



Oral history of Morris Chang

Interviewed by:
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Morris Chang: I was born in 1931 into a middle-class family in China. And I lived in China until I was 18 years old, when I moved to the United States. So the early part of my life between birth and 18, the background was war, poverty, injustice. So those 3 things war, poverty and injustice, they dominated the backdrop, the environment in which I grew up. War, first the Sino-Japanese War, then of course the Second World War and then the Civil War. And I lived through all of them. Poverty was a, China was so poor, most of the people were so poor, even middleclass for me that I was born in, we didn't starve, we were not hungry ever but we're, but our life style was very very modest compared to a middleclass family lifestyle now. Injustice, even back in those chaotic days of my youth I could see and also read about people that were very rich and very powerful and indeed, I even saw, I even met some of them as a young person. But those were just in the very small minority and most of the people that I saw were also middleclass. They also lived very very modestly and then there was a large number of people that simply didn't know where their next meal would come from. And people that didn't have adequate housing, I saw a lot of those people too. And so how did that background influence me? Well, first of all I knew that the war was just a terrible thing. I knew that abject poverty was also a terrible thing and injustice, social injustice I saw something that lots of people ground their teeth at and I, myself included. So much resentment so much hatred in a socially injustice environment. Now the personal lesson to me was, well, I needed to study hard and later on, work hard. And hope that there will be peace. That was the personal lesson to me.

Alan Patterson: I think that's a, I've read your autobiography so to me that part of the book was one of the most fascinating ones for me, just the constant changes in your life. Moving from Hong Kong to Shanghai and then to Chungking. It seems like it was a very unstable time for you yet, in spite of all of that you've seemed to, well obviously you've over come a lot of that adversity that you experienced during your early years.

Chang: Well the United States was paralyzed when I first arrived at the age of 18. Politically, economically and socially. And yes, suddenly I shook off all those shadows in my mind. I quickly shook them off anyway after I arrived in the United States. But you talk about war, you talk about going, having to move from one place to another, yes I mean, I, we, our family had to flee from the air raids in Quamso (ph?). We were living in Quamso when the Sino-Japanese War started and immediately there started to be air raids. So we, my Mother and I moved to Hong Kong and within a few years of peace in Hong Kong, Hong Kong was a beautiful and certainly it was not invaded or anything until the Pearl Harbor day. Everybody knows Pearl Harbor because of what happened at Pearl Harbor but in, Hong Kong was attacked the same day by the Japanese and we lived through gunfire for 2 weeks and then we lived through Occupation, Japanese Occupation of Hong Kong for another year. Then we went to Chungking and we again had very serious air raids in Chungking. And then finally Reja (ph?) Day came and we moved back to Shanghai hoping for a period of peace and development. But then Civil War which of course was happening all the time anyway except in Shanghai was not touched by the Civil War until about 1948 when the Communist Armies actually came pretty close and we had to flee from that again. So we did move from place to place ever few years.

Patterson: How did you end up working the U.S. for Texas Instruments (TI), what sort of work did you do initially?

Chang: Well, I went to the U.S. I went to Harvard, into the freshman class of Harvard in 1949 and after a year I knew that in order to get a good job after I graduate I should go to a school with more specialized training, so I transferred to MIT (Massachusetts Institute of Technology). After I got my Bachelors and Masters <inaudible 10:52:09> at MIT I wanted to go on for my Ph.D. but as I said I failed the qualifying exam so I sought a job in industry. I had 4 job offers and just by a very lucky break I chose without really knowing the implications the ramifications, Sylvania Semiconductor. And I worked for Sylvania Semiconductor for 3 years and I <inaudible 10:52:45> and I was right as later events proved that Sylvania wasn't going anywhere in semiconductors. And I knew already that the Texas Instruments (TI) was rising very fast in Texas. And so I joined Texas Instruments after 3 years at Sylvania. I was first just an engineering supervisor at Texas Instruments. By that, I mean, I had 2 or 3 engineers reporting to me. And I was in charge of a product line – a production line. I rose. I was on the fast track at TI. I rose very fast. By 1961, which was 3 years after I joined Texas Instruments, I had already become a manager of a sizable engineering section. It was at that time that my boss told me that TI wanted to develop me by offering me an opportunity to go for my Ph.D. And they offered— the opportunity was golden because TI would pay full salary while I was a student and they would pay tuition, other school expenses. And I could even go to 2 or 3 technical conferences in other cities in the United States while I was a Ph.D. student. And that was an offer that is hard to refuse, so I took up the offer and went to Stanford for 2 ½ years and got my Ph.D. This time I passed my qualifying exam with flying colors so I had learned to study hard and study efficiently too. And so after 2 ½ years, that took us to 1964, Spring of 1964, I finished my Ph.D. thesis and I went back to Texas Instruments to work fully expecting that I would still stay in the engineering area.

