



Taiwanese IT Pioneers: Chun-yen Chang

Interviewed by: Craig Addison

Recorded: February 16, 2011
Taiwan, R.O.C

Sponsored by:
National Security Council, Taiwan, R.O.C.

CHM Reference number: X6262.2012

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受訪人：張俊彥教授

Craig Addison: This is Craig Addison for the Computer History Museum. The date today is February the 16th, 2011, and I am doing another Taiwan oral history interview. And the guest today is Professor Chun-yen Chang. So professor, could you state your name and the affiliation in Chinese before we begin?

Chun-yen Chang: My name is Chang Chun-yen. My affiliation is National Chiao Tung University in Taiwan.

Craig Addison: Where were you born and where did you grow up?

Chun-yen Chang: I was born in Kaohsiung in 1937. And I grew up there until elementary school. The last two years at elementary school, we moved to Tainan. And since then we stayed there until my graduation from university, National Cheng Kung University.

Craig Addison: What were your best and worst subjects at school?

Chun-yen Chang: I was a fan of Mathematics, Physics and the Chemistry. And I like to read the biography of Einstein and Watt, all those people's biography, in my childhood

Craig Addison: Were you interested in the scientists...?

Chun-yen Chang: In science, yes. From very early time.

Craig Addison: Did you have any role models? You looked up to people like Einstein; were they your role models when you were young?

Chun-yen Chang: Yes, they are... Yes, my role model was Albert Einstein when I was a young boy. Later on, after graduation from graduate school, my role model was Professor Lan-cheng Chu, Webster Chair Professor of MIT. He visited Chiao Tung University since 1961 through 1973. He is a kind person. He made a great contribution in World War II, the direct radar system.

Craig Addison: Could you tell me what was your first exposure to Electronics and Computers?

Chun-yen Chang: That was very interesting. When I was in the middle school, I made vacuum tube radio, then I made transistor radio by myself. The start of my career [was] my hobby in all those things. It's very young time. My age was 13, 15 at the time.

Craig Addison: That wasn't part of your school program, and it was just your hobby?

Chun-yen Chang: My hobby. Yes, my hobby.

Craig Addison: Let's talk about university. Where did you go to university and what subjects did you study?

Chun-yen Chang: I entered National Cheng Kung University in the Electrical Engineering Department. My major subject was microwave and semiconductor courses. [Those were] my most favorite subject when I was there.

Craig Addison: The semiconductor courses were fairly early in Taiwan's development. Where did they come from? Who was responsible for teaching them?

Chun-yen Chang: There was a Professor Shen. He taught us about transistors, semiconductor transistors. That was my very beginning to learn about that.

Craig Addison: Did you work on any particular projects in university that involved transistors? Such as building any equipment or designing any equipment?

Chun-yen Chang: Not really. I took one course of transistors in my senior [year].

Craig Addison: At that time, was the transistor very famous? Was it a famous product or a famous technology?

Chun-yen Chang: Yes, I graduated from Cheng Kung University in 1960. And at that time SONY [had developed] the transistor radio and it was very successful. But they were using germanium transistors instead of silicon transistors at that time.

Craig Addison: At that time, did you hear about the developments in the Bay Area? It wasn't called Silicon Valley then, but around 1960 "the Fairchild and the integrated circuit." Did you hear about the news?

Chun-yen Chang: Yes. At that time Fairchild was born. And Fairchild was making a lot of semiconductor circuits, integrated circuit devices, at that time. But in the very beginning, most were germanium transistors. And later on, they switched to silicon transistors [based upon] planar technology that was developed in Silicon Valley. Gordon Moore, he mentioned that "the origin of VLSI was the silicon planar transistor" in his famous Moore's Law paper in 1965.

Craig Addison: When you graduated from university, what did you do?

Chun-yen Chang: I entered Chiao Tung University in still in electronics. At that time there was only one graduate school devoted to electronics. Therefore, fortunately I was... I entered electronics, National Chiao Tung University here in Hsinchu. That was 1960.

Craig Addison: Was that as a student to study?

Chun-yen Chang: Yes, that was in my Master's Degree program.

Craig Addison: When you finished that program, what did you do?

Chun-yen Chang: I immediately entered the military service for one year. But in that time, we made the first TV transmitter, Taiwan's first TV transmitter. And after one year of military service, I returned to Hsinchu and I started my research laboratory, working on vacuum technology by myself.

Craig Addison: Let's go back to the TV transmitter that was during your military [service]. Was that something you worked on?

Chun-yen Chang: Yes. That's a project from military education. They wanted us to develop a TV transmitter. There was a team working for that.

Craig Addison: Were you on the team?

Chun-yen Chang: I joined the team. [I was] one of the members of that project.

Craig Addison: All right. So...

Chun-yen Chang: It's kind of a very interesting [project], because we designed the transmitter, designed the power transmitters by ourselves. We designed the container, we put the signal to the container, and broadcast to whole Taipei area. That was the very beginning, the very first one made [in Taiwan].

Craig Addison: So then, you said you went to Hsinchu and set up the research lab. Was that on your own or it's part of an organization?

Chun-yen Chang: In this university (National Chiao Tung University). The military education, they gave the TV transmitter project to our group in Chaio Tung University. And all those people were in the military service, so there are about 10 people working on this project. That's the very beginning, we worked on this research project. It's the first time we made it.

Craig Addison: When you left the military and you said you came back to Hsinchu, what were you doing then?

