would have had me do was not the job that I wanted to do. On the other hand, when I went through the interviewing procedure with Sony, with Ibuka-san, they were making radios and vacuum tube voltmeters, and when I told him that I too was making radios and using vacuum tubes he said, "Ah, you're an interesting type, aren't you? Why don't you come and join us?"
Aspray:
And so you did in 1947?
Kihara:
In 1947, yes.

Hellschreiber Automatic Telegraph

Aspray:
What was your original responsibility at the company?
Kihara:
At first when I started at the company I was involved in making products, but Ibuka-san said, "You're good at mechanical engineering," so I was given experience in a wide variety of things, and I developed a Hellschreiber, a type of printing telegraph.
Aspray:
Was this a technology that was imported?
Kihara:
The Hellschreiber had existed for some time, but I had no direct knowledge of it. I had only heard that a printing telegraph called a Hellschreiber existed at that time. I used some imagination, and after many weeks, I

developed a sort of automatic telegraph. But it used radio signals, which came from Germany. The machine would actually work upon the receipt of the signals. However, the language it printed was English. Because of this, the first signal that I was able to receive was a little difficult to understand, but I was told that it was stock prices that were being transmitted. After discussing it with another gentleman at Sony, Higuchi-san, I then took the machine to the Asahi newspaper and showed them the device. Of course they had a much more powerful antenna to receive the signal, and sure enough when they hooked it up they were able to receive news on the device. So we thought, "This is a great machine, we will produce it for sale."

Aspray:
Did this become a commercial product for Sony?

Kihara:
Well, I suppose it did become a commercial product to a certain extent, but we didn't produce more than ten or twenty units. Part of the problem was that the infrastructure at the time was not there to receive the signals. That was the first product that I developed.

Audio Recorders: Wire to Tape

Aspray:
Were there other products that you worked on before you started working on magnetic tape and tape recorders?

Kihara:
Before that, following the product just described, the Hellschreiber, I worked on the wire recorder. This was a product that NEC had worked on during the war. We were able to receive one machine from NEC, a big one and a potentially big item, which Ibuka-san, when he saw it said, "Yes, we should definitely make this." So I started work on that project.

Aspray:
Were you then able to put that into production as well?

Kihara:
We thought that we would convert that into a commercial product for Sony, and we started to work on the most important component, which was the wire itself and the process of drawing the wire. That was the most crucial hurdle to get over, so that was where we started. We thought that the surrounding machine would not be too much of a problem. We started work with the diamond dies, which we borrowed from NEC, and started to experiment with that. We had a plan to buy those in order to go into production with them. I am glad that we didn't because they were tremendously expensive, as it turned out. Next we got an opinion from Shoko-san, an officer of the Occupation Force who was going around to a number of different companies and looking at the different things that they were producing.

When we showed him the wire recorder the first thing he said was, "Well, that's great you're getting sound from a wire, but in America they're getting sound recorded on tape." The reaction from Ibuka-san and myself was, "That's it!" We probably had a little more technical knowledge than the gentleman who was explaining this to us, and as soon as we heard about the use of tape we realized that it must be some sort of metal coating applied to the tape. We didn't know how it was applied, but we immediately knew roughly what the technique would be, and we realized that that was the way to go. The coating material for the tape was based on a ground iron material. I began to work with the ground iron, applying heat to it in order to develop the coating material (g-Fe203). Then I worked on a number of ways of trying to coat the tape itself. Eventually I found that the combination that worked best and actually produced sounds involved using a transparent lacquer that was readily available there.

Aspray:
Did you put the lacquer on first and then sprinkle the iron material on top, or did you put the powder down and put the lacquer over it?

Kihara:
The lacquer and iron material were mixed and then sprayed on the paper tape.

Aspray:
You spray it on. The American groups that were working on this, were they audio companies or computer companies? In some of my previous research in computing I know that the people at Pennsylvania and the Institute for Advanced Study at Princeton were trying out magnetic tape in the period from 1947 to 1952.

