Oral History of Hans-Juergen Wagner

Interviewed by:
Paul Sakamoto

Recorded: August 1, 2013
Mountain View, California

CHM Reference number: X6925.2014

Sakamoto: Hello. My name's Paul Sakamoto, and today I'm interviewing Hans-Juergen Wagner, who is senior vice-president of the SOC Business Group at Advantest Corporation. He is here today and going to tell us a little bit about his time in the semiconductor ATE business and also specifically the development of some of the systems that are used to test semiconductor chips today. Tell us about your history, where you grew up and what your educational background is and your work history, and then we'll get into the rest of the questions.

Wagner: So I'm living in the southern part of Germany. I was educated at the University of Stuttgart and then even as a student already moved to HP [Hewlett-Packard]. HP had a big site and still has a big site in Böblingen, close to Stuttgart, and I started there as a student in 1983. And in 1985 I started as a permanent employee as an R&D engineer in the test and measurement business of H-P.

Sakamoto: So essentially you've spent 30 years working at the same physical location if not the same company.

Wagner: Exactly. I mean, the company changed [names] four times, but I was always staying at the same location even though today I'm traveling a lot, so I'm not sure how often I'm really at home, but my official office has not really changed a lot within those 30 years.

Sakamoto: Just a little while ago we were interviewing Maruyama-san from Advantest, and the traditional Japanese architecture that was supported at the time for semiconductor ATE was the shared resource architecture. It had a very bipolar-centric kind of technology that was descended from the mainframe. Was the technology in the testers and equipment that you were working on ever bipolar, or was it always some other technology?

Wagner: In the beginning it was a combination of CMOS and bipolar just for the different purposes, and in the beginning each technology had its own benefits. So bipolar for high speeds, timing, frequency, position, accuracy, and CMOS more for higher integration and some slower kind of activities like interfacing with the memory and all those kind of things. And just over time the CMOS technology developed so greatly that all of this functionality could be integrated into a CMOS chip, which I think we did very soon, I mean, as soon as this was possible based on our fundamental strategic concept to do exactly the same like our customers did, and they started to integrate everything on CMOS. And when they did this we also did it.

Sakamoto: Some of the older tester companies that had been in the market earlier than Hewlett-Packard at the time had spent an awful lot of energy developing shared-resource timing systems. It was a way in which you could share the most expensive or highest-performance portions of the circuit with a variety of connections to the device under test. But I believe that your organization very early on adopted more of a single-channel architecture where...

Wagner: Yes, and maybe that's because we came from a pulse pattern generator thinking, which was the first idea of an IC test system. It was just having many channels of pulse pattern generators on the stimulus side and then the same kind of receiving-end channels. And this by nature was more a per-pin kind of architecture, and interesting enough it always stayed that way, at least in our LSI and SOC-based solutions.

Sakamoto: During another presentation we recently saw, you were demonstrating the evolution of that product line from separate instruments to systems that were composed of those separate instruments hooked together through a local network and a computer, and then eventually integrated into a true ATE test system. But that transition is always a little harder in reality than people make it out to be, and I think during the first half of your career you were spending a lot of your time implementing, and in the second half of your career you've been managing and directing those kinds of architectural changes. Were there any kind of major disconnects between the upper management thought process about what was going to happen and what you actually had to do as an engineer to make it happen?

Wagner: Yes. <laughs> I think there are always some kind of different views of what a product can do and should do and how you implement it, and we certainly also had this kind of challenges in our organization. For example, we always wanted to reuse the technology which we developed for the system-oriented business also in the boxes, but in fact the reality was almost the other way around. We reused the technology developed for the box [Editor’s note: “box” in this case refers to individual, or discrete, instrumentation as sold by the parent H-P company] business also in the system business. It took a while to really shift the sequence here, because time to market and complexity of the system business were sometimes too slow to support the box business. On the other side, the investment into technology was increasing more and more over time, and it only did have a significant return on investment if this technology was done for the system business, because number of channels, number of pins have been over time much, much bigger and higher than in the individual box business. But this was a change which between the engineers who did the implementation and the top management was taking time to really understand how the goal and the execution can really be come together and solved. Over time we made it, but it took a while.