Chun-yen Chang: Actually [while I was] in the military service I still stayed in the university, because the project was going on in this university. So after military service, I actually...I joined a new company. It was established in Xindian, [and was] called the Taiwan Electronic Corporation. And they appointed me as the plant manager of the semiconductor factory, the first one in Taiwan. But I only worked for that company for one month, then I decided to return to Taipei because at that time I found a problem, I could not go abroad. Therefore I just quit the job and come back to Taipei.

Craig Addison: Was this Taiwan Electronic Corporation the first semiconductor company in Taiwan?

Chun-yen Chang: Yes. It was an assembly company.

Craig Addison: Who actually set that up?

Chun-yen Chang: No, I just worked on planning for one month. Then I just quit because I could not go abroad.

Craig Addison: So that you were doing assembly for overseas chip companies?

Chun-yen Chang: Yes. It was established by an American company called General Instruments. It was a subsidiary company of General Instruments, U.S.A. And [the person who] established this company was Dr.Hall, I remember.

Craig Addison: You mentioned the problem of going abroad. Can you explain what the problem is?

Chun-yen Chang: Not permitted.

Craig Addison: Why?

Chun-yen Chang: Because my father was killed by Chiang Kai-shek in 1950. He did not agree with...Chiang Kai-shek's occupation of Taiwan, therefore he was killed. I was innocent, but they do not permit me to go abroad that time.

Craig Addison: So there was like a blacklist, was it? You were on the blacklist?

Chun-yen Chang: Yes.

Craig Addison: And there were presumably many others as well?

Chun-yen Chang: Yes, many others. Similar cases happened for many people in Taiwan.

Craig Addison: So they saw you as some kind of political threat, and you were not allowed to go overseas?

Chun-yen Chang: No.

Craig Addison: Okay. How did you find out that.... Did you know that you were not allowed to go abroad, or only found out when you tried to leave?

Chun-yen Chang: It was okay for me. Then I became an instructor at the National Chiao Tung University, and started my self-learning program, self-teaching program. Therefore I learned quantum mechanics by myself, and I taught quantum mechanics at the graduate school. I learned solid-state theory and I taught solid-state theory in the graduate school. Therefore I started my self-learning program. And I think it's very successful because I was on the frontier of this kind of science. And then I started to work on semiconductors and it happened to be very beneficial for me to develop my semiconductor career from then on.

Craig Addison: So when did you start to work on semiconductors? Roughly what year?

Chun-yen Chang: Actually, I started my semiconductor work in 1964, I joined with an expert from Bell Lab, Dr. Joseph Chang. He brought back the blueprint of some equipment, like mask aligners, like vacuum evaporators, like wet-etchers. And we tried to make them by ourselves, by our two hands, to make it by ourselves, including diffusion furnaces. All those things we made by ourselves, by our own hands. And it was kind of...it was very successful because...1964 we started the work...I think it was September 1964. And we successfully made the first planar transistor in was May 1965. I think it's the very beginning of silicon planar technology, [when it] was established in Taiwan.

Craig Addison: Was this Joseph Chang you said, from the Bell Labs....Was he [involved in] some kind of technology transfer?

Chun-yen Chang: Yes, we had a lot of discussion because we knew the knowledge. And we discussed the equipment, how to establish the equipment, those topics. And we designed the equipment, like the mask aligner, I designed [it] by myself, and asked the Instrument Center to make it. Then it was very successful, very accurate, a very good one.

Craig Addison: So this mask aligner that you designed...

Chun-yen Chang: Yes, I designed the mask aligner.

Craig Addison: Was that a kind of reverse-engineering from something else?

Chun-yen Chang: It's very difficult to say reverse engineering. We talked about that, discussed about that, and sketched up some sketches, some drawings. And then we made it up.

Craig Addison: On the Taiwan side who was funding all this?

Chun-yen Chang: Yes. That was....We got a special project from the United Nations. We called it the "UN special project" working on establishing Far East Communication Training Center in Hsinchu. And the amount of the budget was 300,000 USD. At that period of time I think it was a very significant amount of money to establish this kind of technology in Taiwan. But it was not the first project we established. We established the first computer lab and microwave lab and laser lab. Then finally we decided to establish the semiconductor laboratory. So that time we established the Semiconductor Research Center in Taiwan for the first time. And [eventually] it became very successful as you know.

Craig Addison: Was this all long time before ITRI and ERSO? They established similar labs many years later. So were you...?

Chun-yen Chang: Long time before that.

Craig Addison: Were you doing this a long time before them?

Chun-yen Chang: Yes. 1964, exactly. Then in 1974, ITRI decided to establish a CMOS pilot plan project. Then they needed, most importantly, the resources of manpower, the knowledge of silicon technology. All the members are from my laboratory. Some are my master students, some are undergraduate students, and some are trained at our semiconductor research labs, almost 100 percent of people were trained in my laboratories before they went to RCA to establish the pilot plan in 1974.

Craig Addison: Do you remember the discussions about the licenses from RCA? The behind-the-scenes discussions? What went on at that time?

Chun-yen Chang: It's very interesting. Before we decided upon RCA as a vendor, there was a

committee. There was a kind of.... How to say that committee...There were two bids, one was from RCA, one was from Hughes. They offered two....There are two bidders, and our committee decided which one would be the winner. And the committee was composed of five people. And finally we decided to go with RCA. That was the first time we started our CMOS project.

