Taiwanese IT Pioneers: Ding-Hua Hu

Interviewed by: Ling-Fei Lin

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Ling-Fei Lin: My name is Ling-Fei Lin, your interviewer. Today is March 9th, 2011. This is an oral history interview project by the Computer History Museum. We are interviewing some of the pioneers of Taiwan's semiconductor and computer industry. Today our guest is Ding-Hua Hu. Mr. Hu, please state your name in Chinese and English.

Ding-Hua Hu: My Chinese name is Hu Ding-Hua. “Hu” as in the common surname “Ding” as in the Chinese for “stability”. “Hua” as in the Chinese for “China”. My English name is a phonetic translation of my Chinese name. DING D as David, hua HUA, last name HU.

Ling-Fei Lin: Good. What can you tell us about your childhood? Where were you born and where did you grow up? Could you tell us more about your family when growing up?

Ding-Hua Hu: I was born on January 9th, 1943 in Chendu City of Sichuan Province. But I came to Taiwan with my parents when I was a child so basically I grew up in Taipei.

Ling-Fei Lin: How old were you when you came to Taiwan?

Ding-Hua Hu: I came a little earlier than most people. I came around November, December of 1948

Ling-Fei Lin: Before that you were at Chendu?

Ding-Hua Hu: I was at Nanjing for a very short period of time after the victory of Sino-Japanese war. Then I came over to Taiwan around November, December of 1948. When I first arrived, I lived in the Yangmingshan area for about a year. Then I moved into the city.No.2 Lane 51 Jiling Road that was where I grew up. I have a photo of the place here I can show you. This was the house I lived in. This picture was taken when I was around senior high. The house is still standing hasn’t been torn down yet. Basically, my school years went fairly well. I probably started school earlier than most people. In 1953, I entered The Junior High Division of The Affiliated Senior High School of National Taiwan Normal University. I was barely 11 years old.

Ling-Fei Lin: Did you skip grades? Or?

Ding-Hua Hu: Like I said, I lived in Yangmingshan for a year when I first came to Taiwan so basically I was not in school. And I was reluctant to start later than kids my age so I skipped first grade. And, there was a difference between spring semester and fall semester. I was in the spring semester class. Then

when I was in the fourth grade there was a change in the educational system. So there was only fall semester so I skipped another half a year. I was 10-and-a-half years old when I entered the junior high school. I was very lucky to be admitted into the so-called experimental class.

In six years, I finished both my junior and senior high school at The Affiliated Senior High School of National Taiwan Normal University. In 1959, I graduated from senior high school. At that time, I remember the most popular major was Physics not Electrical Engineering. Therefore, my admission to the Department of Electrical Engineering (EE) was not the first choice. I think it was my second choice. But technically, both Departments of EE and Physics at National Taiwan University were people's first and second choice in the science and engineering field of studies. Sometimes EE was more popular and sometimes Physics. But not that big of a difference.

My studies went pretty smoothly. I never came across any great problems. If I were to say which subject I was better at I would say math and physics and only average at chemistry not that great at biology. I remember that when I was in National Taiwan University. Both Chinese and English classes had a system where the students were grouped into different classes according to their grades. I think I was in the first class so that was alright.

Ling-Fei Lin: You mentioned earlier that you were from a military family. Did this influence you in any way?

Ding-Hua Hu: Military villages are what people think about when we talk about military family. But like the picture I showed you I didn't actually live in a military village. The Jiling Road and Songjiang Road areas were all basically one-story houses although the houses weren't that big. Most of the people who lived there were basically high ranking military officers. However, our interactions with neighbors were somewhat similar to that in military villages. Because we rode on buses to school together had many interactions with our neighbors. For example, everyone spoke Sichuan dialect. In fact, this Sichuan dialect that we spoke was very different from the real Sichuan dialect.

Ling-Fei Lin: So do you speak it?

Ding-Hua Hu: A little. One of the good things about military villages is that people there value the relationships between people.

Ling-Fei Lin: Can you talk about your time in NTU and National Chiao Tung University's Electrical

Engineering Department? What kind of education did you have and what experience did you have in school?

Ding-Hua Hu: I studied Weak Current Engineering in NTU. At that time, there were two separate studies of power and weak current engineering. Power Engineering was all about electricity, and people could work at power company when they graduated. Weak current engineering is basically today's communications and information. It is pretty basic. But what made an impression on me was that most of the professors were much older. Even though they were very experienced. There was not a lot of interaction with students. However, there was a professor named Juxian Li. The reason why I remembered him was that he had an equipment in his office. Only he had access to it. That was a very expensive equipment. It had something to do with semiconductors. It was a transistor curve tracer. It measured transistor's characteristics. So the first time I heard about anything semiconductor-related was during my second or third year in NTU. Of course, modern physics also talked about semiconductors. Basically, NTU was a very liberal environment so you were on your own when it came to studying. While I was serving my military duties I realized a lot of people applied to study abroad in this field. Although it was the trend at the time. I never actually thought about it maybe because my university grades weren't that good. That made it harder for me to get scholarships. So I stayed in Taiwan for my master's degree. Another reason that I stayed was that my mother was in poor health. So I decided to stay.My mother passed away while I was pursuing my master's degree in NCTU. I have to say that I'm very grateful for NCTU which was a small school at the time. It was located on Bo Ai Road in Hsinchu. The size of the university was less than 25 acres. They just started their undergraduate program and the school was mainly for graduate studies. The masters program was a two year program. There were first and second year students and each had about 20 to 30 students plus undergraduate students. You can say that NCTU was a very small school, population wise. Therefore the student teacher relationship was totally different than that of NTU. NCTU may be small but the equipments were more advanced than that at NTU. They also encouraged students to get hands-on experience on these equipments. I entered NCTU in 1964 and graduated in 1966. In 1964, NCTU had their first-also Taiwan's first- semiconductor lab. There was a professor who worked in the Bell Labs in America. His name was J.J. Zhang.

At the time, he was instructing Chun-Yen Chang who was an instructor, and Shuang Fa Kuo, another instructor. They were in the process of developing transistors. But I didn't study semiconductor while I was in NCTU. I was studying under a visiting professor named Chao Cheng Wang from a well-known laboratory called Sperry Rand. Chao Cheng Wang was later the first Chairman of the Board and President of the ITRI. He was also a fellow at Academia Sinica. He was very prominent. There were about 6 or 7 students studying under him in Quantum Electronics. I mainly worked on helium-neon gas laser. I

believe I was the first person to fabricate it in Taiwan. I was very familiar with the operation of different equipments in the lab. I did everything on my own. My academic advisor was professor Ting-Shun Wen. He's one of the few people I really admire. Any equipment, devices would come alive in his hands. There was one project that we did with professor Wen. We took apart a non-operable radar from Songshan Airport and brought it back to NCTU and made it work again. Do you know how many wires were involved? There were over thousands of wiring and every connection had to be planned. So you can imagine the magnitude of this project. If we didn't plan well then we wouldn't be able to revive it back in NCTU. The teacher-student interaction was very good in NCTU. I think because of this I was able to apply for scholarship in the U.S without any problems. And also because of my experiences in NCTU my time in Missouri went pretty well. Especially in doing experiments so I think small schools have their advantages.

Ling-Fei Lin: How was studying in America different from studying in NTU and NCTU?

Ding-Hua Hu: Like I just said before, the student-teacher ratio was very high in NTU so it wasn't possible for professors to cater to every students' needs or run special programs for certain students. The academic environment in NCTU was much better in comparison. But that was then. I think the student-teacher ratio in NCTU nowadays is not as good as before. The environment of NCTU back then was already very similar to that of American universities. The facilities were good in NCTU and a lot of professors came back from USA. University of Missouri is a state university with quite a lot of students. There are two types of universities in America. One type has more teachers which focuses more on research. The other type, like many other state universities, does not have this kind of advantage. Caltech and Stanford,for example, are the first type. In general, who you get as a professor is important. Some professors look out for their students and also interact with students better while some professors don't do that as much.

So the academic environment in NCTU was comparable to that of American universities. Especially when NCTU recruited many acclaimed professors back to Taiwan. One of them was Professor L. J. Chu who was very well-known in the field of microwave. While I was studying in NCTU Professor Chu spent most of his year in NCTU. Chao-Chen Wang would always come back to Taiwan in winter and summer breaks. Other people like S. M. Sze who was well-known in the semiconductor industry all returned to Taiwan. One thing I found different while I was in Missouri was the dynamics of the society, and connections between people. The atmosphere was livelier and more energetic than that in Taiwan.