But a few months after I got back to TI, the vice president of the semiconductor business asked me to head up a very important product department in Texas Instruments and of course that was what I had always wanted to do, general management. And I then became the manager of more than 2,000 people. Remember back then production was all unsure (?), was all in the United States, in Texas. So the 2,000 people of course included a large number of production people, but still there were maybe about 200 professional people. So it was a big promotion for me from just an engineering manager to a general manager. And after that I was still on the fast track and I became promoted from less important departments to more important departments and in 1967, early 67', I became the general manager of the most important semiconductor group in TI which was integrated circuits. And then a few years later I again was promoted to be the group vice president of all TI's semiconductor business and I stayed in that job for 6 years until TI's consumer business was, it was new to TI and it was not in good shape, and they transferred me over to head up the consumer group and I was in that job for another 2 ½ years. And the consumer business did not improve. I think that was due to many factors but the, I was transferred to a staff job. I was still a senior vice president but effectively I felt that I had been put out to the pasture. And after 2 years of that, still I agonized for at least 2 years as to whether to leave or to stay at Texas Instruments. And, but finally I decided after more than 2 years of agony, of agonizing, I decided to leave. So, that took us to the inflection point that we just,--

Patterson: What were some of the highlights during your 25 years at TI? How did you end up as the head of IC operations?

Chang: Many highlights during my 25 years, a few low lights at the tail end also but many highlights at least in the first 20 years. How did I end up, how did I get on the fast track and get promoted successfully pretty fast? Well I think that I did something in each of my jobs, I accomplished something significant in each of my jobs. In fact, my first big accomplishment was, happened 3 years after I joined TI and I wrote about it in my book one of my Autobiography. In the production line that I was in charge of, I increased the yield, the yield was practically zero in the first 3 months I went there and then one day, and I kept changing recipe, back then the process you know, essentially was a recipe, I kept changing the recipe but I changed the recipe very rationally because at Sylvania I had by self study and by experience, I became pretty good in semiconductor, in transistor technology. And after various numerous changes of <inaudible 11:01:04> recipe suddenly one day 3 years after I joined TI, the yield was up to 25-30% from zero. Suddenly we were in business. Whereas before, we were just cranking out rejects. And it was a very important production line for Texas Instruments at that time. And I remember that night, I mean I couldn't sleep I was so excited, I knew that I had accomplished something big because I knew the impact of the high yield. And the profit that resulted from that was significant to Texas Instruments. So actually when you were asking the question earlier, when was my proudest moment in life, I first considered that. In fact that was at least the proudest moment of my life up to that point. But I decided that later on to tell you about the listing of the NYSE of TSMC, I mean after all in magnitude the TSMC was bigger, but in terms of the pride I felt, the happiness I felt, I think the day when I accomplished this huge hump, I think certainly would compete with the TSMC listing day.

Patterson: I'm just curious, how did you bring up the yield so dramatically?

Chang: It was, back then this was 1958, the industry was during its infancy and the equipment that we used were primitive so it was basically a matter of just having the right temperature, having the right pressure at the you know, various process points and in order to even guess at what the right temperature, what the right pressure and what the right <inaudible 11:03:38> and all those things. In order to even guess at what the right things you should do, you certainly needed a pretty good grounding of device physics. And that was the thing, device physics was what I became pretty good at, at Sylvania.

Patterson: Did you use statistical methods or was it more sort of an intuitive process or what was your methodology?

Morris: It was not statistical but it was not intuitive either. In fact it was quantitative and mathematical. But it was not statistics. I mean, you know that you have to know the basic physics you know, it was alloyed transistor and defused transistor at that time. My line was a defused transistor so you have to calculate how fast something defuses into, it was germanium also by the way, how fast something defuses into germanium and what the base width is going to be. The base width cannot be too wide. If it's too wide

then you don't get a very strong transistor action. And you don't get very high frequency either. But if it gets, if the base width is very short or very narrow then you run into shorts. So I knew device physics pretty well by then and so I tried various recipes and temperature of the core of course was not the only variable. There were other variables as well, such as the impurity of the <inaudible 11:05:41> etc. etc. And the geranium wafer thickness, I mean, heck all these things, they were ancient you know by today's standards. But back in those days those skills of how to achieve good yields in transistors those skills were very valuable skills. So,--

Patterson: Talk about TI and the IC, the challenges in manufacturing device and the competition from Fairchild?

Chang: May I go back to the earlier question because you know, I think we have enough time?

Patterson: Sure.