People went to RCA for 6 months training. After returning to Taiwan, they established the CMOS plan at ITRI. When we, our committee, reviewed the proposal from RCA, they only guaranteed after training and after establishing the CMOS pilot plan, they guaranteed 17% yields. After people came back to Taiwan, when they established the pilot plant, they achieved better than 70% yields. They surprised the RCA people. And that was even better than RCA's yield in the United States. Surprised. And that gave us tremendous confidence in developing the CMOS industry in Taiwan.

Therefore our committee, our people, decided to spin-off the technology to a company in 1980. And in 1980 our government established Hsinchu Science Park. The first one in Taiwan, Hsinchu Science Park, in 1980. And at that time UMC was born in 1980, and the CMOS technology was transferred to...production technology was transferred to UMC. And UMC was very successful after two, three years of operation, they were making money.

Craig Addison: Just before we move on to there, can we just back up a little bit. What role did Dr. Pan...? Dr. Pan Wen-yuan, he worked for RCA. What role did he play in this?

Chun-yen Chang: Dr. Pan was our alumnus. Dr. Pan was with RCA and he introduced RCA to this project. But this is only one of the projects, another one from the Hughes. But we chose RCA because RCA is more mature in this technology. And then Dr. Pan became an advisor to this project. He gave a lot of advice to...going on this project.

Craig Addison: You said that [both] Hughes and RCA bid, was it difficult to get companies to bid? They were not interested in transferring technology or...?

Chun-yen Chang: They're eager to transfer the technology, RCA and the Hughes.

Craig Addison: How about any other companies? Did you approach other companies?

Chun-yen Chang: Yes, there are some other companies like T.I. But T.I. at that time, they didn't have CMOS technology. They only had bipolar transistor technology. So we didn't choose T.I. as a candidate. No.

Craig Addison: Can you just talk a bit about....Why the government decided it was important to transfer this technology? What was the thinking about the reasons behind all this?

Chun-yen Chang: This is a good question. I think our government did the right thing. Our government decided to establish a pilot plant. And at the time, our government didn't know which direction was the right direction to go, but they want to develop semiconductor industry in Taiwan. At that time there are two choices, one is the bipolar technology, one is the CMOS technology. And they made the right choice. "We are going on to CMOS". That was a very important step to go forward for the future, in the development of semiconductor industry. Second thing our government made a very right decision, and [developed] a very successful policy to establish a science park. And you know the [Hsinchu] Science Park was very successful in the world, just next to Silicon Valley. [We] made very important right decisions and [developed] the right policy at that time.

Craig Addison: Well, can we maybe talk about the establishment of the Science Park? Because I understand that many people were opposed to it in the beginning and it was quite difficult to get support.

Chun-yen Chang: [Prior to] 1980, we had a committee to propose and promote the establishment of a science park. We did it. And we were successful. Some people were against it. We didn't care. So I forgot all those things because now it's very successful. So I cannot remember who was against it, but I know some people were against it.

Craig Addison: At the beginning, it was quite difficult to get foreign companies to come to the Science Park. Is that correct?

Chun-yen Chang: Yes. At that time [it was] difficult. At that time [there was] only one company, UMC, United Microelectronics Corporation. And later on there's another company...How to say that in English? Fu-lu, Water-Jet, it is still alive here. Water-Jet Company. At that time [there were] only two companies. Then the director of Science Park was Irving T. Ho. He went to the United States to Silicon Valley, to many places, he wanted to persuade American companies, or Taiwanese companies to [locate in] to the

Science Park. And at that period of time, it was very difficult.

Craig Addison: You mentioned before that the people who went to RCA were chosen from your lab, your center.

Chun-yen Chang: [It was] our committee's decision.

Craig Addison: How were they chosen? Just the smartest guy or...? What were the criteria for choosing them?

Chun-yen Chang: Yes, this is a good point. Because at that time they chose...The best way is to choose people from... get trained, get training from our Semiconductor Research Center. So most of them came from our center, some people went to Fine Products Microelectronics Corporation. Fine Products Microelectronics Corporation was established at 1970. And they hired some of the people from Fine Products Microelectronics, because they had mastered all of the technology, in planar, silicon planar technology. I just give you [the names of] two people, they are the key people in the CMOS project. One is Dr. F. C. Tseng. He's now the co-founder of TSMC. They hired F. C. Tseng from Fine Products. And the second person was E. D. Liu. And he finally became the Chairman of UMC, and established technology side of UMC, and then the management side. And then these two people were hired from Fine Products, because they mastered all of the silicon technology. It was successful because at that time, Fine Products made transistors, their yield was better than 99%, technology-wise.

Craig Addison: Fine Products Microelectronics, was that a Taiwan company or a multi-national company?

Chun-yen Chang: A Taiwanese company. And all the technology came from our Semiconductor Research Center. But it survived only for 17 years

Craig Addison: But the silicon planar technology.... Did they license that from Fairchild or developed in...?

Chun-yen Chang: No, the technology was developed in our laboratory. All the technology in Fairchild... [was] in Fine Products company. They got the technology, all the technology from our laboratories.

Craig Addison: What kind of products were they making?

Chun-yen Chang: That time they were making silicon transistors. And they were making some kind of the...for transistor radios. At that time Taiwan... the Taiwanese electronic companies were mostly transistor radio companies. So they supply transistors for transistor radio companies. And second product they're producing was LEDs. We made the first LED in Chiao Tung in 1970. We made the first one in 1970. I instructed my technician, Mr. Wu, Wu Ching-Bing. He made the first red light LED in Chiao Tung.