There was some difference between state universities and research universities. The difference was professors. Who you got as your dissertation advisor would influence your development in the future. The

professor I had was EJ Charlson who had an Electrical Engineering Ph.D. from Carnegie now called Carnegie Mellon University. He was a very generous person and according to Carnegie tradition whenever they were conducting an experiment they always designed their own equipment set-ups and experimental methods. They were very strong when it came to practical work and that made an impact on me. Of course I didn't continue on with Quantum Electronics, instead I switched to semiconductor-related subjects. My project with Professor EJ Charlson was about the properties of III-Five semiconductor which is the III-V Compound film of today. Up until now, it's still a very interesting material and there are still research studies on it. But basically it was not widely used for industrial use. There were Pakistani, Indian, American and of course Chinese and Taiwanese students studying under Charlson so there were some interesting things that happened in the lab. We would hang out and chat. we also had common hobbies like going to the movies, drinking beer or going on to roadtrips. There were hippies, so to speak It was the Vietnam War era so there were upheavals on campus causing lots of problems. Like the Kent State Shooting incident in which the National Guard was involved. It caused a lot of trouble. This was why I returned to Taiwan right after I graduated from Missouri and took up a teaching position in NCTU.

Ling-Fei Lin: So you left because of the turmoil on campus?

Ding-Hua Hu: There was turmoil on campus also in the society…I found it meaningless.

Ling-Fei Lin: While you were teaching at NCTU from 1970 to 1974, did you set up another semiconductor lab there?

Ding-Hua Hu: I didn't set it up. Like I said, the semiconductor labs in NCTU were used for different purposes research, or labs for undergraduates. This semiconductor lab basically started in 1964. NCTU knew that this was important. At the same time, there was Fine Products Microelectronics Corporation (Fine Products Electronics), one of the earliest companies to manufacture transistors. It was the so-called factory with wafer fab that made semiconductor components. The school had a co-op program with the industry thus our semiconductor lab was fairly large in scale. I accepted the job offer as the Director of Semiconductor Research Lab in my second year there. And at the same time, I was also the Chief of Experimental Studies. NCTU doesn't have that position anymore though. As the Chief of Experimental Studies, I was in charge of the planning, servicing, and maintenance of all the laboratories in the school. So I spent a lot of time working in experimental studies.

Ling-Fei Lin: So the experimental studies were for students?

Ding-Hua Hu: Yes, they were for students.

Ling-Fei Lin: And the research labs were for professors to do their research?

Ding-Hua Hu: Yes.

Ling-Fei Lin: The collaboration with Fine Products Microelectronics Corporation helped you with the establishment of the lab?

Ding-Hua Hu: It wasn't a collaboration. Fine Products was in the process of building a factory. Fine Products sponsored several equipments and facilities so the structure and content of the lab in a sense was much more advanced than other semiconductor labs in Taiwan. As for Experimental Studies, they also worked on many other things besides semiconductors.

Ling-Fei Lin: And that was 1974. Around 1973, Taiwan had just started planning the development of the semiconductor industry. What was the reaction of academic and industrial communities regarding the semiconductor developments?

Ding-Hua Hu: I have to say what influenced Taiwan on many things were enthusiastic overseas scholars who gave a lot of advice after they returned. At the time, there were two forums, the National Construction Forum and the Modern Engineering and Technology Seminars. The National Construction Forum focused on general policies and invited overseas scholars, local representatives, local scholars, and industries to participate. It was a place for interaction, connection, communication, and suggestions. The other forum was Modern Engineering and Technology Seminars which I found more unique. In my hand is the book for the Modern Engineering and Technology Seminars. This was for its tenth forum. The forum is bi-annual so the tenth forum means that it's at its twentieth year. The forum started in 1965 so this book was from 1985, the twentieth year. If I remember correctly I think it was the forum in 1970.

I was talking about the history of the forum. The forum started in 1965. Of course I wasn't there because I was studying in NCTU. The forum in 1970 discussed the manufacturing of transistors and integrated circuits. And what do they do at this forum? They invited many overseas scholars every two years. Most of them were experts in their fields and they also worked in some of the major companies in the U.S. such as IBM, Bell Labs, and AT&T. They all got consents from their companies. Of course they wouldn't talk about company secrets but they tried their best to teach or introduce new technologies to engineers, professors, and students in Taiwan. In addition, they also discussed and offered advice. And many

suggestions came from here. In the 1970 forum they were already talking about semiconductor-related subjects and more would follow later on. Two men started the Modern Engineering and Technology Seminars in 1965. One of them was Walter Fei who was the vice-minister of Ministry of Communications(MOC). The other one was Wen-Yuan Pan. He's another person whom I really admire. He contributed a lot to the semiconductor industry. He can be called the father of Taiwan's semiconductor industry and no one could be more deserving of the title than him.

The reason for bringing Wen-Yuan Pan up was that he's a very generous person. In 1965, Walter Fei was the vice-minister of Ministry of Communications. And Wen-Yuan Pan brought up the idea of starting the Modern Engineering & Technology Seminars. In 1970, they started talking about things like integrated circuit. And they started thinking about how to put things in action and started developing plans. And thus, the story about the "Little Xin Xin Breakfast Shop". The story goes like this: At that time, Hua Fei was already the secretary-general of Executive Yuan, if I remember correctly, The Ten Major Construction Projects have already begun so President Ching-Kuo Chiang started pondering about what to do next. So scholars and experts from the forum suggested integrated circuits. President Chiang was of course the Premier and he asked the Secretary-General, Hua Fei and he naturally ended up asking Wen-Yuan Pan. There was also Hsieh-Chi Fang who was the Director General of Telecommunications in MOC. They all knew each other pretty well. It was still the time when a few men ruled. They were all connected NCTU, Shanghai JTU. Walter Fei studied civil engineering, Hsieh-Chi Fang and Wen-Yuan Pan both studied EE. And they were all couple of years apart. Their wives knew each other fairly well too. So the fact that they can initiate a great plan in a breakfast shop is not that legendary or surprising. If they didn't know each other and had started talking about it there was no way that everything could be manifested from a breakfast shop. I always thought that the exaggeration of the story twisted the truth and the history. I will talk about it later when I have the chance. The important thing as how did TSMC started. I don't want to mythologize it maybe I'll talk about the history later.

Ling-Fei Lin: Can you talk about why you entered the RCA project? And since you were the director of the project what were some obstacles you faced during planning, or on the direction of the project?

Ding-Hua Hu: The major players involved in the Modern Engineering & Technology Seminars have all reached a consensus that they wanted Wen-Yuan Pan to write a proposal. So he wrote the proposal at The Grand Hotel. I knew about this because at the time there was already a team set up by the Ministry of Economics called Electronics Industry Consulting Team. There were a lot of people involved, like S. M. Sze, Eugene Du, Gerber Ma. I was also part of it. Hsieh-Chi Fang was in charge because his position at the Telecommunications Bureau made him the most suitable candidate. He also had the resources. I was

a member of this Electronics Industry Consulting Team at the time and found out about this project and thought that it was a great opportunity for me so I called up Pan to ask if I could be part of it. Did I recommend myself? I don't know. But I was very eager. I wanted to be involved not because I want to be in charge. In fact, I told Pan that I was still willing to join even with others in charge. Unless they couldn't find anyone suitable. I just thought that everyone should pitch in to help even if they were lacking in skills. That was something that needed to be done.

Ling-Fei Lin: Did you think this project was a prospective one? Or was everyone unsure about it?

Ding-Hua Hu: It wasn't about the prospective. It was more of a young man willing to accept a challenge. It was something I had to do. Later on, some people said that if they were to do it again knowing the risks involved in the process, they wouldn't want to participate in the RCA project. If it weren't because of those professionals who came back from schools or companies in the U.S. and their willingness to participate most of the local people would think that the project was too risky. Still, many professionals were not willing to come back. There were lots of reasons involved, kids at school, family issues, etc. Or they didn't want to quit their jobs. So it allowed a group of inexperienced but courageous young men who were willing to face the challenge. There was a lot of potential for this group of young men. The reason I say that is because I just turned 30 at that time. I was born in 1943 and started on this project in 1973 so I was only 30 years old. Ding-Yuan Yang, Chin-Tay Shih, Robert Tsao were all barely 30. F. C. Tseng was also barely 30 not to mention C. C. Chang. But I think this was a great arrangement by fate.