Chang: Because you know, you asked me what highlights and I just talked about the first one. It happened in the first few months after I arrived at TI and then I developed, when I became a bigger manager still engineering manager, I developed a number of new geranium transistors. In fact one of them, another one now, turned out to be extremely profitable to Texas Instruments again and that was already after I came back from Stanford, from my Ph.D. And so I was promoted to the general manager job that I spoke of earlier, and in that general manager job I finished the involvement of this second important geranium transistor that I had started to develop. I finished the involvement and put it into production. I also had to negotiate a deal with, then the most important customer of Texas Instruments, IBM, and then we put this newly developed transistor into production just to sell to IBM and that turned out to be very profitable for Texas Instruments again. So I quickly got promoted to become the general manager of a more important department, which was silicon transistors. Now in my year as the general manager of silicon transistors, I think I did maybe one important thing. I set up a factory in Canada because there was a Canadian market which the new factory in Canada would allow us to explore it and I mean, that was probably the first time that TI set up something like that, a factory. And then I went to integrated circuits, became the general manager of integrated circuits and there we started a learning price, a methodical use of the learning curve, learning curve, I think I said learning price or something, learning curve, as an control, as an influencing pricing and as it influences our cost reduction efforts. And this was a pioneer effort in the semiconductor industry. We did it together with the Boston Consulting Group, in fact, they talk about it quite a bit. This was in the, let me think, late 60's, late 60's. And Boston Consulting Group was a very small outfit. When we bid this, when Texas Instruments, and I was the key contact guy that worked with them, they were of course our consultant. And we used it, we used what we worked out with them, loads of data, a lot of theory and a lot of effort put into the practice of the theory and use of the data we had already taken. The result was so called learning curve pricing. And we would automatically reduce the price every quarter. Even when the market did not demand lower price. And this was a very successful effort even though it was somewhat controversial, a lot of people

think that, a lot of people thought that we were being foolish. Why do you reduce price when you didn't have to? You know, but we did that because I believed in it and indeed our market share just kept expanding and we did it of course, that wasn't our only strategy, price reduction, learning curve pricing was not our only strategy. We had other strategies too which were just as important, such as developing new products, developing medium scale integration at that time. And any way, all those strategies combined to make our integrated circuits business, the TI integrated circuits business, the biggest integrated circuit business in the world and the most profitable also. And that was what I then became promoted to the semiconductor business job. So those were, well the semi, I mean, I could go on with the highlights, we were just during that time when I went from integrated circuits to the semiconductor job the IC world was changing. It was changing from bipolar to MOS. And TI was nowhere in the MOS game. I, as the integrated circuits general manager was not responsible of MOS development at all. I was just in charge of the business, of the integrated circuits business, which was 100% almost bipolar. The development of MOS was in another group, but when I took over the TI semiconductor business entirely of course, MOS became increasingly more important. It pretty quickly took over the bipolar integrated circuit world. So I would say the highlight in the time, at least the early highlight during the days of my semiconductor general manager job was to catch up and in fact even surpass our competitors in MOS technology and MOS sales. And we did that mainly through <inaudible 11:15:12> chips and through the DRAMs, the memories and also, not just DRAMs but also PROMs and EPROMs, those products. And those kept me busy for quite a few years. The highlight in my consumer days I have to say was probably one product, the educational product, *Speak & Spell*. That was developed and marketed during the time I was in charge of consumer. It happened to be I think the best product that the TI consumer division ever did.

Patterson: That was during the late 80's early 90's?

Chang: No, no.

Patterson: Around what time?

Chang: It was around 1978.

Patterson: Okay.

Chang: Yeah, okay.

Patterson: I remember looking at the product, of course I wasn't really in the market for it but you had quite an interesting product.

Chang: It teaches spelling to the <inaudible 11:16:36> little kids.

Patterson: Any other highlights?

Chang: I'll be bragging more and more if I kept talking about highlights.

Patterson: 5-4-3-2-1. Talk about TI and the IC, the challenges in manufacturing the device and how people, we already talk about that so, sorry, talk about TI leaders Mark Sheppard and Pat Haggerty, what were they like to work with, how did they shape TI during their 10 years as CEOs?

Chang: This is not here, but I will talk about them, yeah.

Patterson: Okay.

Chang: I think Pat Haggerty was a really, the major figure at TI. It was he that made TI a big successful company. TI was a very small unknown and not all that successful company before him. He was the one that made the key decision of entering the semiconductor business. And the semiconductor business of course became the <inaudible 11:18:10> of TI Mark is a very smart person. And I think that he certainly contributed greatly to TI's success. But then of course, when TI branched out into consumer business and computer business as well, TI started to lose its focus. Now of course TI has been refocused again, so it's a very successful company now again.