Sakamoto: As an outsider we always had presumed that you were able to have access to the full library of H-P and Agilent technology, and you would just roll it into your systems and that's the way the technology went, and I guess what I'm understanding is it was supposed to go both ways.

Wagner: Yes, exactly. I mean, we always had, but the individual market requirements for pulse pattern generators, for logic analyzers always had their own dynamics and their own requirements for time to market, for competitive situations and so on than in the system business. And if you want to synchronize technology development it's really hard, because you need to overcome all those individual characteristics of different marketplaces, and therefore it really took a while until we did get there, including the need to get to a very critical size of the business to justify those kind of investments. But, again, it took a while, and at the end I think we did it well, but it was part of our evolution, of our development and of our learning curve.

Sakamoto: Do you have any interesting anecdotes you could share regarding that time when someone made a presumption and it was just incorrect?

Wagner: Yes. For example, we wanted to use the timing system of a tester also in a pulse pattern generator, and we have moved forward very far, and then we finally learned that in a tester you can have those kind of idle cycles where the system is synchronizing with the device under test, but in the box business you cannot afford it, so we had fundamental issues from a dedicated system architecture point of view which then broke the whole assumption. So we didn't even have a good overview at that point in time of all the specific requirements for the different businesses to really follow through on the reuse of components, and therefore we again split apart and had our unique technology for the boxes and the unique technology for the systems.

Sakamoto: During a lot of the time when you were operating separately as earlier H-P-related companies there was no Internet. Global communication was very difficult. How did you manage to coordinate the assets that were spread around the world?

Wagner: Yes, I mean, this was reality for me from the beginning, and it was really tough. When I started, just after university in 1985, I was IC designer for an output amplifier of a pulse generator. This IC process was located in Santa Rosa, California. My design was located in Germany, so we needed to start a relationship with the Santa Rosa people and understand how a gallium arsenide process can be used for a pulse generator, which was the first time we ever did this, and it required a lot of communication. And at the end it was really traveling, meeting, communicating via phone, writing email; so using everything which was available, but without face-to-face meetings it would have never worked out. And, by the way, this is true even today with all the great technology. You first need to build up a very, well, great relationship on which you can base your working style, and then you can use all of the new tools like email, like video conferencing and all those kind of things.

Sakamoto: Some things never change.

Wagner: Yes, it's a high-tech and a high-touch industry still.

Sakamoto: You mentioned gallium arsenide. Most of the ATE companies that I'm aware of at one point or another did in fact try to use gallium arsenide for its technical promise. You mentioned using it in some limited amount. Did you ever use it in the actual ATE system itself, and, if so, how did it work out?

Wagner: We tried it once. <clears throat> Sorry. But the level of integration was not sufficient, and therefore it was not really a good technology for a high pin count kind of system, so that's why we did run into limitations, and certainly also the—now a little bit more technical—if you look at what is the English term for that, the amplification...

Sakamoto: Yes, the beta?

Wagner: The beta. I think it's G sub S for field effect transistors. This is relative to other technologies not really steep, so you need many differential amplifiers, many amplifier stages to really get strong performance, and this combined with a relatively low integration was creating very big chips, so overall the technology didn't really work out for high pin count system-oriented testers.

Sakamoto: In the '90s I think Schlumberger tried to use gallium arsenide on a broad basis in their timing systems. From a competitive standpoint were you aware of that, and what did you think of it?

Wagner: Oh yes. And I think we have had more experience about the specifics of gallium arsenide, and there was one specific thing which the microwave people never realized, because the microwave people used gallium arsenide for high-frequency but small-bandwidth applications. For example, four gigahertz amplifier but just 100 megahertz bandwidth. If you use it for digital systems you had DC up to gigahertz, and we learned that the amplification was frequency-dependent, and therefore the duty cycle performance of gallium arsenide was really critical and required a lot of compensation. So if you build very complex timing systems based on gallium arsenide you have some unknown challenges at those times.

Sakamoto: That's an interesting amount of knowledge that I guess you're saying was a cross-pollination from your earlier instrument efforts into the ATE, so it was a definite advantage.