Ling-Fei Lin: So there were some people who worked abroad that were unwilling to return to Taiwan?

Ding-Hua Hu: Yes. If I remembered correctly. Ding-Yuan Yang and Chin-Tay Shih were supposed to come back together but it was Yang who came back first. By the time Shih returned, the RCA contracts were ready to be signed. From what I knew, it was Shih who asked Yang to test the water first. If everything was alright then he'd come back.

Ling-Fei Lin: So Mr. Pan asked you to be the project director? What were some of the obstacles at the planning stage and how did you recruit all these experts? Anything interesting during that process?

Ding-Hua Hu: This project didn't turn out the way it supposed to be. Actually, the earliest idea was to set up a lab in MOC's Telecommunication Research Laboratory. The reason we did that was simple. MOC's Telecommunication Research Laboratory spends a certain percentage of profit from Telecommunication Bureau as the annual budget for the Laboratory. So it had a budget to operate. And the organization at

ITRI wasn't established until 1972 and its budget came from a project plan of the state budget. So according to the earliest plan, the lab was set up under the Telecommunication Research Laboratory. Later on, we thought we should have something on a larger scale instead of just a lab but still remained as a lab. And we could get away from MOC's Telecommunication Research Laboratory which was a government unit so proposed subordinate to ITRI under the Union Industrial Research Laboratories. It was located on Guang Fu Road. It was the electronic research lab underneath the UIRL as the main lab. The interesting thing out of all this was that everyone involved, only saw their own part. But in reality, whether it was important or not, there were lots of participants and they put their effort into that. All I can say is that I worked very hard to accomplish this transformation.

Ling-Fei Lin: What kind of transformation?

Ding-Hua Hu: Finally, we decided to set up the fourth research organization under ITRI, An independent research center, not subsidiary to the Union Industrial Research Laboratories. Industrial Technology Research Institute was formed by Union Industrial Research Laboratories (UIRL), Metal Industrial Research Laboratories (MIRL) and Mining Research and Service Organization (MRSO) in 1972. These three institutes formed the ITRI. The original idea was to set up an electronics lab under UIRL and expand from there. But I didn't think it was a good idea because this was something brand new so it needed a new concept of management and policies. I thought it should be independent. That's why I tried to fight for it but I also knew there were others doing the same thing. This new organization was established on September 1st, 1974. The fourth organization under ITRI was called Electronics Industrial Research Center (ERSO). instead of Integrated Circuit Research Center, there was already an underlining meaning to this that the main application of integrated circuit would be for our development in electronics industry.

Ling-Fei Lin: Can you talk about how you recruited everyone?

Ding-Hua Hu: Sure. When we became an independent research center the proposal was written up. And of course, we needed to find people. However, I wasn't too worried about that because of the Fine Products Microelectronics Corporation I mentioned earlier. Although Fine Products wasn't successful the company managed to cultivate some excellent people. If I remembered correctly, F. C. Tseng, Bao-Tong Dai and few others all worked there. And there was another company called Taiwan Microdevices Corporation (TMC). The company was located in Ba De Village in Taoyuan County. Chun-Yen Chang was the general manager and I was on the board of directors. But things didn't work out. Again, few good people came out of this. For example, Jhon Hsuan's first job was TMC's business manager. Although some people worked at companies that didn't do well in the business area. That didn't mean that they

didn't learn anything. So we paired up these people with newly graduated people or experts on semiconductor assembly in Taiwan. It started in 1964. It was 1964 that Texas Instruments Incorporated came to Taiwan and set up factories. That was the beginning of export processing zone. Then in 1966 Philips set up their factory in Taiwan. And there was a Philco Ford that also set up factories to do assemblies in Kaoshiung. And Andrew Chew, who was my classmate in both NTU and NCTU. He was successful with Kaoshiung Electronics doing assemblies so then he replicated the knowledge and technologies for business profit. That was how many companies of various sizes doing integrated circuit assembly and tests emerged in Taiwan. And amidst all of this, S. M. Sze established Universal Electronics in Chupei. The reason for mentioning Universal Electronics is because Stan Shih's first job was with Universal Electronics. His job at the company was developing calculator with small vacuum tubes. And then he established Acer. But like I was saying, everything was there already. Didn't matter if it was integrated circuit assembly or processing. These local companies were mediocre in technical know-how.

But foreign companies such as Texas Instrument, Philips, Philco Ford brought great manufacture and management systems, which was top notch in the world. In other words, these people had experienced world-class manufacturing system and methods. So what they were lacking were the technologies on semiconductors. We were very lucky to have this opportunity to recruit these people into our organization. I think there were about 40 to 60 people.

Ling-Fei Lin: Did you sign a contract with RCA first or did the recruitment first?

Ding-Hua Hu: We signed first, then worked together with RCA to recruit and interview people. I even designed the test. The test was on the physics and devices of semiconductor. This booklet is quite interesting. It's the request for proposal. This was something we presented to 30 some American companies. To show what we wanted to do and to ask for cooperation. So this was the request for proposal.

Ling-Fei Lin: Was it written by Mr. Pan?

Ding-Hua Hu: It was written by the Electronics Research Center with lots of help from Pan and TAC. This project was the plan for the demonstration plant of integrated circuit. It was also because of this plan that attracted people to come. I'm not exaggerating when I say that none of them did this for money. It was completely different from establishing a company today. No one was in it for the money. We felt that this was a special opportunity we wanted to see if we could manufacture cost effectively an integrated circuit.

Ling-Fei Lin: You said that no one was in it for the money and you said earlier that you looked for professional personnel overseas. Is there anything you want to add?

Ding-Hua Hu: We had a deadline to finish the project so finding the right people for the right job was a very important part of this whole thing. Thus, finding someone with experience from America was the best option but unfortunately, at the beginning of this project, besides Ding-Yuan Yang and Chin-Tay (Stan) Shih, technically, I wasn't able to find people with experiences abroad. Ching-Chu Chang was still at school. He joined much later. Of course like I said, we were very lucky to have found some brilliant people who were very hard working. They were the ones that made it possible. We had a very satisfactory result with recruitment.

This was the procedural execution plan within our implementation plan. This page shows that if equipments were purchased by RCA. Then here were the procedures, and this is the procedure. if we purchase equipment as ITRI. What I wanted to show is that every block represents many signets of many different organizations. This meant that everything had to be done by the book and that was quite annoying. But we still followed the rules. There was a lot of military and government procurement during that period in Taiwan. So we had our personnel stationed in New York to work with them in a joint procurement. The benefit was that RCA recommended items didn't have as many procedures. A lot fewer blocks as you can see.

This chart here made me lose a brilliant participant. His name was L. P. Hsu. He used to work for Philips and also worked as at eaching assistant in NCTU. I knew him back in NCTU and it took me a long time to persuade him to join the Electronics Center. But he quit right after he finished this chart. He went back to Philips and did very well there. Philips later got the Deming Prize and Japan Quality Award. Although Y. C. Lo was the leading man L. P. Hsu was the one that carried out the execution on most parts. He's a very cautious person.

We came across a lot of problems during the procurement process. For example, Ministry of Audit sent three department heads. So they came into the Electronics Center and started asking a lot of questions and most of the questions were pretty specialized. They would ask interesting questions and I would give interesting answers. And he would ask why I had to dig that much earth up to build the plant. I told him the construction follows the designs from the architect and Sinotech Engineering Consultant Ltd. And assuming that I knew the reason why they are digging up all these earth then I would be an architect and not whatever I am doing now. The department head probably thought I was obnoxious. Everyone had

their eyes on us. The budget for this project was $489 million NT dollars for four years. The currency was about 40 NT to 1 USD so it was about $12 million US dollars. It was fairly large amount. But the money was a part of the problem, too.

There were certain technologies that we wanted to import to Taiwan. But to do that, you had to train a lot of people and process of transfer technologies. One example, Fairchild wanted $12 million US dollars in royalties. Even when we first contacted RCA they also asked for $7.5 million US dollars. I told RCA that not all of our employees were inexperienced so we didn't have to train as many people as expected. But of course we still ended up training over 300 man-months. Still a lot. And you may have noticed that this was the layout of the demonstration plant for integrated circuit. And this one here was the complete task report. Can you see the difference between the two?

Ling-Fei Lin: The arrangement of the words is different?