Patterson: And of course the company that you still have a fairly close relationship with?

Chang: Yes, very much so.

Patterson: Of course, I don't want to go too much into that but I think TI is probably among your largest customers at this point?

Chang: Yes.

Patterson: Do you think, what do you think has contributed to that relationship, has it been some of the people who you know at TI or has it been more, it's been a less personal sort of—

Chang: It's not personal at all. The people I knew have long since retired I think. Remember you know, I'm way past retirement age, I should say way past normal retirement age myself. And so people that I

knew have long since retired now. So there's nothing, there's no personal relationship but we have established a very good business relationship with Texas Instruments. As we have with many other companies.

Patterson: Certainly. TI produced most of the device manufacturing equipment in house for along time. Can you talk about how and when that turned around and you started buying from outside vendors?

Chang: It didn't turn around during my days as the semiconductor group head. In fact it was one thing that I felt we should not have done, that we should not do and I personally was not in favor of it, but the company. I was not a CEO remember, I was manager of the semiconductor business. But the company at that time decided that, that was what we should do and we continued for a long time to pull a lot of resources into that, when we could have put the resources in more product involvement semiconductor product involvement. I'm sorry Alan but your kind of deviating the parting from the—

Patterson: My apologies, some of these questions apparently were added to the agenda after you were given this so if your not prepared to address some of these questions then I mean—

Chang: Yeah, I know for instance I think you can edit part of this out right?

Patterson: Uh-hum.

Chang: What is this question about Haggerty and Mark, I mean I have only good words to say about Pat. And then Mark I didn't say very many words and all the words I said about Mark were good also I think, so, so that's okay, but I was a little surprised that you raised that question that's all.

Patterson: I'm sorry. I'm sort of the messenger here so I hope you won't shoot me.

Chang: No, it's just that if you raise other questions that I will not answer, I will say that, but I will like that to be edited out of the thing, you know.

Patterson: Absolutely. What opportunities made you leave TI for General Instrument?

Chang: I left TI without any job offer, and I left because I felt that essentially I had been put out in the pasture at TI. I felt sure that I would still continue to have a job, in fact even a job with a good title, but my hope of further advancement at TI was gone. I mean I decided that there was no chance that I would advance further. Actually there was only one step further. It was the CEO, you know. I decided that there was no hope of that, and besides I wasn't doing anything that interested me very much any more.

So that was why I left TI. But immediately after I left, and my resignation was published in the Dallas papers in the electronics trade papers, and in the Wall Street Journal also. Immediately after I resigned I started to get a lot of phone calls, and I pursued three or four of those opportunities, and one of them happened to be General Instrument. It was to be the President and the COO of General Instrument in New York. And at that time General Instrument was a sizeable company, not as big as TI, but it was a sizeable company. It was very definitely in the Fortune 500. I decided that this would be an opportunity for me to manage a sizeable company and accepted that offer. Unfortunately after a year or so at General Instrument I found out it was so different a company from Texas Instruments. Texas Instruments focused on organic growth. Even the branching out to consumer business and to computer business was organic. They just took good people from other businesses, principally semiconductor business, to staff and manage the new business, so even that was organic. Whereas, General Instrument was mainly about acquisitions, mergers, and then after a business became successful, sales of that business, so that General Instrument could acquire new businesses, and remake them, or improve them and sell them again, so.

Patterson: If it's okay with you maybe we could take it to 5:25?

Chang: Of course.

Patterson: So back to General Instrument then. So General Instrument was sort of like a holding company it sounds like.

Chang: Well, it wasn't meant to be holding, and in fact, before I arrived, well, a few years, I mean they changed it only in the few years before I arrived, but when I was being interviewed I did not know that it had become that kind of a company. I mean there's nothing wrong with it being that kind of company, but it was just very different from what I was used at Texas Instruments. So after a year of General Instrument, a little more than a year, I decided to leave again. Again, without another job prospect, but then Taiwan beckoned, and the offer was to be the President of the Industrial Technology Research Institute, ITRI, in Taiwan. And at that time ITRI was a very important institution in Taiwan. It was the largest and the only significant industrial technology research in Taiwan. The Premier who appoints the President of ITRI told me that he particularly wanted to use my ability to transfer technology from just research results to economic benefits for Taiwan industry.

Patterson: The Premier at the time was K.T. Li, is that right?

Chang: No, no, no. He was O.K. Yu. No, not O.K., I'm sorry. H-a...

M1: Yu Kuo-hwa.