Craig Addison: How did you keep up with what was happening in Japan and the U.S. in transistor technology? Did you... basically [read about it] in magazines or...? Because you couldn't travel there, so how did you keep up with all the technology?

Chun-yen Chang: You are right. That was very difficult for me to explore internationally. But I'm free to read all the international journals, and the magazines or Japanese information. But I think it's still kind of difficult for me to explore all those kind of things internationally.

Craig Addison: The Semiconductor Research Center, what was your role there? Were you the boss or what? Did you establish it? What was your position in that Semiconductor Research Center?

Chun-yen Chang: I became the director of the Semiconductor Research Center in Chiao Tung in 1965 because Joseph Chang just stayed in Chiao Tung for one year. Then he returned to Bell Labs. Therefore they appointed me to be the Director of the Research Center.

Craig Addison: How big was it in terms of numbers of people, for example?

Chun-yen Chang: We hired some technicians. We hired two highly-educated technicians and five to six other associate technicians, to maintain the laboratory. Diffusion furnaces, mask alignment, wet-etch. And those people are still working for a laboratory, Nano Device Lab, although they are already retired. But after retirement, they are still working for this laboratory right now. There are many of them still working because they're pioneers of semiconductor industry in Taiwan.

Craig Addison: You talked about the mask aligner, did you build any other pieces of equipment?

Chun-yen Chang: Yes, I built a vacuum evaporator by myself. Vacuum evaporator, alloying furnaces,

and boron diffusion furnaces, and phosphorus diffusion furnaces.

Craig Addison: Were you involved with the building the production line for the CMOS, the RCA CMOS devices?

Chun-yen Chang: No. The equipment was bought from all the semiconductor [equipment] companies. So in the RCA project we bought the furnaces. Actually I should say that in Fine Products, we bought all the equipment from semiconductor equipment manufacturers, like Themco for diffusion furnaces, like K&S for mask aligner. For production, we bought the equipment outside, [we did] not [use] our homemade [equipment]. For the research purposes they were good enough, but for production [purposes] [they were] not suitable.

Craig Addison: Could you describe the Taiwan semiconductor industry around that time, around 1960, and around the time before you set up the [Semiconductor Research] Center? There were some assembly companies here. What sort of industry was here at that time?

Chun-yen Chang: The first one, I had just mentioned, the Taiwan Electronics Corporation established by General Instruments. In 1966 the first assembly company was established in Kaohsiung. It was called the Kaohsiung Electronics Corporation. It was a subsidiary of Philco-Ford. That is Kaohsiung Electronics Corporation in Kaohsiung. They were doing semiconductor device assembly work. And I introduced our graduates who became the key persons in that corporation.

Craig Addison: [Were there] many more companies like that? Many more established in the next few years?

Chun-yen Chang: Then in 1970 there is another company established in Kaohsiung. It was Huatai, I don't know how to say in English. I think it's Oriental Electronics Corporation. It is still [in business] in Kaohsiung [today]. They are still working on assembly work, IC assembly work.

Craig Addison: Didn't Fairchild set up a factory here very early?

Chun-yen Chang: No.

Craig Addison: Maybe Hong Kong? They went to Hong Kong.

Chun-yen Chang: Fairchild established a division in Taiwan. They are only selling their products. No manufacturing company here. No manufacturing unit here.

Craig Addison: How about after the Semiconductor Research Center? What happened to that? Did it keep going or close down?

Chun-yen Chang: [It still exists today]. It still keeps going here. And we expanded it and changed the name to the Nano Facility Center at the National Chiao Tung University.

Craig Addison: Were you still involved right up until you retired?

Chun-yen Chang: No. I just.... I had some equipment. I was just doing my research, we were using those facilities. There were many facilities that I made use of...all these facilities. But I didn't have my own facilities, I used the center's facilities.

Craig Addison: Can we just move on to your own career? What happened after that? What did you work on?

Chun-yen Chang: The Semiconductor Research Center is still going on and [is under] expansion. And they provide all kind research services to all the professors at this university. So for semiconductor-related research or auto-electronic research work, I think they're serving more than 100 professors at the university. So the concept of a [research] center works very well here. And we established this laboratory still using to same concept to provide service to the whole country, to all universities in Taiwan. This national research laboratory is serving, providing services to all the universities right now.

Craig Addison: So Professor Chang, we've talked a lot about the 1960s. Could you talk about what you did in the 70s? Start from the 70s to 80s.

Chun-yen Chang: In 1970 we established another semiconductor company...the first one in Taiwan called Fine Product Electronic Corporation...in Hsinchu. It's a brand new kind of silicon technology. They made silicon planar transistors, etc., for Taiwanese electronic industries, especially for transistor radios.

They need a lot of silicon planar transistors from signal amplifiers to RF to power amplifiers... all kinds of things.

Craig Addison: What was your involvement with that company?

Chun-yen Chang: The first time they established the company, they invited me to be the Chief Technical Officer. I was responsible for the establishment of all the production lines there. So we bought all kinds of production equipment from many... especially from United States companies, like Themco, Hugel...all kind of things.

Craig Addison: Was this the company where you only stayed for one month because of the problem of going overseas?

Chun-yen Chang: No. We can get all the information for the magazine and the international magazine and the catalogues. And I can get some information from other semiconductor companies. And they gave me 'it's good or not'. I knew all of this. I chose the best semiconductor equipment vendors in the world. I chose them.

Craig Addison: But before, you said you join the company but you have to leave one month later, was that Fine Products or a different one?