Ding-Hua Hu: No. This word here means "shop". Shop is small in scale. It's a "batch", meaning that batches process in small amounts. This one here is a "plant". Plant is an actual factory for quantity production. This was not approved in the original project. This was a industrial technology, but just knowing the technology wouldn't make an industrial technology. You had to mass-produce under a competitive environment. You had to have lower costs than everybody else or least as low as them, or cheaper and better. Then, that is a industrial technology. As I was saying, the earliest idea was to set up the lab in the Telecommunication Research Laboratory or set up an Electronic Research Lab Integrated Circuit Lab under UIRL. There was an agreement that we were to produce 500 pieces per week. But that wouldn't be mass production if it were only 500 pieces. It only showed that I could do experiment with this and I knew how to do it. However, with this factory, we were producing 4000 pieces per week, three inches, 4000 for one week. That's a real factory manufacture. After the products were produced you had to buy more raw materials. And then you've got to sell your product. If you couldn't, you wouldn't have the money to buy your next round of raw materials. One way or another, money was also a problem. And during this whole process, I couldn't blame Minister Y. S. Sun for lying to me. It was more like I misunderstood him. He said, "Ding-Hua, don't be afraid. Work as fast as you can on this project. You can still apply for money after you're done". I didn't find out until later on that you need to apply for the budget 18 months ahead of time for state budget like this. I didn't know. I had no idea. So there was a short period of time. Back in Electronic Research Organization that everyone including Chin-Tay Shih and Ding-Yuan Yang all took a temporary pay cut of 20 percent. We got through a difficult period by cutting back. I had always thought that Shih wasn't a person who would ask others for help. But he did. He asked his classmate in Hong Kong in a company called Yi Hang Company. That was our first order. We had to pull

some strings to get the order. We worked hard for it.

Ling-Fei Lin: So your original plan was that small shop?

Ding-Hua Hu: No. This was it, which was 4000 pieces per week. It wasn't a shop but our name still wasn't being recognized. It was later on when our execution was good and our cost of production was looking good too. That we were allowed to call the place a "factory".

Ling-Fei Lin: You mentioned earlier that there were some troubles in the beginning. Can you talk about the process of picking RCA?

Ding-Hua Hu: Sure. We knew this project would be successful but not without many risks. We were a group of young men under Wen-Yuan Pan's leadership from TAC technical advisory committee. We also got help from a lot of people. We did so many right things, which was very crucial. If we made the wrong decision then there was no way back. We were right by choosing CMOS in the first place. We picked the right technology. It wasn't without any risk. There were still a lot of people thinking that we shouldn't have picked CMOS. There were few people with IBM background in National Science Council saying that it was impossible for us to work out with CMOS because even they couldn't do it. There were also some other people saying that any technology would do. Who cares if it's MOS technology. We had nothing to begin with anyways any technology would do. And another group of people were saying that we could've picked something else, why CMOS? In my opinion, with CMOS technology as a target and building an industry with integrated circuit as the foundation.

Taiwan's electronic industry was still more consumer-related. Even if everyone knew what CMOS was, electronic products were still consumer oriented. CMOS is everywhere in telecommunication or controls depending how you use it. But when it came to consumers, there was a huge competition for good quality. So we chose the right technology.

We also made the right decision on something else. While we were negotiating with RCA we said that we needed to train 10 designers, design engineers to design the integrated circuit. Think about it, if we didn't do that then our IC design industry would've fallen behind for many years. People like M. K. Tsai who was one of the first people to get their training. RCA was the one and the only one company out of the remaining 7 companies that was willing to train 10 designers. And that was one advantage. The other was that RCA had branches and subsidiaries in Taiwan. Internationally, they had a good reputation so even though their technology wasn't the most advanced like I said, RCA had its advantages. They wouldn't turn

away from their contract and we had many demands for them. RCA was one of the pioneers in CMOS technology. Although they were not the leader in technology they had a lot of experience in Medium Scale Integration (MSI) gates and Small Scale Integration (SSI) gates. They had abundant CMOS logic circuits. They had a complete set, hundreds of types. That was a deal in our contract that they'll let us have it for a really low price. Why was it important? Because once we got the design, we didn't have to brainstorm over it again. All we had to do was to take the original and revise it a little bit. It was much more convenient. This development took us on a completely different path than the Koreans. We could do designs. There was CPU, a chip set with lots of small circuits , and later with the world wide web we had companies like Accton, ZyXEL, all because we could design the IC. Our quality, compatibility and time to market were better than most competitors, which meant we were faster to deliver the product to the market. Our competitiveness gained us a lot of rewards.

Ling-Fei Lin: So this technology import plan was mainly the import of manufacturing technology or design technology, or both?

Ding-Hua Hu: I said this earlier. We believed that IC could be used on all sorts of products and it was also a basic component in many products. So like I said earlier, "building an electronic industry with IC as the foundation. We weren't only establishing demo plants. We thought we could manufacture low cost IC and design the IC ourselves. This pushed us further on the application of IC which allowed our electronic products to enter the market earlier than others. This concept on time to market was fundamental to our information technology industry. This concept was something we had in mind ever since we started.

Ling-Fei Lin: So both the importing of manufacturing and design technologies were the focus?

Ding-Hua Hu: Yes, both of them were important. The ideal situation for us was to have both. But if RCA didn't agree for both at that time, we would've prioritized the manufacturing part and signed the contract for it. The RCA contract was missing a lot of things too. They weren't complete so the difficult part of the plan was that I still had to keep money on me. Of the 12 million US dollars, I gave about 3 million dollars to RCA and I ended up having only a little over 9 million US dollars on me.

Ling-Fei Lin: : I thought you said that RCA wanted 7.5 million dollars?

Ding-Hua Hu: No, the price was lowered. After the negotiation, the price dropped. Pan also quitt his job at RCA before this negotiation to avoid conflicts of interest. We needed to reserve some money, so we thought we should do something to serve the industry. Here I was setting up a factory that was doing

pretty well in the production yield and then turned it into a privately run company to serve Taiwan. Then the industry people said that they couldn't wait any longer. Thus applications-oriented services became pretty important. It took me a lot time to come up with the English name, "Electronics Research" meant that the place was about research and "Service" so research and service were both important. I added "Organization" at the end so we could call it ERSO. ERSO sounded quite nice. And the name said it all. Basically it's research and service to serve the industry. At the beginning, there was another department at ERSO called the Electronic Inspection Team that now as an independent organization was called Electronic Testing Center, Taiwan. There were lots of organizations that spun-off from ERSO. I won't go into that.

Ling-Fei Lin: The project was not just the technology transfer, but you learned everything including design, manufacture, testing, equipment, even management and procurement You even had a demonstration plant. All these were specific models. What made you think about doing things this way? Did you see this abroad? Or saw other people working with that model?

Ding-Hua Hu: There is no easy way to say this, not something that comes to mind right away. If our task was to be competitive and to mass manufacture IC then we had to consider the possibility that there will be real commercial purposes for IC factories. There were a lot of problems involved. For example,, the supply of gases. It wasn't something you could just buy off the street and all different kinds of chemical raw materials. So we had to digest the transferred RCA technology and we did that very well. I have to say our contract with RCA was a great decision. Our people already knew the operations, management, and system of an international electrical plant. They just didn't have the know-how on processes of semiconductor IC manufacturing, which was why we sent them to RCA. And RCA people were great. In the beginning, they used this "big brother" method that we also used. A big brother takes the little brother to the new working area. And for a while, the little brother is left alone to do the night shifts. So for a period of time, it was all our people working the night shifts at the factory. I thought RCA honored their contract very well. However, RCA was lacking in some things, so there were things we didn't learn. They didn't teach us photo mask technology. So we worked with an overseas Chinese, named Stephen Lin. We signed a contract with him and were introduced into his company, IMR, to acquire that technology. And that was how Taiwan got a number of listed photo mask companies. In addition, RCA was not expert in quality assurance, so we got help through TAC to get in touch with other overseas Chinese then we sent L. H. Chiu along with another person over to HP to learn about quality and reliability.

Ling-Fei Lin: HP?

Ding-Hua Hu: HP, Hewlett-Packard. They are very good in this area. And we found a Chinese guy, named William Mao in the testing equipment. That was what RCA used for their testing too. Then Chin-Chu Chang went over there with a small group.

Ling-Fei Lin: So during this whole time, whatever you were lacking you immediately looked for help?