Chang: Yeah, Yu Kuo-hwa, yes, uh-huh, yes. K.T. Li, however, was a Minister without portfolio. And K.T. Li turned out to be a very important man in my career in Taiwan, but he was not the Premier. So it was that part of the Premier's appeal that he wanted me to use my abilities to transfer research results into economic gains for Taiwan industry that really appealed to me because I had not been a purely research or technical person for a long time when I took the job there. I took the job in ITRI. But I had always, at Texas Instruments and later for a short while in General Instrument, I always thought of my job as one of transferring on the results to economic gains for the company. So I felt as if I could do this ITRI job also.

Patterson: So you've already gotten into this subject a bit about how and why you ended up coming back to Taiwan, but perhaps you could just explain in a bit more detail, what was it that clenched the decision to move from General Instrument in the United States to Taiwan and ITRI?

Chang: What made me-- again, I left General Instrument without this job offer from Taiwan. Now, why so-- I think you'd rather me talking about why I came to Taiwan.

Patterson: Uh-huh.

Chang: I think it was because it would be a new kind of a career. Rather than being a corporate executive here, this job, the ITRI job, presidency of ITRI would mean serving the whole industry, serving the whole Taiwan industry using the research results of the institute of ITRI to serve the whole Taiwan industry, and try to make money for the whole Taiwan industry with the results of the research in ITRI. This was a completely new kind of a job for me, and also the environment would be completely different. A Taiwanese environment as opposed to the U.S. environment, the kind of people that I would work with would also be very different. So it was the newness that appealed to me, difference, difference from what I had been doing for several decades first in Texas Instruments then in General Instrument. And, I mean, everything seemed to me so different. And by then I was financially pretty secure. I was not rich, but you also you have to realize that the standards of wealth were much lower back in 1985, you know. But still in absolute standards I was financially secure which meant that I could live according to the way I desire, which was actually pretty modest, for the rest of my life without having to earn a living or a salary. So I came to Taiwan at a much reduced level of compensation, but because it was so new, and appeared to be so challenging that I came. And this was why I said that you need to follow your interests not where you think the big money is. Because, obviously, back in 1985 the big money was thought to be in financial venture capital, or maybe even continuing to manage a company in the U.S., but I felt that the Taiwan opportunity appealed to me from the interest point of view.

Patterson: So personal considerations didn't really-- just the fact that your standard of living was changing completely that wasn't really a consideration.

Chang: Well, standard of living didn't change that much because as I said, I was already financially secure. I could live the rest of my life without making any income other than the income that would come from the wealth that I already had. But as it turned out, when you don't chase money, money comes to you. Now, not in the ITRI job, in the ITRI job itself it's just a salaried job. It still is. It was at that time, it is now. But I got a chance of starting up TSMC after I came to Taiwan, and TSMC, obviously, was an opportunity to make some money personally.

Patterson: How much of a gamble was it for Taiwan to enter the semiconductor industry through the RCA Tech Transfer Program, and how much credit do you think the political leaders in Taiwan deserve for that decision?

Chang: Well, the political leaders deserved all the credit for getting the RCA license, but that didn't mean that Taiwan entered the semiconductor industry just by licensing the technology from RCA. All it meant, this license of RCA, all it meant was that Taiwan got the then RCA current technology which was probably a generation behind the leading technology in the U.S. then. Now, after Taiwan got it, a group of people got it, a group of people sent by ITRI, they were there for several months, I think, got it, they brought it back to Taiwan, and they continued to work on it in the laboratory, you know, small scale. It was not the business. It was not the production. And then they licensed the technology from RCA in 1975, and in 1980, which was five years later, they spun off a company. And so that company, of course, used the technology to some extent. And then seven years later, 1987, TSMC was started. And by 1987 the ITRI technology, which was first obtained from RCA, and then worked upon for 12 years now between '75 and '87 for twelve years, in the 12 years they managed to get another generation and a half behind. So by 1987 the ITRI technology was already two and a half generations behind the leading technology. And, I mean, that's understandable because first of all RCA was not a first tier semiconductor company when it licensed its technology to Taiwan, to ITRI. And secondly, without a real commercial base the ITRI people, you know, certainly was limited in improving the technology, in keeping up with the pace that the other companies that are commercial companies, companies like Intel and TI and so on, and they set the pace, and ITRI couldn't keep up with the pace. So when they got the technology it was a generation behind, and when TSMC got the technology in '87 it was already two and a half generations behind the leading level.

Patterson: How did Phillips come into the picture? Was it at the same time as TSMC was spun off, or what sort of a role did Phillips play?