Wagner: Yes, exactly, and we did even do some public information about this kind of behavior in the late '80s, and we talked about that, so...

Sakamoto: Half the industry went with critical gallium arsenide circuits, and they didn't do so well with it on average.

Wagner: Yes, we observed that, and we have been lucky that we learned that early and then we moved more to bipolar and later to CMOS-based technology.

Sakamoto: When you look back on the development of the various systems that have come from your group, can you think of any particular item that had great promise but didn't work out quite the way you thought it would?

Wagner: Well, certainly we also did memory testers in Germany, and none of them worked out. We once sold exactly one system, and then we basically canceled the whole project and moved it off the market. So we also have a memory test history in H-P Germany, but it was never successful. All the other logic testers and later on SOC testers at the end really have been I think very, very successful, but all of them, be it the 82000 or the 83000 or the 93000, had some initial start-up issues which we need to deal with and which are related with the fact that you always need to learn what really the requirements of a market are. And the changes of a market and the innovation was, and still is very fast. Our development cycles at those times have been five years, six years. The market changed a lot, and we needed to adapt the product to the market shortly before we introduced and even after we introduced, but in all cases I think it went very well from a overall results perspective, but it was challenging and we took the challenge.

Sakamoto: I vaguely remember the Böblingen memory tester, so that was interesting that it didn't succeed. It seems like usually most companies will push a lot on something before they give up, but I think you have to be credited with deciding that it wasn't going to work, and if it's not going to work then you need to stop. How did you reach that decision process, and how did it get executed so cleanly?

Wagner: Well, certainly it always was based on the initial customer feedback and the initial customer success. There was one memory tester which we did in the middle of the '80s, and we did find out very, very soon that we didn't keep track with the speed innovation of those memories, so the memory tester was not really fast enough and did not have enough margin to develop over time, and so therefore we stopped it. And then later on there was this whole Rambus-based vision that all PCs will have Rambus memories on it, and, I mean, each tester company at that point in time I think invested into RDRAM-oriented memory testers. It was a big challenge in terms of speed and power consumption and so on, but even this market strategy didn't really pay off, so I think at the end Intel changed the architecture in a way that RDRAMs have not been a major part of the PC architecture, and so we basically decided to stop because the market in that sense collapsed.

Sakamoto: Congratulations on making the decisions early, because that's when you need to make them.

Wagner: Well, in fact on the other side Advantest at that point in time did follow through. They shifted the product to new markets and different markets, and it allowed them to have a really strong position in memory test basically in the '90s and in the first decade of this century. So sometimes when I'm looking back I think maybe we even need to be more persistent and follow through longer and never really give up. But, I mean, in our case looking back I think it was the right decision, and it helped to focus and focus the investments into areas which have been more promising. But I think on the other side it really created a very unique position for Advantest, which at the end we also did benefit from, because they had deep pockets and could make the acquisition of Verigy.

Sakamoto: One of the key competitive technologies was the sequencer-per-pin architecture, and the 93K channel was one of the things that allowed you to do memory test on the system, but at the same time it also seemed like it was a hard thing to coordinate the activity across the channels, and it added a layer of complexity that the competitors had trouble understanding. What do you think was the key factor that really made the 93K so successful?

Wagner: Yes. Well, I think for the 93K it was really the platform value so that our customers could use the platform for a long time, for many different types of devices and applications. And this worked out very well. It was certainly based on a universal architecture like the per-pin test processor, which made it much more flexible, so each pin could basically do all the different kind of functionalities and could be easily adapted. The configuration could be changed very quickly. It was scalable, upgradeable and those kind of things. But making sure that the platform value is a true value for customers and not only an internal value to leverage and save cost, I think was a key difference. And I personally learned this approach also from the box business, in which we always tried to create platforms for a wide range of applications but mostly for internal reasons to leverage investments and technology and so on, and this never really paid off, but establishing a platform as a customer value and really making sure to focus on those values for customers helps to follow through and I think was very successful.

Sakamoto: Was there a key customer that was very influential to this that helped you develop that, or was that an internally developed concept?