Ding-Hua Hu: That was a must. If we didn't do this then we wouldn't be capable enough, and would end up seeking help. That person wasn't the IC designer even if you asked for help that person wouldn't see it as first priority and then you'll screw up your whole cycle time.

Ling-Fei Lin: It was later that you found out that they [RCA] weren't strong in quality control?

Ding-Hua Hu: We knew already, we weren't clueless. As I said, we didn't have a lot of practical experience in IC manufacture, but we still had a good understanding on factory management and quality control. Our people were all very good. Of course everyone would agree now. If they weren't good, then there was no way that they could go on their own independently. So we did contract manufacturing for OKI from Japan manufacturing for their watch chips. The Japanese were known to be very picky. But that forced you to correct defects and imperfections, and made your products better. I just want to say that none of us were in it for the money. We only thought about what we could do to establish the foundation of Taiwan's electronic industry with IC. To let that happen, we found James Koo abroad who worked at National Semiconductors to help us out and train us for memory-related knowledge.

Ling-Fei Lin: Can you analyze the reasons for your high yield rate later?

Ding-Hua Hu: Let me briefly describe the reason for the high yield rate. There were some basic facilities in the factory to provide quality, gas, water, pressure and things like that. And there was equipment to reduce dust pollution to a certain level. We had to standardize our facilities in the factory. The factory couldn't be completely automatic, so some of the facilities required people's judgment to make minor detail adjustments. Every piece of equipment had their own characteristics so in other words, people were the greatest invention, and God was the greatest creator. People were the element that connected everything. And while we're on the subject, what was the function of people in all of this? I'm not being rude, condescending, or callous. The truth was if you could count them as an integral part of the system at the place, in that moment, and at that time. Because you saw them as a link. Otherwise if the machine acted up, then there would be a discrepancy in the control. In that kind of situation, people were the most important asset. And when it came to people, discipline was most imperative. SOP is Standard Operating

Procedure. The reason our factory got better and better was because we could force the mistakes tp happen repeatedly, to be represented [in an orderlymanner], and then we could correct those mistakes

Ling-Fei Lin: We were talking about people controlling the yield rate. Were there other factors that influenced the yield rate?

Ding-Hua Hu: The yield rate is related to the design. All designs and manufacturing processes have certain margins. The SOP in every process is to ensure good result. There are over hundreds of procedures in IC manufacture so this comes down to personal discipline. So people's performance is an influential factor. This is under the presumption that basic facilities in the factory are all under the same situation in the circuit design.

Ling-Fei Lin: So did we design the IC?

Ding-Hua Hu: We trained 10 people from the ERSO and later were able to design our own IC, which sold pretty well. One of them was the melody IC for musical cards. When you opened up the card, the card would sing the Happy Birthday melody or others. It still exists but this was a top seller at the time. And this product was turned over to UMC. Another reason why UMC was successful was the fact that America lifted the ban so that there's no need to purchase the telephone from the operator of the telecom company but free to buy on your own. And this created an IC called the telephone dialer. With this and the melody IC, along with UMC's other products, UMC was able to make a turnaround from financial deficit to earning a profit.

Ling-Fei Lin: During the process of technology transfer, you started building the demo plant right?

Ding-Hua Hu: Yes, we had people training in America as well as building the plant here.

Ling-Fei Lin: How was everything done?

Ding-Hua Hu: There was another group of people here building the plant.

Ling-Fei Lin: Did those people go to RCA too?

Ding-Hua Hu: They didn't stay there for a long time training. The group that stayed long-term was learning the production process, management, and design. And the group that built the plant just flew

over for a short time. There was a guy from RCA, his name was Watson. His last name was Watson, I forgot his first name. He passed away already. He was assigned to help us with the plant and meanwhile helped us train Sinotech Consulting on the design of the clean room. We transferred a lot of things in this technology transfer period including the design of a clean room. This guy, his name's Lu-Man Chang, who was involved in the demo plant construction.

Ling-Fei Lin: Is he on the right or on the left?

Ding-Hua Hu: Yes, this is me. I was still young. But this was 1999, he came back to visit me. I was at Macronix as the Chairman of the Board. Why did I introduce him? Look at him, while he was studying in National Cheng Kung University he was on the University rugby team. He was very strong. He dared to fight with the construction workers when he was supervising the construction. There's a mixing ratio for the cement which is mixed with lime and sand. There's a certain proportion. If you didn't keep an eye on the workers, chances were, I can't say that they did it on purpose but they mixed up the proportion fairly often. This would cause terrible consequences and that's not something we could afford. Because this was important, Chang was great. Everyone I recruited was brilliant. He went to study abroad after the demo plant was finished. And by the time he came back he was already a full professor in Purdue University. Everyone we recruited were the best picks at the time.

Ling-Fei Lin: Did he study Architecture in NCKU?

Ding-Hua Hu: He was in the Department of Civil Engineering. So the great thing about this project was that everyone did their part in this whole project.

Ling-Fei Lin: At the end the whole project spun off to become UMC. Do you want to talk about this process?

Ding-Hua Hu: This is the demo plant on the site. This is an incline, a big one. This first row here is the demo plants. If you go there nowadays there's a tall building. It's behind there. Why do you think I picked this location? I picked this place because there was an old road that led to Chutung from Hsinchu. It was an old highway. And I picked this place because if we were successful on our initial project there still would be one lot left over for further development, for expansion. And when I circled up this area this would put it on the outskirt of ITRI. And so we planned to turn this whole place including the people and the facilities into a private company if we were successful.

Ling-Fei Lin: So you had this idea right from the very beginning?

Ding-Hua Hu: That was the idea at the beginning, but this was a public affair. Things didn't go as planned. It was later on when I was thinking about the implementation that I found out a problem. That property there belonged to the government so the land, factory and facilities inside the factory all belonged to the government. Government property could not be transferred. And that was it, got it? It was completely impossible. That forced me to establish a new entity UMC.

The big plan was, as I said before, to build an electronic industry with integrated-circuits as the foundation. And this was why we had the "second phase". It was a VLSI plan with Chin-Tay Shih in charge with Submicron until later. And we ended with what we had. It turned into a spin-off. Some people said that this spin-off strategy was wonderful and that we had thought of it. My words are still the same. "Don't mythologize". That was just the environments, interpersonal relationships, and trust. It was like the trust that Wen-Yuan Pan had in me. There must be a lot of trust for it to turn into something good. If there was an obstacle, we could go around it a little sidetracking, a little change. And adjustment was not a problem. So with high risk and high tech projects, there must be adjustable mechanism and adequate toleration. If there weren't any of those, things couldn't be done. It wouldn't be possible to plan out the whole thing 18 months prior.

Ling-Fei Lin: Why didn't you join UMC then?

Ding-Hua Hu: Of course I didn't join UMC. My personality is more of an innovator. I'm interested in exploring and pioneering, but if you want me to repeat and execute, I really don't think I'm good at it. That was why I didn't join TSMC later either. But I put in a lot of effort at the beginning stage for both UMC and TSMC. More in TSMC than in UMC. We signed the RCA contract on March 5th 1976. We started sending people over to RCA around May while building the plant. So by then, the demo plant had been operating for over a year and of course, we were getting some results. The yield rate set by RCA was also our plant's yield rate. And we were able to surpass the standard in two months and kept it there.

Ling-Fei Lin: What was the yield rate set by RCA?

Ding-Hua Hu: Here. 80%. It's pretty good.

Ling-Fei Lin: They set it at 80%?

Ding-Hua Hu: It was not a fixed number. It was a number that they believed we could accomplish. It wasn't the guaranteed yield. Their guaranteed yield was very low. After we started operating for a while we used the actual data and estimation to come up with a cost structure pie-chart. The diagram showed that we could do over 21% of net profit. The result was amazing, while others had minor problems here and there. I used this estimation to persuade Ministry of Economic Affairs (MOEA), showed them that we had the potential to establish a commercial operation, and that it could have that much profit. The Vice Minister of MOEA at the time was Yong-Ning Wei. He was the former Director General of the Industry Bureau. He called President Hsieh-Chi Fang to say that he asked Sampo and Teco to invest in UMC. After he made those calls I started paying visits to those companies. I think this whole process basically came down to this pie chart. This pie chart was not just a random drawing. The chart was a fairly precise result from a year of operation.

Ling-Fei Lin: So it was the Electronic Center that help built the UMC Plant?