Chang: Phillips played the role as the only willing investor in TSMC, or the only willing significant investor, I should say. Now, I have to go back to the weeks after I arrived and took the presidency of ITRI now. A few weeks after I arrived in Taiwan, and became the President of ITRI, I was called in by Mr. K.T. Lee, whose name you just mentioned. And he said, "Well, we want to promote a semiconductor industry in Taiwan." Of course, they wanted to do that in 1975 also when they licensed the technology. And Mr. Lee told me, "You have a lot of experience managing large semiconductor businesses, so you seem to

be ideal to start a new company in Taiwan in semiconductors. And you come back, tell me and tell the Premier how much money you need etcetera, etcetera. In other words, give us a business plan, you know, in a week or so." So I went back to my office in ITRI and started thinking. And it was during those few days-- actually I didn't have to wait a week. A day or so later he wanted me to go back and make a presentation in four days, I think, not in week. It was during that time when the idea of the pure-play foundry gelled. Now, how did the pure-play foundry come about? I think that was going to be your next question. It was really, I mean, two or three things combined together. First of all, of course, I had read some of Carver Mead's writings. Carver Mead is a prominent researcher. He wrote several important papers. In fact he published a book back in the late '70s, I think, on IC design and architecture, and he made a point that the design part could be separated from the technology. But he didn't advocate the advent of pure-play foundries, but he did make the point which would lead to the conclusion that you could start up a pure-play foundry. But the market really didn't appear to be there for a pure-play foundry. So I had read Carver Mead, so Carver Mead's writings were know to me even when I was at Texas Instruments. But the only trouble is, of course, that there didn't appear to be a stable market for that kind of pure-play foundry. So in other words, one thread of thought as I paused and thought about the task that Mr. K.T. Lee gave to me he wanted me to present a business plan, he wanted me to start a semiconductor company.

Patterson: So we sort of paused here in the pure-play foundry business. You were about to make this presentation to K.T. Lee, so what was it that made you decide to go into the dedicated foundry business at this point?

Chang: Well, I already mentioned the one thread, which was Carver Mead's writings, and so on. And another thread was what I had already observed, closely observed, for three decades. I mean, I had been in the semiconductor business for three decades before I came to Taiwan. And I knew, I learned, at close quarters how competitive the field was, the industry was, and how good some of the players were, companies like Intel, Texas Instruments. Even then the Japanese companies were very fierce also. So I knew how competitive it was, and how difficult it would be to carve out a niche for a new Taiwan company. So that was the second thread of thought. The third thread of thought was I paused to try to examine what we have got in Taiwan. And my conclusion was that very little, you know. What strengths have we got? The conclusion was very little. We had no strength in research and development, or very little anyway. We had no strength in circuit design, product design, IC product design. We had little strength in sales and marketing, and we had almost no strength in intellectual property. The only possible strength that Taiwan had, and even that was a potential one, not an obvious one, was semiconductor manufacturing, wafer manufacturing. And so what kind of company would you create to fit that strength and avoid all the other weaknesses? There was pure-play foundry. So maybe you could call it the least evil choice. The least evil because we've got no strength in all of these and I knew how difficult it was to compete even when you have strengths. It would be impossible to compete when you really had very little strength. But if we chose a pure-play foundry business model then we at least have the manufacturing, potential manufacturing strength that we can lean on. And we also manage to avoid the other weaknesses. We have no strength in design. We have a weakness in design. Well, we don't need design as a pure-play foundry. We've got no strength in sales marketing. Well, sales marketing for

foundries is relatively simpler than sales marketing is for a conventional IBM company. At that time the IBM model was the conventional model. In fact it was the universal model. We got no strength in IP. Well, it turns out, at that time, that process was the part that was least vulnerable to IP attacks from other companies. Most of the IP disputes were about circuit designs. So in choosing the pure-play foundry model I managed to exploit, perhaps, the only strength that Taiwan had, and managed to avoid a lot of the other weaknesses. Now, however, there was one problem with the pure-play foundry model and it was a fatal problem, it could be a fatal problem which was, "Where's the market." Well...

Patterson: The idea really wasn't very well received in the industry at that time.