Wagner: Well, I mean, it certainly was mostly driven by the fact that we have been initially very successful in the outsourced supply chain, so in the fabless OSAT-based [Editor’s note: OSAT = Out-Sourced Assembly Test] supply chain, and those OSATs by nature require a solution which they can use for many different kind of customers for many different kind of market segments and devices. And those customers helped us to really understand what is required to make a platform a real value for those customers.

Sakamoto: At one point in the '90s Credence Systems was the largest ATE vendor to the OSATs, and later Agilent then Verigy came in and displaced them. What were the key assets that allowed you to do that?

Wagner: I really think it was a combination of things. It was certainly having a tester based on an architecture which could deliver a platform as a value, but it also was having the specific capabilities to meet the needs at that point in time. And I still remember at that point in time I think it was that the memory interface for graphics chips and computer chips had—the speed moved up again I think, I don't know, 155 megabits or something like this, and we have been able to test this while I think the quartet at that point in time was struggling with that kind of speed. And then also our sales strategy, by driving what we call upstream customers, or fabless design houses, and winning the designs there who will then drive test capacity at the OSATs was also very important. We had an engineering test house here in the US, here in the Bay Area, which was really important for us in that time, because by them we could win new fabless design houses, which initially have been really small companies, like big graphics suppliers today, and they helped us to offer test capacity to their designs, and by that we did get the design wins, and this drove the requirement of the related test capacity at the OSATs. So it was a combination of all those three things which helped us to basically become pretty dominant in this fabless supply chain.

Sakamoto: A lot of times you just kind of happen into these things, but other times it's good to hear the plan.

Wagner: Yes, I think not always the plan was always there from the beginning. In fact I think in our industry it is by far never about a waterfall kind of approach. That means you define something, then you execute, then you deliver results. It is really more about a continuous learning together with customers, and I think that's something which we developed very nicely over time, that we have become more open to customer voice, we listen more. We didn't try to educate them why our technology is the best. It was really more learning from them and listening and then having an exchange and learning together. Then drive the change, drive the innovation, drive the evolution based on that. And I think all of our history is about this learning, and it's even about learning to learn together.

Sakamoto: During the first 10 years that you were working what was the big competitor in your mind, and how did you view them, say, back in the '80s?

Wagner: Well, for us because in the '80s we still focused a lot on engineering test the biggest competitor for us was IMS [Integrated Measurement Systems], which was interesting enough led by Keith Barnes, who later on became the CEO of Verigy. We did really compete about the engineering test space, which is design verification, characterization and so on. So in those times we didn't even look at Teradyne and Advantest, Schlumberger and all those other guys who have been in the manufacturing test side. This then started basically in the '90s when we really looked at expanding into the manufacturing test area, and I think initially Schlumberger was very prominent for us, and then for sure Teradyne because of their broad market coverage, like you said. In the OSAT space Credence and—so it depended a little bit on the business situation in which we have been in, but, again, engineering test, IMS, and then later on Schlumberger, Credence and even LTX and then Teradyne.

Sakamoto: Can you outline the difference between an engineering and a production tester?

Wagner: Yes, the engineering tester is much more focused on performance and functionality to really be able to test at speed in what we call mission mode in the real application and make sure that there are margins and the specs are met and so on. Throughput is not so important. It's really more at-speed capability, mission modes, real functionality and those kind of things, while in manufacturing it's really much more optimized around "Does it work or does it not work, and how fast do I find out if it doesn't work that it doesn't work?" So it's much more optimized on throughput and lower-cost test methodologies and those kinds of things.

Sakamoto: What were the primary changes you had to implement in your testers as you went from the engineering market to the production market?