Ding-Hua Hu: Yes, yes…

Ling-Fei Lin: It was a newer plant right?

Ding-Hua Hu: Of course it was newer. Our demo plant was 3 inches, upgradable to 4 inches. But UMC could go from 4 inches to 6 inches. The original RCA technology transfer was 7.5 micrometers. By the time the technology transferred to UMC, we could do better than 3.5 micrometers. It was an advantage that UMC was built.

Ling-Fei Lin: Do you have anything else to add regarding the process of establishing UMC?

Ding-Hua Hu: Basically, the important thing about UMC was that it proved that Taiwan could run it commercially. It was profitable. Because past experiences from companies like Fine Products and TMC were disappointing so no one had any expectations on the development of the industry or business. We had to have something in the beginning to prove that this thing could be done. And for us, that's ERSO and the technology transfer that gave us this conclusion. But that wasn't enough. Our second step was to operate commercially and gain a profit. That was the only way for more people to follow. That was UMC's main function. Of course, at the beginning, UMC was an IDM company that had its own product and operated on its own. A successful company wasn't enough. It had to be able to replicate the business model. And that was TSMC's wafer foundry. And that was how we were able to continue growing, and clustering in this field. So UMC was significant and meaningful in this whole history of industry

development.
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Ling-Fei Lin: Can you add anything to the time when ITRI sent some people over to UMC? Did you send those people there? Or did they volunteer to go? Why Robert Tsao?

Ding-Hua Hu: What's the "Hua" in Lian Hua (UMC's Chinese name)? Key inventors such as China Development Corporation (CDC) Kwang-Hua Investments, Oriental Semiconductor Electronics (OSE), and Walsin Lihwa. They all have "Hua" Chinese character in their company names. So who coined the name UMC? It was Eugene Du.

Anyway, after UMC was established, naturally there was a technology transfer team being set up. so that's why some people were transferred there. Of course it's up to each person. Some were not too eager about going while some agreed wholeheartedly. I didn't care what their reasons were. It was their own choice to take whichever path they wanted. In-Dar Liu was one of the earliest people to go to UMC. He was a student of mine from my Master graduate class in NCTU. He was brilliant. He's now retired from UMC. As for Robert Tsao, when did he go? He went to UMC after it was established for almost a year. Eugene Du was the executive manager of UMC. At the time and Hsieh-Chi Fang was the chairman of the board. Du said that he needed a vice-president in UMC to help with the company operation. Since the plant was also in operation Du had Chin-Tay Shih in mind and hoped that he'd go there to help. But I saw things differently than Du. I looked at the person's personality and abilities. I thought that Shih was more suitable in research and development. And Tsao was more suitable in company management. So I told Du that in my opinion, Tsao was more suitable to explore new business ventures. That's more beneficial to UMC. He would be great at the job. And now looking back, he was indeed great at his job so I was right about him.

Ling-Fei Lin: It was the Executive Yuan that wanted the wafer foundry model, but before this was mentioned, Tsao had already proposed this model and Morris Chang was against UMC doing it. Can you talk about how everything happened?

Ding-Hua Hu: Let me show you this. You can probably have it. "Electronics Development" was published by ERSO. It's like a small-sized newspaper. This one here, we can see that it was from October 1st 1978. What did it say? "Develop electronics industry with IC as a foundation". And then it went on talking about

the different phases. This here says, “Electronics enterprises in Taiwan are designing their own IC and contract ERSO to manufacture” Isn’t this one type of OEM? If you want concept the concept had been around for a long time even in Taiwan. This was proposed by Ding-Yuan Yang.

OK. I can show you this. This was from 1979 by Carver Mead. He was a professor from Caltech. He had been promoting this concept that he later wrote a book on VLSI system, which he wrote with Lynn Conway. I want to talk about this lecture here. The title of this lecture is “VLSI Technology and Innovation”. He described here. "System design, not technology is now the arena in which small firms outshine their giant mentors. Implementation of such designs, however, requires a silicon wafer-fabrication capability unaffordable by any single small-enterprise. A fabrication facility serving many such firms can set the industry on a course even more exciting than that of earlier times". Mead said here that the best example to describe this operation model is the printing business. This was why he used two words, “Silicon Press” to conclude the lecture. Press stands for printing shop and silicon print shop to describe the designer or the creator. The manuscript of the book and the actual printed books are correlated to each other. Don’t you think it’s the appropriate description. Isn’t it the basic foundation of the foundry? So what is the concept? Each era has a representative whether it’s in America or Taiwan. Personally, I feel that Mead was very clear on the concept of the foundry already. There’s no doubt about that.

Here, I’ll show you something else here. This was from July 7th 1980. It was a consulting company called Integrated Circuit Engineering, ICE. The company holds a conference annually with scholars and industry experts for discussions and to publish this. This page in the middle here. The title was…remember this was 1980…“Silicon Foundry” The word “foundry” was already used by someone here. OK? And this here, I’ll just read this middle part here. “The foundry concept is far from new. Before it got its feet all tangled in standard products”. This here talked about things such as the customized product designs. Here’s something interesting. On this day, they invited Gordon Moore, a semiconductor pioneer, to speak on the forum. He’s the Moore of Moore’s Law. The commentator wrote “I was particularly pleased to hear Gordon Moore endorse the concept at the forum, generally when Gordon talks, people listen”.

The foundry concept definitely didn’t come from Tsao or Morris. Unless they can prove it. I think that people see only their side of the story. But, basically, you can't erase other people's evidence, Right? In other words, maybe these two have their own versions of this history. But for most people I’m talking about inventing the foundry concept. It definitely wasn’t these two people. It wasn’t Ding-Yuan Yang either. Now I’m going back to Wen-Yuan Pan’s comment in Modern Engineering & Technology Seminars (METS) that I showed you earlier. He commented on the creator of the word “METS”. He said that it’s not important who invented METS. The important thing is how to implement it. In other words, I’m not here

today to please or belittle anyone. I think that both made their own contributions. Morris had read Tsao's proposal for UMC expansion. Ok, he's read it.

Ling-Fei Lin: That version said that he's going to do the wafer foundry in a pure wafer foundry version?

Ding-Hua Hu: No, no, no. In that version, he used customized ASIC as an example. This was why Morris kept saying that UMC's working on ASICs, because Morris had seen the proposal. But if you had understood what Tsao was thinking Tsao was actually talking about foundry. But this thing was exclusive, sort of like a membership club model. What does that mean? It means that you join as a member, then I'll render you the service. If you're not a member then I don't necessarily need to serve you. So what Tsao was planning was that when he was expanding UMC. He set aside some money specifically to invest in ASIC companies, especially owned by Chinese people. So the foundry that he was talking about was a membership foundry. It was a little different from Morris' dedicated foundry. One way or another. I didn't see the point to argue. What's there to argue about? You do your foundry and I do mine, Right? I don't want to repeat the Generalissimo Chang joke (Why fight over a basketball in a game?) Everyone should get a basketball. What I mean is that there's just no need to argue it. Because every idea produces a different thing.

Ling-Fei Lin: So he proposed to do an exclusive foundry, but he was still going to manufacture his own product, right? Or was he just going to work on other people's designs?

Ding-Hua Hu: Things will gradually dissipate. In his new plan, he seemed to be going down that path.

The reason why I'm saying that there's nothing to argue about is because there's no need to fight over concept. In a sense, there are lots of similar ideas that pop up at the same time. Venture capitalists like us would know that you can receive similar proposals at the same time and you'll be investing in similar ventures. I just feel that we should just applaud whoever does a good job. Why argue that one's concept is better than everyone else's.

Ling-Fei Lin: Why was the government against it at that time?

Ding-Hua Hu: This was what happened with the government. This letter here was written by K. T. Li to L. D. Hsu. Basically it's about how Irvine Ho gave him a proposal to expand UMC's IC manufacturing then he asked Irvine Ho, George Yang, and Paul Wang to voice their opinions. K. T. said "after reading UMC's proposal the chosen product targets mostly ASIC, thus the company is required to have strong design

skills and good understanding of market opportunities to be competent in the operation of the business. If the company can serve a major client and can cooperate with a company with high IC technology, and also have several stable market segments while developing ASIC products the company is much more likely to be successful….” He said that. After he came back to Taipei from Hsinchu he immediately contacted Morris Chang in the States. Morris was fairly positive on the possibility of collaborating on manufacturing plants. He wrote, “positive reply over the phone” . And, “ will call back immediately”. That was for L. D. Hsu, who was the Minister of MOEA. And then he replied, “Will contact to go over matters and will send someone specific over to New York to discuss the possibility of collaboration” .