Chang: No. It was very poorly received. It was very poorly received. Well, people just dismissed it, you know, heck, "What the hell is Taiwan doing? What the hell is Morris Chang doing?" They really didn't think that it was going to go anywhere. There was no market because there was very little fabless industry, almost none. No fabless industry. So who are you going to sell these wafers to? Who are you going to manufacture the wafers for? Of course, the obvious answer was the companies that already existed at that time, the Intels, and TIs, Motorolas, and so on. Now, those companies knew that they would let you manufacture their wafers only when they didn't have the capacity, or when they didn't want to manufacture the stuff themselves anymore. Now, when they didn't have the capacity, and asked you to do the manufacturing, then as soon as they got the capacity they would stop orders to you, so it couldn't be a stable market. And when they didn't want to make the wafers anymore, well, the chance was that, I mean, it was losing money for them. The product was losing money for them. And so what do you want to do? Do you want to take over the loss, you know? And so that wouldn't be a very good market either. So the conclusion at that time, the conventional conclusion was that there was no market. Maybe this idea, this pure-play foundry idea, exploited the only strength you have, which is manufacturing, but there's no market for it. That's why it was so poorly thought of, this idea. What very few people saw, and I can't tell you that I saw the rise of the fabless industry, I only hoped for it. But I probably had better reasons to hope for it than people at Intel, and TI, and Motorola, etcetera because I was now standing outside. When I was at TI and General Instrument I saw a lot of IC designers wanting to leave and set up their own business, but the only thing, or the biggest thing that stopped them from leaving those companies was that they couldn't raise enough money to form their own company. Because at that time it was thought that every company needed manufacturing, needed wafer manufacturing, and that was the most capital intensive part of a semiconductor company, of an IC company. And I saw all those people wanting to leave, but being stopped by the lack of ability to raise a lot of money to build a wafer fab. So I thought that maybe TSMC, a pure-play foundry, could remedy that. And as a result of us being able to remedy that then those designers would successfully form their own companies, and they will become our customers, and they will constitute a stable and growing market for us.

Patterson: Which were some of the fabless companies that gave TSMC its first big start in the business?

Chang: Well, actually the first ones were in Taiwan. They were pretty small though. But excuse me. I think we're getting ahead of the game here. Our first customers were still the big companies, the IBMs except their business was not stable, you know, and it was pretty much leftovers, you know, from them. Now, so the first few years of our start we didn't grow very fast at all. We started to grow fast when the fabless industry really started, and that was about '91, '92. We actually planned our business model in '85, I made my presentation, we start to raise money and so on, and we raised our money in '86, and we did not physically start operation until '87. Between '87 and '91 we depended mainly on the big companies giving us leftovers, and a few small companies, first in Taiwan, and a little later in the United States. And then from '91 on the number of fabless companies just started to mushroom. And you have the history of the Fabless Industry Association that we can look at. I mean, now there are hundreds of, maybe close to a thousand fabless companies in the world now. Most of them, of course, are still in the United States, in Taiwan, but, well, in China alone there are maybe four or five hundred, so my thousand number doesn't even count all of the four or five hundred. And there are a few in Europe, and there's a couple, maybe, in Japan. So now there are about a thousand. But back before '91 the number was in, at most, two digits, you know, less than a hundred, and most of them were struggling. And we, frankly, TSMC, had to mature a little bit before we could serve those fabless customers. So in the first few years after we started, the few fabless that were in business were still going to the Japanese companies for their foundry work.

Patterson: Mainly because of the technology or capacity?

Chang: Technology and trust. You know, that sort of things. And we had to develop the trust of our customers too, but technology, well, technology and trust, yeah, uh-huh. I mean foundry is very important to them. It's the source of their products, and they can't just go on and just trust you immediately. We had to prove it.

Patterson: I think we can skip over these next few questions here. Was there ever a time when it looked like TSMC, or the dedicated foundry idea would not work?

Chang: Oh, yeah, I mean the first few years were not easy, but look, the investors had already put in so much money, and we never had any thought of failing. And in fact we only had two loss years in all our history. We had a loss year in 1987, the first year that we started, and we again had a loss year in...

Patterson: 2000?

Chang: No, no, no. No, we didn't lose money in 2000, 1990, yeah. I mean the first few years were pretty tough, but from '91 on we just grew without looking back. 2000 that you mentioned, that was a tough year for a lot of people, but, yeah, it was a tough year for us too, but we were profitable, 2000, 2001. We have not lost any money, and we don't intend to lose any money from 1991 on.

Patterson: In your view, why has the Taiwan foundry industry been successful?

Chang: Why has the Taiwan...?

Patterson: Foundry industry been so successful?

Chang: Well, when you say, "Why has our foundry industry been so successful," I have to change that. Actually as of two years ago somebody, some analyst made a calculation, we had made TSMC, up to that point, accumulatory, had made 110 percent of the total foundry industries'-- total pure-play foundry industries' profit. That means our profit exceeded all other peoples' loses by 10 percent. Yeah, I guess that's what it meant, yeah. So when you say, "Why is the foundry industry so...," maybe you should change your question to, "Why has TSMC been so successful?"

Patterson: -- the fact that, I think you've mentioned this idea before to when one company sees that another company is successful soon everyone and his brother has a business doing the same thing.

Chang: Yes.