Kihara:

I think they were smaller companies. They weren't major manufacturers. It's difficult for me to recall because at that time we didn't have much information about the United States or about what U.S. companies were doing. But I do remember that about two years later products began to emerge from them. The Magnecorder and the Stancil-Hoffman are two that I remember.

Aspray:
My understanding is that there are two advantages to tape over wire, one of them being that you can put more information on tape and the other being that wire is very abrasive as it goes through the machine. Are these the reasons for going from wire to tape?

Kihara:
Yes, your explanation is accurate. Also the wire is more delicate. Any tension in the machine will very easily break the wire. Tape also breaks, but you can always use scissors. Tape is more readily splice-able than wires.

Aspray:
Once you had this lacquer process for making the tape, did you then turn to building a tape recorder?

Kihara:
That's right, once we had developed the coating material and its application process in principle. I then passed that on to somebody else to refine. My next task was to move on to the recorder itself.
I'm not sure whether this is my way or Ibuka-san's way, but the process that I have always followed is that once a product has been developed in principle and we have decided that we want to produce and sell it, I usually turn it over either to my staff or to the staff of another department to bring it to the final product stage. I move on to the next idea for a new product.

Advances in Recording Density

Aspray:
What were the technical challenges in building the tape recorder?

Kihara:
I think the most fundamental challenge was raising recording density. Looking for a greater and greater density of information recorded onto the smallest possible area is, of course, a process that is still going on today. I have a display panel that I'd like to show you that brings to light the development of information recording density. These progressively smaller areas represent the amount of tape necessary for recording one second of audio information.

Aspray:
This shows the surface area required of different types of tape?

Kihara:
That's right, yes. Over here is DAT. So for one second of information this is how much tape is required.

Aspray:
A very small amount, yes.

Kihara:
This represents 35 years of history.

Aspray:
So recording density has increased by a factor of about 20?

Kihara:
Even more than that. That's one second on the Ampex original system. This is broadcast purpose Omega. This is for professional use, this for digital recording, this for D1, D2, and those formats. This is 3/4 inch U-Matic, a worldwide video standard, and 8mm which requires only 1/230th of the area of original Ampex. Now, of course, we're moving into digital recording on 8mm, which requires an area only 1/500th or 1/600th as large as earlier tape.

Aspray:
So the density has already increased by a factor of 230, and will soon be 500?

Kihara:
That's right.

Portable and Stereo Tape Recorders

Aspray:

I understand that you moved from the tape recorder to the development of the portable tape recorder. Did you foresee greater business opportunities for a portable machine?

Kihara:

Actually, the switch from a large system to a portable system was a process lasting over four years. The very first, very large, open-reel system that Sony developed was basically too big to sell. You can see all these models in the museum, by the way; from there the next step was a model which was, in fact, housed in a case like a suitcase, for some sort of portability. The next step was then the H type and the P type, representing a gradual downsizing of the models. The external development that prompted the development of the portable tape recorder was the then-new practice on NHK radio of broadcasting man-on-the-street interviews. This involved announcers actually going out and gaining interviews on the street from people. Obviously for that kind of broadcast the sensible thing to have would be a portable tape recorder.

Aspray:

Before there were transistors available what made the shrinking in size technically possible?

Kihara:

One of the limiting factors was a motor that could operate on a small battery. At that time there were no such motors, and that was one of the first challenges. This presented such a persistent problem that at first we went so far as to try a spring-operated system, hoping that if we could get the machine to work at all that it would be sufficient for demonstration purposes. That was the way around it at first. Quite literally, as long as it moves, it was okay; it was all right.

Aspray:

Were there other companies in Japan that were trying to develop tape recorders at this time?

Kihara:

That's a slightly different subject. At that time Sony held the patent in Japan for high-frequency bias, so the same sort of products were not available from other companies. It was a monopoly in effect, and it was actually not even possible to import competing products from America because of that patent.