Notice it’s February of 1985. So right away, Robert Tsao brought along In-Dar Liu and met up with T. M. Soong who was the chief of second division of IDB that was in charge of electronics. They went to New York together then Soong wrote up a report, thick one too. He did an analysis on this whole thing. Then Morris wrote a letter to K. T. It was nothing about whether he’s positive about this or not. He just wondered why UMC didn’t have more ambition to pursue memory related technology. Other than that, Morris had nothing else to oppose to. Minister Hsu had few problems on his hands. First of all, 1985 was a horrible year for the semiconductor industry. But in Taiwan, UMC wanted to expand. And UMC hoped that MOEA would allow great capital increase. Also Vitelic wanted to build their own plant and Quasel also wanted MOEA to subsidize. There was also Mosel Electronics asking MOEA to give investment support. So there were 1, 2, 3, 4, Four companies along with the National Science Council that had concepts on HIMIC. Technically speaking, this concept was more experimental, and would need a public space to process most of the manufacturing processes. Each company would have a small private space to work on their own specific procedures. It’s like a central kitchen with different sections that make different cuisines for each individual customer.

Ling-Fei Lin: Was it a NSC project?

Ding-Hua Hu: It was a NSC project. So there were five wafer fabs to deal with. But like I said, the economy in 1985 wasn’t too good. The MOEA would only support one wafer fab. What happened then? MOEA didn’t reject right away. In my opinion, my reasonable guess was that MOEA put a hold on the projects to delay the process.

Ling-Fei Lin: The semiconductor industry wasn't doing too good worldwide that year right?

Ding-Hua Hu: Not very well in that period of time. Here, this picture was taken inside of the National Tsing Hua University campus on May of 1985 when Morris visited Taiwan. This one here is S. S. Shu and

this one is Gao-Wen Mao who was the president of NTHU at the time. This is Wen-Yuan Pan, and this is R. C. T. Lee. This is me here. At the time, Morris accepted Shu's invitation to come to Taiwan to work as the ITRI President. So this was the picture Morris came around May of 1985 to check things out and agreed shortly after that. It was the perfect timing that Morris was available at the time, otherwise he would've turned down the position. In the beginning, Morris wasn't that interested in what was happening in Taiwan. It was coincidental that he happened to be available at the time. K. T. Li and S. S. Shu were very enthusiastic on the invitation so when Morris agreed he arrived around August.

When he arrived in August Li met up with him and told him the problems. I was just talking about that four to five wafer fabs needed governmental investment support. He asked Morris to help with the problem. And by September 10th Morris did a briefing at the Executive Yuan. Since the briefing report was done in such a short time. Computers weren't as common as now.…you can see here these words were handwritten by my secretary. I'll flip through these handwritten pages and show you Morris' concept at the time what he was thinking. First, Morris briefly talked about the situation of the moment. He mentioned Quasel, Mosel Vitelic, and UMC and their collaborations with ERSO. But you couldn't mass-produce so there were some problems. And Taiwan wasn't capable to make this into a large-scale industry.

Then, Morris made a suggestion. That was Alternative 1. Alternative 1 was that all those companies were still design companies. So besides UMC, they were going to establish TSMC. That was September 10th. The name TSMC started from there. It wasn't some random person that named TSMC. It was Morris who named the company. Then he changed ERSO's tasks so that people would only go to UMC. The reason why there weren't a lot of people asking for UMC in this project was because it wasn't a dedicated foundry. If UMC turned into a dedicated foundry then there would be two competitors. There's nothing wrong with two privately owned companies competing. So, that's Alternative 1. Alternative 1A was to utilize all the new functions at UMC and skipped TSMC so that was another option. I'm going to talk about the meeting at Executive Yuan on September 10th. I remember that K. T. Li voted for 1. It was the establishment of TSMC which would be more acceptable to design the company as a manufacture center rather than the expansion of UMC. Because 1 was a dedicated foundry while the other wasn't. And he believed that UMC will continue to exist. But UMC still needed investments to modernize their wafer fab. He felt that would be two similar companies. Then Chang-Chin Wang said that we should start all over and think carefully. Does the ROC need to do VLSI? Morris answered that we didn't have to. Then Li said that the relationship between oil companies and their downstream companies were the same as the relationship between VLSI and IT Industry. He said that there was no way that you could separate the two. So it was Li who answered Wang's question for Morris. By the way, Wang was the Secretary General of the Executive Yuan.

Ling-Fei Lin: What's the relationship between VLSI and foundry?

Ding-Hua Hu: Which?

Ling-Fei Lin: You said that Wang said that we had to do VLSI?

Ding-Hua Hu: Yes. Why? Why VLSI? Why this structure? He asked if it was OK, if we decided to do nothing neither Alternative 1 nor Alternative 1A. T. H. Lee was the Minister of MOEA at the time and he said that another option was state-owned but operated by private sectors. Meaning that the government provides finances but operated by private enterprises. However, it was too risky so he rejected the idea even though Morris didn't mention this concept. Li said that it was risky in the long run so forget about it. He felt that backing up one company was better than backing up four companies so he preferred Alternative 1. What's better about Alternative 1 than 1A? Was that 1A was a monopoly? 1A was to expand only UMC. Y. T. Chao was the Council for Economic Planning and Development (CEPD) Chairman and he said that VLSI would create a huge impact so the success shouldn't belong to only one company but the whole industry. However, company such as China Steel was a state-owned company run by private sectors and it wasn't suitable to model it. VLSI should be strictly private operation. And another thing he asked was where's the CEO? I thought Chao was fairly neutral with his opinions. He said that without a CEO, you might as well not do it at al. Lui-An Chen who was the chairman of NSC suggested that we should set up a task force to do a study. To do the project or not, he said that we didn't have to decide at this moment. I guess he was thinking about the HIMIC project. Then Wang jumped in and said that the government should support the idea of private sector operation. And George Yang thought that 4 or 5 small scale VLSI houses were impossible to do. So in the terms of wafer fab the support of a larger scale company was the right thing to do but there were three business models here. There was the state-owned, privately run the second was to expand UMC and the last one was to branch out. Sam C. Hsieh said that he's not against 1A. Basically, Premier Kuo-Hua Yu didn't make any decisions during this meeting. So what was important about September 10th? Was the conclusion on that day to focus on just one company. Second, Yu asked K. T. Li to chair some discussions to decide which alternative. But Chao had a special request at the moment. He said, if the business model of VLSI factory was a great financial risk, then it would be difficult to build the second fab with the money collected from the first fab since the second fab would be more expensive than the first one. That's the basic thing about semiconductors

You can't use all your profit to invest not unless you've acquired more financial resources. So in this situation he said that we should consider, "Discounted Cash Flow" which was a financial technique to

analyze project finance. It's to make sure that when you're done with each project you would have a positive cash flow. So it was decided that it would be privately-owned.

You talked about separating manufacturing and designing. If this concept was from very early on, why did other country didn't take actions, and why did we dare to do so?

Ling-Fei Lin: Would you like to share your thoughts on Taiwan's contribution to the world's high-tech industry?

Ding-Hua Hu: I remember a scene in a movie; I think it was a space movie in which some machinery went wrong. And someone asked "Where was it manufactured?" Then there was a line that went"Makes no difference where they were manufactured, the ICs are all made in Taiwan" I think it helps with the reputation of Taiwan. I remember once there was an earthquake that caught the attention of the whole world because our quantity in this wafer fabs design industry was so high that we have become very high-profile. In fact, many integrated manufacturers also rely on Taiwan's manufacturing ability. So; I think that in a market like Taiwan where the demand is not that great vertical disintegration probably played an important part in helping OEM and ODM and in exploring new possibilities. This vertical disintegration had helped the industry remain competitive.

Ling-Fei Lin: What about the contributions that certain people or companies made?