Chun-yen Chang: A different one. That is the General Instruments company in Taiwan. That was in 1963. But this one was in 1970.

Craig Addison: How long did you work for Fine Products?

Chun-yen Chang: I worked for 3 years. Established all the lines and made the product and tested the products. At that time a very important person was the co-founder of TSMC, Dr. Tseng, F. C. Tseng. He was the QC Manager. He checked all products with the test equipment. And the yields were successful [good], very nice at that time.

Craig Addison: What kind of challenge? Did you have to get the yields up?

Chun-yen Chang: I think the most important [thing] is you should know all [related] technology very thoroughly. And I trained all the people with a very solid education. Like F. C. Tseng, like Dai Pao-tung, and Liu Ing-da. They were the first badge of CMOS project later on in 1974. But importantly all those people got very good experience in establishing a production line, a semiconductor production line, in Fine Products. So I think that is very important. Some people told me that it was the "Taiwan Fairchild". That was Fine Products.

Craig Addison: Were you there for 3 years?

Chun-yen Chang: Yes. I was there for three years. Unfortunately I left because there were some management problems. Although technology-wise, it was successful, there were some confusion in the business model and management, some kind of conflict. Therefore I left. And then later on I...[after those] two or three years, I returned to the University.

Craig Addison: When you went back to the University, what were you doing?

Chun-yen Chang: I returned to... not Chiao Tung University. I returned to Cheng Kung University, and established another new facility there and started some..., the first one in Taiwan was amorphous silicon technology, polysilicon technology, and III-V, gallium arsenide technology. And then...amorphous silicon technology became the technological source for LCD, liquid crystal display, companies. For gallium arsenide, there were many gallium arsenide, photo-voltaic cell companies. And that would be the human resources from my training. I'm the first one to establish all those kind of things, at the Cheng Kung University. That was 1977 through 1987. Ten years.

Craig Addison: So many of your students probably went on and became famous in the industry. Do you have any stories or anything to tell about some of your students?

Chun-yen Chang: You mean about my philosophy, education or my concept education, or some kind of education?

Craig Addison: I'll ask about that later, just some of your students today. Later they became famous in the industry.

Chun-yen Chang: A bunch of them. The first one, let's say Dr. Tseng, F. C. Tseng. He is a co-founder of TSMC. For example, John Hsuan, he graduated from Chiao Tung. He became the Vice Chairman of UMC. And Dr. Stan Shih, Stan Shih is a founder of Acer. And many others. In the academic world, there are some students when I was teaching at National Taiwan University for five years. And at that time almost all the best students came to my group, to work on their theses and to learn from me, about semiconductors, physics and technology. These included Dr. Cheng, Hwa-Cheng. He's the first person who made the first blue laser in the world. Very successful. And the same, many others, they're very successful.

Craig Addison: Could you comment on the difference or similarities between engineering education in Taiwan and in Silicon Valley, for example?

Chun-yen Chang: I think [they are] almost the same because we were taught the American system in our university. But the difference is that Taiwanese universities are working more on practical areas. But the universities in America, they emphasize more the fundamental research. So [they are] a little different.

Craig Addison: How about your involvement with the Bell Labs? Can you talk about how that came about?

Chun-yen Chang: It was a very happy time when they invited me to the Bell Labs. And I joined the group called the VLSI group. And that time my boss was George Smith. In 2009 he was confirmed for the Nobel Prize in Physics, because of his invention of the Charge-Coupled Device, CCD. And we had a very good time together with him. And we had time to discuss with him about the future of VLSI, and about the problems, how to solve the problems, about the short-channel effect, because for scaling... according to the scaling issue, miniaturize the dimension, and then [there was] the problem of short-channel effect. And we have a very interesting discussion about... I had some proposals for him and he was very happy about that them. Unfortunately it was very short time. I returned to Taiwan, but later on he invited me to Bell Lab many times. So we have had a very good time with him for many years. [He has] become a very good friend. We're [still] good friends.

Craig Addison: But how did you get introduced to Bell Labs? How did you get the job there in the first place?

Chun-yen Chang: At that time Professor Simon Sze was with Bell Lab, and he introduced me to this group. And he immediately....they immediately invited me to [visit] there. And he gave me a very good package, as a member of technical staff at Bell Labs. So I'm very honored for that.

Craig Addison: So obviously now you were allowed to leave Taiwan? There was not a restriction?

Chun-yen Chang: No. No problem. After that, no problem. After Chiang Ching-kuo.... After the death of Chiang Kai-shek, and Chiang Ching-kuo got the power. And actually I'll tell you that, the development of Taiwan high tech industry, was originated by Chiang Ching-kuo. As I remember, in 1970 he invited me and several people to his office, and he told us he wanted to develop a high tech industry in Taiwan. And I gave some advice, suggestions to him. I would like to say the Taiwan high tech industry, the idea was originated from Chiang Ching-kuo. I should say that although a lot of people say Li Kwoh-ting, or Sun Yun-suan. But at the very early time, Chiang Ching-kuo decided to develop high tech industry in Taiwan, as early as 1970.

Craig Addison: Did he have any particular interest in technology? Why do you think he was the...?

Chun-yen Chang: Why he invited me was because he was very interested in developing a semiconductor industry. So that time he invited three people. They are all involved in semiconductors. So you can imagine he was very wise to make the decision. He was very wise as a kind...as a political person. He was very wise to make this kind of decision, and it happened to be very successful as you know. Because you can see that all the Taiwan high tech industry, was originally from semiconductor...the success of semiconductor industries in Taiwan. We spun off [from the semiconductors] to LCD displays and then to the computer business. Frankly speaking, Stan Shih learned...studied semiconductor technology at my laboratory, under my instruction. And he left... after his graduation, I introduced him to his first job in Unitron in Chupei.