Aspray:

Were you familiar with the work that was going on in other countries, and were other countries familiar with the work that was going on in your laboratories?

Kihara:

To a certain extent there was information available about what was going on, but because of the ban on any similar products being imported, there simply wasn't the opportunity to take those products like the Magnecorder, open them up, and really come to grips with how the machine worked. Possibly as a result I feel that some extremely innovative and very unusual products came out of that period, the spring-operated system for example. The lack of information and the need to work on one's own development was a sort of double-edged sword.

Aspray:

Were there other products or projects that your group was working on that are important in this history, before the move to the transistor radio and the transistor television?

Kihara:

I think probably the most important one was stereo tape recording, which we undertook for professional tape recorders for the likes of NHK and other broadcasters. At that time we were working on how to orient the microphones in order to obtain the best directional sound, to eliminate noise. I think that was extremely important. We were working on recording both large orchestras and on recording small jazz ensembles, for example.

One of the strongest memories I have of that period was when the world famous conductor, Herbert von Karajan came to Japan and conducted for NHK. We recorded his concert.

Transistor Radios

Aspray:

How did you decide to use transistors in these products?

Kihara:

It was a gradual process. It was Ibuka-san who first had the idea of importing the transistors for use in radios.

Aspray:

What was perceived to be the value of using transistors in radios at the time? Was it more reliability, or cost, or size?

Kihara:

Cost was not really a factor because the transistors themselves were very expensive, but the battery consumption was very low, and power consumption was the major issue. Vacuum tubes were very power intensive, both for the heater for the tube, but also for the electricity applied to the plate, which was something like 70 volts, and involved the use of multi-layered batteries. Miniaturization was not really a crucial factor in our minds at that time. Conventional vacuum tube based radios were already a reasonably small size. The problem was power consumption. Also, the reception of signals was not so good in those existing models. Both of those problems were solved by transistors.

Aspray:

I have here one of the early seven-transistor radios that's about the size of two hardback books put together.

Kihara:

In the initial period, interestingly enough, rather than extremely small models, what the market was looking for was good sound quality and a good, powerful signal. Products like this radio delivered that. I had worked on much smaller models, but they didn't seem to sell well at first. That was something that came further on down the road.

Aspray:

That's very interesting.

Kihara:

In the meantime we worked on actually reducing the size of the components as an aid to miniaturization, and that was a key process that has continued. The problem was that while we put in orders to parts suppliers to try and reduce the size of these different components, they didn't seem to be able to achieve that. But within something along the lines of six months to a year they were able to reduce the size of the components to the desired specifications. I think one of the reasons for the success of companies in Japan is this process of having the parts makers reduce the size of the components, forcing them to develop their own techniques. This has stood them in good stead and allowed them in turn to grow into major companies.

Aspray:

I see. Had they been your traditional parts suppliers before? When you were making vacuum tube radios?

Kihara:

Sony did not actually make vacuum tube radios at all, so this was an absolutely new development for us. It entailed going to a whole new set of suppliers and putting very strong pressure on them to produce very small components of the size that would be used for the kind of products that Sony wanted to bring out. I remember going to these small, rather dinky component makers and explaining, "This is what we want, and this is what we need you to do in order to fulfill that." As a general rule, that those companies that fulfilled those requirements, those that were able to match the requirements of miniaturization, are indeed those companies like Mitsumi that went on to see great success and build their own profits based on their own miniaturization skills. It's a two-way process in the sense.

Aspray:

Was Sony a large enough company that they could persuade these manufacturers to do this?

Kihara:

The point is relative. Sony was not a large company, but we were larger than the suppliers that we were asking, and that was the important factor.

Aspray:

So this was an important business contact for these suppliers?

Kihara:

Sure.

Transistor Tape Recorders and TVs

Aspray:

What other products did you desire to put transistors into in the mid-1950s?