Patterson: So, there is that issue, like you say, I mean, now you have companies in Taiwan and the _____ foundry business and--

Chang: Um-hum.

Patterson: -- the gallium arsenide foundry business so it's like you say, you can't really say that overall the foundry business model has been very successful here in Taiwan.

Chang: That's right. Yeah. Um-hum.

Patterson: On a rather different subject, do you think the Taiwan government should allow its semiconductor technology to be transferred to China?

Chang: I think the Taiwan government should certainly watch what the U.S. government is doing. The U.S. is a signatory of the Larson arrangement, and the Larson arrangement, of course, tends to, the Larson agreement does prohibit is probably the wrong word but high discourage products and technologies that we used for military purposes. And the U.S. government, I think, has been the strictest among all the signatories in prohibiting, preventing the sale of, transfer of any technology that could be

used for military purposes. The U.S. is the strictest. It's stricter than either the European Union or Japan. The other countries, of course, don't count very much because they don't have nearly as much technology as those three countries. So I think that the Taiwan government should observe standards, perhaps, as strict as the U.S. government observes.

Patterson: It still seems like that's rather a gray area, though, because you've got a company like Applied Materials, which wants to sell technology to China, whereas, maybe some other companies are less interested in transferring their technology to China.

Chang: Well, no, actually, you mean other companies in other countries or what?

Patterson: Well, as far as I understand it. I once did a story on a subject in, you know, and you've got Tokyo Electron, you've got ASM, those companies are interested in selling their equipment to China. Whereas, Applied Materials in the United States sort of has its hands tied by the Larson agreement.

Chang: Yeah, um-hum, right.

Patterson: So--

Chang: So you're saying that maybe the U.S. should loosen up also. Well, recently I think they have.

Patterson: Um-hum.

Chang: Recently they have.

Patterson: Um-hum.

Chang: Recently they have a new kind of arrangement now. So, for instance, Intel's plan for building a factory in Dalian, China would, the 90 nanometers technology. In fact, I think that by the time they build the Dalian plant, by the time they produce in the Dalian plant, I think that technology, the use may be more advanced than 90 nanometers. So, you know, that alone I think shows that the U.S. has loosened up on that also.

Patterson: Um-hum. Would you characterize that as sort of a crack in the dike and the dike is now breaking, or--

Chang: Whose dike? The U.S. dike, or?

Patterson: Yeah, sort of the U.S. dike.

Chang: The U.S., oh, I think that with the Intel, with the permission they have given to Intel, and also with the permission they have given to the equipment manufacturers to ship more advanced equipment to China now, I think, yeah, the dike has broken, you know. But there's still a dike, but it's now lower. It's now weaker and lower than it was before.

Patterson: Do you foresee a day when, this is a rather big picture question, but do you think Taiwan is ever going to ease regulations that it has on transferring technology to China?

Chang: Well, I'm certainly going to strongly urge Taiwan to be not any more strict than the U.S. Yes.

Patterson: Okay. And, also, one final rather big picture question here, how would you contrast American and Asian engineering styles?

Chang: I think the Asian engineers tend to be more methodical, they tend to be more studious, more orderly engineers; whereas, the U.S. engineers tend to be more innovative, but they tend not to be as methodical and orderly as the Asian engineers.

Patterson: Do you think it's, is there some sort of a, are those two types of engineers mutually exclusive, or do you think that it's possible to have an engineer who's very studious and diligent but who is also quite creative?

Chang: Oh, yes, very much so. But what I said was just the norm let's say.

Patterson: Um-hum.

Chang: I mean, there are obviously many exceptions to the norm. I mean, in the U.S. you also find the Asian type of engineers, you know, methodical, orderly but not very innovative. And, by the same token, in Asia you find many innovative engineers too. But the norm, as I see the norm, is as I described it for Asia and for the U.S. But you said, well, certainly those two categories of abilities are not exclusive to each other. You can have the same two; you can have them at the same time in one person. On the other hand, I also think that one group can accompany another group, you know. You can have an innovative group but not so methodical and so on, and then you can have a methodical group maybe not very innovative accompanying each other.

Patterson: Yeah. It certainly is a dynamic industry. You look at what Japan did with the DRAM industry and that would be sort of very methodical push which took away the DRAM business from Intel, but Intel kept, it sort of pushed Intel on to doing more innovative _____.

Chang: Yeah, um-hum. Right.

Patterson: Okay. That's it.

Chang: All right. Okay.

Patterson: Thank you so much.

Chang: I'm sorry that, you know, we ran so late.

Patterson: I know you're busy so I really do appreciate you taking the time.

Chang: Well, thank you for coming over and doing this. Yeah.

Patterson: I'm very happy to.

END OF INTERVIEW