Craig Addison: What kind of student was he?

Chun-yen Chang: You mean Dr. Shih? He is number one in his class. I don't know before he was number one or not, but in my class he was number one.

Craig Addison: Did he actually start in semiconductors before he moved to...?

Chun-yen Chang: Before he established the computer [business]...

Craig Addison: You could see he was a very smart guy from the beginning?

Chun-yen Chang: Not only smart. He is a kind person. He is very considerate to all of the people [around] him, including his colleagues, his team, the people in his companies. He has a very good humanity [about him].

Craig Addison: Did he talk to you about what he wanted to do? Did he have a vision of starting a company?

Chun-yen Chang: Actually, no, because [it was] only when he was a student that we had good interaction with each other. But after graduation, we had very little communication. But he [did tell] me something about his new business and new start-ups very early [each] time.

Craig Addison: And that was Unitron, did you say?

Chun-yen Chang: Unitron was a kind of assembly company. After two years he joined another company, Qualitron. And then after two or three years, he left Qualitron, and he established his own company, Acer. And started with a little processor, a small computer. I think it was in 1975 or 1976 that he started his new company.

Craig Addison: When you came back Taiwan from Bell Labs, what did you do?

Chun-yen Chang: I continued on [with] my research work. And I was doing some pioneer work in semiconductors, like new ballistic transistor devices. I was pioneering in some new semiconductor devices at that time.

Craig Addison: Were you looking into the VLSI area?

Chun-yen Chang: Part of it. I worked on VLSI areas and then [the rest of the time], we were working on some new devices, new physics and phenomena at that time.

Craig Addison: When you came back from Bell Labs, what was the Taiwan semiconductor industry like in the 1980s?

Chun-yen Chang: It had just started. UMC [had been founded] only one, or less than one, year. At that time, UMC was not very profitable. But after the operation for two or three years, UMC turned out to be very successful, making money, because they [implemented] the right business model. They chose the [right] products at that time. They were making...they found the [right] product, and were very profitable. That was a watch chip. Then they are selling watch chips for many years, from the [beginning of] the 1980s through the end of 1980s. They produced a lot of watch chips and were very successful and very profitable. Interestingly, at the very beginning, they are selling watch chips at the price of twenty cents per watch. Then the price went down to 15 cents, 10 cents, 7 cents, 5 cents, and 3 cents. They were still making money. They were still making money and good profits. And then the price [went] down further to two cents.

Then UMC quit the [watch] business and did different things, for example, making some other products, or doing some foundry services to IDM companies...IDM, integrated device manufacturer companies. Why did they quit this business? Because at that time, Korea was supplying the watch chips at the price of two cents. They were making this chip by a Russian company. And they were very cheap. Therefore, UMC quit this business. Anyway, in this period UMC was very successful so they had the strength to establish different kinds of products. And they survived and they developed [new businesses] at that time.

Craig Addison: The founder is Bob Tsao. Bob Tsao is one of the founders of UMC. Did you know him?

Chun-yen Chang: Yes, I know him very well. He graduated from our school. In 1970, he entered school in 1970, and graduated in 1972. And I had been his professor before.

Craig Addison: What kind of student was he?

Chun-yen Chang: I'm not teaching their subject, but I am his.... In the mini program...I became a committee member so I knew him very well at that time.

Craig Addison: Yes. Any funny stories to tell about him?

Chun-yen Chang: He is a brilliant person. He invented many new [business] models, new semiconductor models. For example, he invented a kind of model still in use right now. That is very famous one. Everybody knows [about] that. It was the stock bonus. He invented that. And everybody used it. Even TSMC adopted his idea...bonus stock. And many others.

Craig Addison: What about the foundry model? Morris Chang said he developed the foundry model. Sometimes I heard Bob Tsao say he did. Do you know the history of the foundry business model?

Chun-yen Chang: Good question. Frankly speaking, I would say that he raised this idea before Morris Chang did, because at that time, Morris Chang was the Chairman of UMC in 1985. But in 1986 Morris Chang was an adviser to UMC. Because UMC was so successful, Morris Chang decided to return to Taiwan in 1985. And after that, maybe 1986, around that time, Bob Tsao made a foundry proposal. And that proposal was delivered to our Ministry of Economic Affairs. They found this document [the proposal] after that. But frankly speaking, the foundry [model] was Bob Tsao's idea.

It was definitely right. But at that time, it was not a pure foundry [model]. They were doing both things. But after 1988, when Morris Chang started running TSMC, the company was running a pure foundry model. Therefore, Morris Chang was the founder of pure foundry model in the world. Because of the successful pure foundry model, then created many different kinds of business, like fabless [semiconductor companies], like design houses. Because of the foundry services, those companies could survive. So they created a new business model in the world, in semiconductor area. The PC world already had this kind of concept before. Stan Shih can tell you that. Before that, in the PC business chain, they already had this foundry kind of concept.

Craig Addison: During the 1980s, there were many semiconductor companies. You mentioned UMC, but then Winbond and Hualon and so forth. That must have been a very exciting time when many companies were starting up. What was your impression of that period?