Ding-Hua Hu: I don't want to choose people, because I think that my understanding on this subject was based on several key events and their significance. Those who want specific persons can match the events with the names themselves. For one thing, if you ask me whose contribution it was to set up the ITRI demonstration plant, I'd say TAC and ERSO both made their contributions. On top of that, there were also many individuals such as S. M. Sze, Chun-Yen Chang. Their students also made a lot of effort which was also very important, right? So I think to take this event the establishment of the ERSO demonstration plant as example, it incorporated all the above. The second event I would like to talk about was the establishment and development of UMC. The development probably mattered more than the establishment. The third item on my list is the new business model brought forth by TSMC that gave Taiwan a new path for development in terms of clustering and replicability. The fourth, I think, is the science park. Its existence brought the industry together. I think that the four events were the four major factors that contributed to Taiwan's golden age of semi-conductors. If you are thinking to assign people, I think there's a right place for everyone which brings out one of my beliefs. I don't believe that things will sort themselves out. That's why I always tell management students the things you take care of are often

problematic or troubled situations. Therefore, it's a process of problem solving and situation management.

Ling-Fei Lin: You left ITRI and went into the venture capital business in 1988.
Would you like to talk about the venture capital business? And perhaps about the relationship between venture capital and the developments in Taiwan's high-tech industries since Taiwan's venture capital business is quite robust.

Ding-Hua Hu: Personally, I find the developments of Taiwan's venture capital industry a bit abnormal. Taiwan did one thing wrong from the very beginning. Taiwan's company law had rules on Limited Liability Company. However; the limited liability company does not suit the limited liability partnership system in venture capital. What mattered most in this system was the easiness to gather resources and to distribute later on the right timing. However, Taiwan's law incorporated the two processes, namely they had been corporatized and limited to the scope of a company. And therefore a venture company was bound up with restrictions of the company law. Rules such as if you were to allocate money, it should be done at the meetings of shareholders. What's more, you can distribute in the form of cash only because you couldn't divide the stocks. You needed to go through a certain procedure to cash out before you could do that. There were some other regulations that you had to follow. Therefore, the whole venture capital industry had gone wrong to invest later stages mostly. So what did it become after it had gone wrong? There was a mechanism in Taiwan used to prevent such things from happening. People investing in venture capital companies were granted tax cuts but at the same time required to invest up to a certain percentage of fund to early stages. This kind of activity was very prevalent at that time. Like when I went to H&Q in April, 1988.
Ling-Fei Lin: May I interpose? Why did you choose to join a venture capital company instead of establishing a semiconductor company or something similar?

Ding-Hua Hu: I'm the kind of person who loves to try something new, but feels indifferent to serve loyally for one company. Also, I had an extensive social network at NCTU. I taught several classes and had hundreds of students. On top of that I was the mentor of John Hsuan, Shun-I Chu, Young-Kai Chen, and Barry Lo. So basically I had these contacts from NCTU, and moreover, I had contacts with ITRI. My thinking was that if I were to set up a venture capital company, I could help quite a few companies reduce their risks. Therefore, I offer more venture capital in the early stages of investment. Most Taiwanese venture capital companies invested very little in the early stages, especially after the tax shelter policy had ended. In Taiwan, almost no one invested in the early stage. For a venture capital company not investing in the early stage meant lower risks. Another factor was that Taiwan's stock market was not doing so well. As far as Taiwan's stock market was concerned a company's value was decided upon whether it made

money or not. Only a few biotech companies had relatively higher private equity. But then again, it was uncommon for one to consider a company promising if it was losing money. The situation in Taiwan was different than other countries, In the States; a biotech company had a certain value after approval from the FDA. With this value it could be publically listed. It could be sold to larger pharmaceutical companies and start making profits. Due to the fact that there was a lack of entrepreneurs and the stock market was not being supportive enough on the valuation of technology companies. Most venture capital companies did not invest in the early stage which was a pity. On the contrary, things looked very hopeful in a terminal market like China, because there was a chance that you would succeed in a terminal market. If you don't believe me, go watch a show called, "Go, Go, Reminbi". I don't know if you have seen it. It tells the stories of many self-made people including people in the agricultural industry and other fields.

By the way, venture capital wasn't all about high-tech, anything that involved risks will do. Where there are risks, there are rewards. That is the basic definition for venture capital. There are a lot of opportunities like this in mainland China. In other words, if you're asking about Taiwan's next move, we cannot afford to miss newly-emerged markets. The way we work with these newly-emerged markets, I think President Ma has said it very clearly that Economic Cooperation Framework Agreement (ECFA) is only the first step. Next, you need to sign the Free Trade Agreement (FTA). Only through FTA and ECFA can you open up the doors. When the doors are open, you may identify a good competition model for products in each market segment. In other words, I think Taiwan needs to think about how to develop the semi-conductor industry, IT industry, whatever industry it may be. Using the channel of ECFA and FTA, and actually achieve something. Not just the extensive use of OEM and ODM models.

Ling-Fei Lin: Overall, is there any kind of bond between venture capital companies and the developments of Taiwan's high-tech industry?

Ding-Hua Hu: If what I just said is true, then Taiwan would have a huge opportunity. All we have now are OEM models and ODM models. What's next? If we only think of a supply side, you can't really focus on the demand chain. The biggies on the supply chain are the more promising players. Therefore, you will notice that a lot of venture investments made co-investments with the biggies. So who are the biggies? Enterprises that are linked with Foxconn are the biggies. People who follow KY Lee of AOU are the biggies. Those who follow UMC are the biggies. TSMC even have its own venture capital firm. Therefore, with ECFA and FTA rolling, there must be some entrepreneurs who are willing to take risks. Who are able to think about certain market segments in the context of demand chain. That's a good brainstorming material for venture capital.

Ling-Fei Lin: Would you please compare venture capital firms in the U.S.A. and in Taiwan? American venture capital industry seems to be of great help to the development of their high-tech industry. Did Taiwan's venture capital industry help the developments of our high-tech industry in any way?

Ding-Hua Hu: U.S. venture capitalists invest in companies when their values are still very low. In other words, they start investing at the early stage of a high-tech company. Once the venture capital firm chips in, it works very closely with the company. No matter if it's the recruitment, management, important projects, or marketing sales, they offer help. Why does the venture capital firm make so much effort? It is through making such efforts that American VC companies multiply the value of the companies they invest in, a phenomenon which we call return multiple. In the past, VC companies only invested in a company when they considered that the company's value could increase by a dozen times. Because there were high returns, so it wouldn't be too hard to understand why some VC companies would go all in.

There were many such cases in Taiwan in the early days of venture capital, in the 1980s and even the early 1990s. Take Zyxel as an example, I invested in them after I joined H&Q. So let's say you invested in them eight to nine years later, you could get a return that was 200 to 300 times their original value. It is very shocking. Even MXIC, if you invested in them in their early stage, you could get a return dozens times their original value. At the time, Acer's stock price was lower than twenty NT dollars per share. You could get a return of ten times what's their original value in a few years. Not forgetting that at that time, in 1988. Acer was about to become a public listed company. At that time, Taiwanese OEM and ODM models have not yet come to a dead end. There were still good opportunities for SMEs. With unique design or outstanding product features, they could make a fortune selling their products to the States and Europe. And the stock market would have applauded them.

However, OEM and ODM have become fully developed. Being fully developed means that it had become very difficult to differentiate. There was nothing you know that I didn't. There was nothing you could do that I couldn't. Therefore, with a lack of differentiation, the strong will remain strong. Meanwhile, the manufacturer went to mainland China. Under these circumstances, there were two opportunities for the VC companies. One was the Taiwanese businesses in China; the other was OEM companies in Taiwan. There are two kinds of people you can't compete with. One is the leader in the OEM industry, for example Foxconn is the leader on a supply chain. When Foxconn invests the company wants their capital, not yours. The company wants AU Optronics' capital, not yours. They want UMC's capital, not yours. And then there are other risks that you have to take now that you've come to China. These risks you cannot see or feel. What's more, some issues are different from management problems and cannot be solved that easily. Therefore, many Taiwanese VC companies try to beat one another in getting companies that

are about to become publically listed. These companies cannot offer as much profit but provides lesser risks. But even then, you can't compete with the banks because the perks they offer along with the loans are something you cannot afford to offer. Hence, the number of VC and the injection of money in the VC industry over the past few years are nothing compared to the golden years between 1980 and 1990.

Ling-Fei Lin: What kind of advice would you give to the young people who wish to get into the semi-conductor industry?

Ding-Hua Hu: Here's what I think about young people. Firstly, I think that they should take the lead in doing something great. If there's something wonderful, that's worth the while, they should strive to do it even if it means hard times. And don't just go with the flow. Do something within your power that others do not dare or do not have the time to do. Do something that's innovative. Be yourself. I think these are the attitudes young people should adopt.

END OF INTERVIEW