Kihara:

Possibly the next stage was to put transistors in tape recorders. I have here the first recorder in the world to use a kind of cassette magazine system. It holds two batteries, but because we didn't want to draw on the batteries

too much it has this manual rewind function. The Babycorder was produced in 1956. Previous to that in 1955, the Cinecorder went on sale for cinema use. And then the TR-55, the famous transistor radio, was also produced in 1955. They were under development at exactly the same time, and I worked on both projects simultaneously.

Aspray:
I see. I understand that there was also work on a transistor television set during this period?

Kihara:
That's right. We worked on a project to try and develop an all-transistor television. We managed to develop a successful prototype in 1959.

Aspray:
What was the value of the all-transistor television?

Kihara:
It was a good prospect to apply the principles of lower power consumption, more miniaturization, and more reliability to this product for the consumer. Just as we felt that these were viable principles for transistor radios we also felt they could be applied to television. Those three elements were the key things.

Aspray:
It took a bit longer for the television prototype to be developed. Was it more challenging technically?

Kihara:
There were several difficult challenges associated with transistors. One was the necessity of having a power transistor roughly at the rate of about 20 watts and able to accept a large current. A second one was the sensitivity necessary to endure high-pulse voltage. Thirdly, high frequencies were a problem. Those were the three main challenges in employing transistors. Through close work with the semiconductor group within Sony, we managed, in the development of the transistor television, to develop a very high-power, high frequency transistor. That was almost a by-product of that development. The key thing for me was to give the developing groups a sense of direction. If you just say to them, "Develop a high power transistor," with no real goal in mind, it's much more difficult. If you say on the other hand, "Develop it because it is necessary for this specific product to solve these problems," then that allows them to concentrate their efforts on a single development. I'm convinced that the reason they were able to achieve this was because the goal was standing very clearly there in front of them.

Video Recorders and Betamax

Aspray:
Since time is short, let me ask you to tell me the story about the development of the video recorder in the late 1950s and in the 1960s.

Kihara:
The basic principles of video recorders were probably thought of by many different engineers. If you could record sound, then surely it would be possible to record images as well. So about the time, just after the development of the stereo recorder that I was talking about earlier, I first started to think of the idea that a consumer or a professional VTR would be possible. From that point onwards, we started to work on things like the rotary head and the recording method. At about that time there were available subsidies from the government for particularly important developments. We applied for such a grant from the government, but it appeared that we were ahead of our time. They would not grant us the money for the development. As a result, we gave up on the development for a period.

In about 1957, Ampex brought out their first broadcasting use video recorder. When we heard about it, my first thought was that it was the same sort of product for which we had tried to obtain the grant from the government. I said to Ibuka-san that we definitely should develop a VTR product, and he agreed with me. So we started on the development, and by August of 1958 we had finished our first successful prototype. It took only three months to reach that point. Having realized that we could develop a VTR, the next step was the transistorization. We finished the research and development on the transistor for the VTR in 1959. We were able then to inform Ampex that we were able to produce a transistor-based VTR, and from that point stemmed the joint development with Ampex. At that time, following from the discussions with Ampex, we achieved a form of agreement that said that Ampex would develop a transistorized video tape recorder for professional use whereas Sony would look to a more miniaturized product for the home market.

Aspray:

Why join forces with Ampex at all? Why not do it alone?

Kihara:

One of the key reasons was connected with patents. We thought at first that a certain technology would not be covered by a patent, but it turned out in the end that it was, and for that reason we worked together with Ampex. So we developed a cross-licensing agreement between Sony's transistor technology and Ampex's FM recording technology. That was the benefit for both sides in coming together.

Aspray:

How would you compare the technical capabilities of the two organizations?