Chun-yen Chang: After the success of UMC from 1980 to 1987, and continuing on to right now. But 1987, that was a very important time, because there were many companies established including TSMC, Winbond, Mosel, Vitelic and many others. You're right. That time was a very important time for the blooming of semiconductor industries [in Taiwan]. But our government decided to establish a new

company, that was scale-up, and we called that the “10 billion project”. And that project went to TSMC. The idea was our government decided to invest 49%, and 51% was from the commercial society, not [funded] by the government. So after that decision was made, then TSMC was established. And simultaneously Winbond and the other companies I mentioned, they were established at the same time. Some are still [in business]. Some already disappeared. Like Vitelic disappeared and it merged into Mosel. A lot of different stories came up at that time.

Craig Addison: Did many Taiwan engineers in the U.S. or Silicon Valley come back to start companies? Was that a trend?

Chun-yen Chang: Yes. At that time, I think you are right. But before that, we did not have too many interactions with Silicon Valley. But after that there were many engineers coming back from Silicon Valley, Texas Instruments, especially many people come back from Texas Instruments, Silicon Valley. There were many. A kind of “brain return” were occurred. That was very beneficial for Taiwanese semiconductor industry development since then. You’re right. It’s very important.

Craig Addison: Why do you think they came back to Taiwan?

Chun-yen Chang: Simply speaking, because there were very good [employment] packages, especially bonus stock. That made a great contribution to the development of Taiwan’s high-tech industry in that period, although now it has already been given up. But at that period of time, it made very significant contribution to Taiwanese high-tech industry as you know. Maybe you agree with me about that?

Craig Addison: Do you know the story of TSMC being established? Especially that Philips was an investor?

Chun-yen Chang: I know that because I am one of the promoters to establish TSMC. And at that time, the Prime Minister was Yu Kuo-hwa. And Yu agreed to establish TSMC with the condition that [reflected that] he had no confidence if there [would not be] a foreign company involved. He had no confidence. Therefore they decided to invite Philips to join in, and shared about 27% of the shares. Then after that, Yu signed the whole project. That’s why Philips got a lot of benefit from this project.

Craig Addison: Was it difficult to convince Philips, or did they think that there was a good potential?

Chun-yen Chang: I don't know the details. But I know that...I think they were going on smoothly. Smoothly. Because Philips had been in Taiwan and invested in a lot of things in Taiwan, and had been there for 20 years or more. And even I knew Philips very well because [it] was my recommendations [who] became their chief officers in Taiwan, including Lo, including Lin, many others. Their chief officers all [came] from Chiao Tung University. So, I knew Philips very well, and Philips knew Taiwan very well. Therefore I thought that it would be easy to convince Philips to invest in TSMC. And another factor is that at that time, UMC was just at the very beginning, but UMC was very successful. They provided a very good model, a very good example, that Taiwan could do this kind of things. Nobody believed that Taiwan could do [that], but UMC proved it. Therefore I think they invested TSMC without any hesitation.

Craig Addison: I just want to ask you a question about education. Actually earlier we were talking about Fred Terman, and he really believed that education and the business should work together. And he encouraged his students to go into business. So in Taiwan is there that same kind of cooperation? Or is the government kind of helping education in terms of learning the right things to help the industry? What happened here?

Chun-yen Chang: Frankly speaking, I don't think so. But I can give you some of my own story about my education, and my ideas about education, or my philosophy of education. Like F. C. Tseng, he was my Ph.D. student...and another guy, B. S. Wu, the Chairman of Himax. He was very successful. He told me that when he joined my group and he learned my class subjects from the Masters program to the Ph.D. program, almost 6 years, that his academic performance was number one in the class. The top. Number one in the class. He got very good scores [in every subject]. But he told me that before that, he had not [gotten] good scores in his schooling. So he always is grateful to me, to the way of teaching, and keeping him [encouraged]. He became so successful, not only in academics, but also in running his businesses. This is one of the examples.

Even now some students have a similar situation. They're not very good in their undergraduate school, but after, in my class, they become number one in the class. Become number one in the class. So they're always enjoying that. They very much appreciate that they were [encouraged], their minds were opened up and [as a result] they became very devoted into their studies, research, and then, their future careers.

Another thing was that I was teaching semiconductors in Taiwan University since 1975 through 1979, for

five years. That is not very strange because all the best students, top one through top three, they come for my supervision for their theses. And after graduation they decided to study semiconductors, not other subjects. There are many others [subjects], but they decide to study semiconductors. And then after graduations, after [in their] professional work, like Dr. Cheng, he made the first blue laser...others do things like that. But I think that is a different kind of thing because they're very good and after graduation, they're still very good. But some people, they're not very good in their schooling, but after my instruction they become the best. So that is my value. I very much enjoy the value of education. And, even now, I still enjoy this value of education. Even now, I have maybe ten Ph. D. students or thirteen Ph.D. students. They work with me and they have this kind of spirit. So I can see the value of education exists.

Craig Addison: Professor Chang, could you just talk about..., you mentioned it before, but just going to a bit more detail about the problems, you had in going abroad to study?

Chun-yen Chang: Yes. The first time I applied to go abroad to study was after my graduation and I had finished my military service in 1963. As you know, I [wanted to] apply for scholarships and admission from U.S. universities. I did that, and I got some admissions and some scholarships, like from UCLA, from some universities. But I have applied for the permission of go abroad. But it turned out to be rejected in 1963. Then I got... After that I got a different kind of scholarship to study abroad. Several times, especially from the National Science Council, or from our universities, or from some...International Atomic Commission. They gave me a scholarship. Therefore I applied several times, at least three or four times, for permission to go abroad. But [the applications] were all rejected. I think the last time the government rejected me was 1970.