Wagner: Well, many, many things. At the end it was really about the complete integrated solutions, and there are several aspects. The data interface is the most prominent. I mean, in engineering test at least in those times, engineering test was more done on a bench. You have the engineer sitting close to the machine and varying parameters and checking out what's going on, while in the manufacturing test the test head needs to be connected to a handler or to a prober, which is a very different kind of interface into the device and the test. Today it's getting closer, so sometimes people are also using this manufacturing environment for characterization, but in the '80s it was very different. The other thing in terms of throughput was that controlling the instruments via GPIB or what we at that time had, HP-IB, was by far too slow. There was by far too much software overhead to communicate to each channel and give instructions for set voltage 2X and those kind of things, so the software was not optimized for fast throughput, it had by far too much overhead. And in engineering test this didn't really matter. And the third thing is usability. I mean, engineering test requires a lot of perspectives on waveforms, signals, so you need to think in terms of how the device is designed, while in manufacturing test it is really more about structural tests, stuck at one or zero, I mean, those kind of things, which is very different. It is operated in the manufacturing flow by operators, and it's in that sense a very different environment and has very different requirements from a usability and use-model perspective.

Sakamoto: At different junctures in the industry's maturation there's been this notion that the market is going to be depleted by design for test or structural test methodology that's going to eliminate the need for testers as we know them, and yet here we are today and your division in particular is selling more classically full-performance, full-function systems than ever. What do you think is the future of that trend? Why hasn't it already happened?

Wagner: Well, I think the change to structural test has really happened, but if you now look at those complex CMOS chips you have always a very big digital core, which is doing all the signal processing and calculation and computing and so on, and this is tested based on structural methods. You have also some memory embedded where you're using BIST, so built-in self-test approaches, and those kinds of things. But then you have always those high-speed and performance-oriented interfaces, which in the real application are not only digital circuitries. It's really more the analog performance and behavior which is important for the whole chip quality and performance in the later application. So there will be always a need for functional and performance-oriented test for interfaces, be it RF interfaces, be it high-speed interfaces, be it mixed-signal analog interfaces, and there is this big, huge digital core in which you have different test methodologies. However, even today because this big digital core is so big the timing requirements, the memory requirements for even that core continuously increased and became still a dominant aspect of the overall cost of test equation. And I think this will always go on as long as the innovation of our industry goes on, because our customers compete with each other, and they want to either win on time to market or on better performance, higher bandwidth, faster throughput of video information or whatever, and they will always try to maximize their business strategy on the technology they are using. And they don't have the time or the money to do it in a way that they can be sure that kind of based on guaranteed by design everything is working, so we are always an element to enable the strategies of our customers by offering them the right balance in terms of innovation and being sure that everything works.

Sakamoto: For someone to have foolproof DFT and foolproof built-in self-test they would've essentially had to engineer a tester per device, and they just don't want to spend the time that way.

Wagner: Yes.

Sakamoto: Bill Hewlett visited the facility and looked at the progress of the ATE a number of times, which surprised me. Did Dave Packard ever come there? What was their big takeaway from the experience of seeing the division?

Wagner: Yes, I think both, how we said, Bill and Dave had a big sympathy to test and measurement world, because that's basically where they by themselves came from. And it was really interesting that both Bill and Dave never really did get disconnected from the engineering work. I also met Dave Packard once, but not in Böblingen but in Grenoble [France], and he gave a speech about the continuous innovation of technology and why there is always a need for making your own contribution in the test and measurement world for those new technologies. It was really very inspiring, and you also could feel there that also he never really gets decoupled from technology and what engineers are doing with technology. I mean, that's some of those really unique characteristics of those two gentlemen, and that's what makes them very inspiring for many, many people within the old H-P world.

Sakamoto: An outsider's view might be that the spirit of the original Hewlett and Packard Corporation is probably more alive in this group than it is in the computer company that we see on the shelves today.

Wagner: Yes, I don't want to get on the toes of my friends of H-P today, but I really think so.

Sakamoto: Okay. Great. Is there anything in your perspective when you look back that you think is of particular importance that we might've missed in our discussions today that you'd want us to record and know about as far as the development of ATE and your perspective?

Wagner: No, I think we covered everything.

Sakamoto: Okay, great. Well, once again I thank you very much for participating in our oral history program. Once again I want to thank Hans Juergen Wagner of the SOC Business Group—he's the senior vice-president there of Advantest Corporation—for spending the time with us today.

Wagner: Thank you very much. It was a pleasure.

END OF INTERVIEW