Kihara:

Prior to this development, Ampex had already developed a very professional audio recorder for broadcasting, so we had already had some contact with them. In that sense one could say that Ampex was the sort of company that produced very high quality products for the market with very high functionality. But they were not a company that could make products for the mass market. Their mass production capability was very small. This was very different from Sony, who I felt had undeniable strengths in the area of mass production and of designing and producing products for the consumer market. I think that this was a basic difference between the make-up of the two companies.

Aspray:

Will you now please tell me the story of the development on the Sony side?

Kihara:

Basically it goes back to the same kind of philosophy that governed the development of the transistor radio. Those key elements were; transistorize the product, miniaturize the product, lower the power consumption, and make it for the consumer. Both Ibuka-san and I strongly desired to make this product in a way that it could go into people's homes. Once that direction had been decided and that goal had been set, I felt that it then allowed us quite easily to concentrate on the various different technical challenges that had to be overcome. The important thing was the establishment of that direction and the establishment of the goal to produce a home use VTR.

Aspray:

Were any of those particular technical challenges extremely difficult?

Kihara:

There were a number of breakthroughs. The most important one was the rotary head. The reduction in size and the cost of that particular component was the biggest challenge we faced during the development. The product that stemmed from the solving of that challenge was developed in 1965: the model CV. It was an open-reel VTR with half-inch tape. That CV model was basically a tape recorder to which had been added a rotary head. It was the first product of its kind to go on sale in the mass market, at what was comparatively a very, very low price for the average consumer. As a result, we achieved very good sales with it. One of the most important things to remember about that CV model was that we were able to apply for a number of very crucial patents as a result of that development. Those patents have survived. They govern the basics of video tape recording and are still held in connection with Betamax and the 8mm development as well. There's a good comparison also with the CD there, where there were a number of patents that came out of that development as well.

The next challenge, once we had developed that open-reel system, arose from our feeling that if it was really to be a consumer product, then it shouldn't be open reel. Already in the audio arena, tape recorders were becoming cassette- based for ease of use, and we definitely thought that in the video arena too we should move towards a cassette-based system. And we were able to succeed. Unfortunately, having achieved the cassette and made a product, we found that it did not sell. The reason for that was that in the meantime, televisions had moved to color, and that presented a new challenge in the videocassette area.

Aspray:

So these were black-and-white originally?

Kihara:

Yes, they were black-and-white. So those are the three major area, the rotary head, the development of the cassette, and color video tape recorders.

Aspray:

Are those the innovations that facilitated the move from this first product in 1965 to the Betamax in 1975?

Kihara:

Yes, that took about a ten-year period. Of course, within that period we were also working on 3/4 inch VTR (U-Matic) and the ΩVTR for broadcast use.

The Engineer's Way of Thinking

Aspray:
Since we have only about five more minutes, I would like to give you an opportunity to talk about other things we haven't talked about yet that you think that historians would like to know about, or other engineers would like to know about, either concerning the development of the Betamax, or some of the products which followed.
Kihara:
Sony's ability to develop new products is often seen from the outside as very strong. I personally feel that that is based on a very traditional engineers' way of thinking. This has always been my way, ever since the development of the tape recorder. In my role in Sony's development activities, I was able to train all the engineers that came to the company in that way of thinking. During that process of training or education, aside from training for their day-to-day jobs, there were a number of different principles that I wanted to instill in the engineers that worked for me. One of them is that anyone can find out the common sense things, and my role is not to teach common sense. My message has always been to break through what is common sense and common knowledge, and make the impossible possible. That is the key element. But, of course, just saying that alone is not going to help anyone. In terms of how they go about achieving that, my advice has always been to develop your own devices, assemble your own prototype, and operate it yourself. Do it all yourself, rather than looking at what somebody else has made and trying to come up with ideas based on that. That's the way that people learn to break through problems and to overcome them. Thereby you build up a store of knowledge about how problems were overcome, and building up that storehouse of knowledge, is what enables you then to take on new challenges and solve new problems which no-one else has solved before. It's that accumulation of experience that is important.
Aspray:
Thank you very much.