Then I decided not do it again. I forget about it. And I established my own self-learning program. I learned. I teach. I learn. I teach. I [progressed] in my academic career. It was very successful. Then in 1979, I applied again. And at that time, 1975, Chiang Kai-shek was dead. And then I tried but it was still not permitted. 1979 was my first time to get approval from the government for me to go abroad, 1979. Therefore I had a chance to contribute my expertise in Bell Labs. It happened to be a very happy time with George Smith, my boss.

Craig Addison: But if you had been allowed to go overseas for the first time, it would have really changed your career, I guess. Have you ever thought about that? What might have happened...?

Chun-yen Chang: Yes. After that I visited it many times. I go abroad almost every year and I have a good connection with all the international laboratories, universities, international-wise. So people say “you are very international, and you know many about international concepts, affairs, something like that.” I say that is not very special because I have a chance to explore internationally. Even international conferences, symposiums, they appreciate my reports. So we make a lot of friends internationally. I have many international friends academically, some research institutions. So it's very good resource for me after that (1979).

Craig Addison: Just looking back, what accomplishment are you most proud of?

Chun-yen Chang: My technical career.

Craig Addison: Anything in particular you are very proud of? Any particular project or something?

Chun-yen Chang: Nothing [that I am] so proud of. But I would say that educations are kind of my pride. We can educate a young man and he becomes very successful. That's one. And the second one is my research activities. I made some the first in the world, like I have developed MOS stabilization method in 1968. I accomplished that and that drew a lot of attention internationally, especially the inventor of MOSFET, Dwang Kang, he immediately flew to Taiwan to visit me. And then, in 1967, the semiconductor pioneer, Dr. Frank Fang, he came to visit me. And he was a witness of semiconductor development in Taiwan, because he visited my laboratory and saw our capabilities there. And then G.L. Pearson visited us and he...he saw many of our activities. And some technical achievement, I 'd like to say, I was the first one to develop low pressure MOCVD. It is now a very important technology in the making of LEDs, microwave devices in the world. The first one develop low pressure MOCVD.

Craig Addison: Looking back at this, if there's anything you could change or do differently? Would you do something differently?

Chun-yen Chang: What kind of...?

Craig Addison: Anything. Would you have chosen the different path? When you look back, are you happy with what things turned out?

Chun-yen Chang: What kind of difference you mean?

Craig Addison: Different career choice or a different area of study, for example? Did you ever think about that?

Chun-yen Chang: In two parts. One part is I established the Fine Products Electronics. This is very different from my academic career. But after 3 years I quit because it was a little bit complicated. I didn't like it, so I returned to the academic [world]. And then in academia, my interest was very wide. Therefore in many semiconductor areas, I have developed the "first in Taiwan". Almost all of the semiconductor materials, like silicon, crystalline silicon, amorphous silicon, polycrystalline silicon, and even gallium arsenide III-V materials...all kinds of things. So as a semiconductor researcher, my area is very wide. Compared to professors at a U.S. university, they are only dedicated to one direction. Like the "father of LED", Nick Holonyak, he was devoted to III-V, devoted to LED and lasers. I'm making different kinds of things. Even now I'm making....we made.... just last year I made the world's first continuous wave, room temperature surface, emitting laser. That's a kind of breakthrough, a very big breakthrough in the past 30 years. The most significant part was made by one of my Ph.D. students. Even last year we're still... and right now we're still working on different kind of very important topics in these areas. So we are gathering many good young people are coming to my group. They want to be in my group. And I turn out... them to be a very prominent, outstanding scientist. I still keep on that way.

Craig Addison: What advice do you give to young people who want to pursue a career in electronics?

Chun-yen Chang: I think most importantly...I think a student should be committed to his study. Commitment. As my professor told me: you should make a [strong] commitment to your work. And then you should [have] loyalty to your work. And you should have a positive way of thinking, positive attitude towards your job, your work. So I always use those three words to my students, to keep on their work, and to contribute to the society.

Craig Addison: What about now? Are you active now or basically retired?

Chun-yen Chang: Unfortunately I'm still very active.

Craig Addison: What kind of things are you working on now?

Chun-yen Chang: Because I'm still very active in one area I just mentioned, high efficiency green LED lasers. I'm working on green solar cells, photovoltaic solar cells, and those happen to be very useful for our industry to improve their efficiency, energy efficiency. And another direction I'm devoted to, the most important thing in the 21st century, is energy storage, energy generation, high efficiency energy generation, and I'm devoted to developing energy storage, high density energy storage. That could be the most important thing in 21st century.

Craig Addison: Is Taiwan ahead in that area? Does Taiwan...?

Chun-yen Chang: I think so. And I'm also.... I always told my students, we should do the best in the world. Do the best. If it's not the best, don't do it. So I'm doing the best. The best in the world. We're trying to do that. Otherwise we just forget about it.

Craig Addison: This is probably the final question. Instead of looking back, looking forward, what do you see is the next big thing in electronics or computers?

Chun-yen Chang: I think in the 21st century, the most important thing is green energy, green environment. So we're devoted to it. The second thing is that... I think it's... This is on the physical side, and on the huge scale side. I think it would be cloud computing, cloud networking. The network in medical care. The network in sensors. Network in the environment. Network in our daily life, into the system to benefit mankind. That would be most important in the 21st century.

Craig Addison: Thank you very much. Thank you.

END OF INTERVIEW