The Brookings Institution and Center for Strategic and International Studies

Vying for Talent Podcast

"Can semiconductor manufacturing return to the US?"

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Guest:

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Episode Summary:

In the first episode of "Vying for Talent," Morris Chang, the founder of the Taiwan Semiconductor Manufacturing Company (TSMC) shares the story of his journey in establishing the world's largest producer of semiconductor chips. In discussion with hosts Ryan Hass and Jude Blanchette, Dr. Chang offers insight on the importance of the cultivation of technology talent and the future for semiconductor manufacturing returning to the United States.

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SEC. GINA RAIMONDO: *"Your entire life runs on semiconductors."*

SEN. CHUCK SCHUMER: *"The chip shortage has raised the prices of cars, of appliances, of iPhones."*

PRES. JOSEPH BIDEN: *"Today we barely produce 10 percent of the computer chips, despite being the leader in chip design and research. And we don't have the ability to make the most advanced chips now—right now."*

BLANCHETTE: Semiconductors, or chips, are key components of nearly every electronic device we use, from computers and smartphones to cars and fighter jets. Yet since the onset of the COVID-19 pandemic, a massive global chip shortage has focused public attention on the semiconductor industry. You may have heard of the Chips Act, which includes $1.2 billion in incentives for the semiconductor industry here in the United States, or Intel's $20 billion plan to build new chip factories in Arizona. Both moves designed to reassure semiconductor production. But as the U.S. tries to rebuild this industry, the big question is whether the U.S. has the necessary talent to achieve its ambitions.

Hi, my name is Jude Blanchette from the Center for Strategic and International Studies.

HASS: And I'm Ryan Hass from the Brookings Institution, and we are co-hosts of Vying for Talent, a podcast exploring the role of human talent in the unfolding competition between the United States and China. In today's show, we will be looking at how America's human talent profile will allow the United States to compete at the cutting edge of innovation. We're delighted that we have Morris Chang, the founder of Taiwan Semiconductor Manufacturing Company with us. TSMC is the world's largest and most advanced producer of semiconductor chips. TSMC also provides financial support to Brookings. Chang is the living embodiment of the role that human talent can play in impacting the national fortunes and global competitiveness of countries. He went from being a war refugee in Hong Kong to a student in the United States to a global titan of industry today. He has an incredible life story that we will hear about. He also has sharp insights into how the talent pool in the United States has changed over recent decades.

BLANCHETTE: We're really thrilled to have Dr. Chang as our first guest on the Vying for Talent podcast, as Ryan said, there's really no better guest to understand the nexus of human capital and the future of competition for talent and technology. So, without further ado, let's get to the discussion.

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HASS: Dr. Morris Chang, it's wonderful to be with you, thank you for joining us. I'd like to start at the start of your life in understanding where you grew up. What did you want to be when you grew up? You're famous now for being the founder of Taiwan Semiconductor Manufacturing Company, but was that your ambition all along?

CHANG: No, no, hardly, hardly. Well, I was born in Ningbo, which is a pretty big city in China now, and all of this was before the Communists took over China. I was born in 1931 in Ningbo, and I spent my primary school years in Hong Kong, all six of my elementary school primary school years in Hong Kong. And in fact, Pearl Harbor happened when I was in the sixth grade. Of course, the Japanese attacked Hong Kong at about the same time they attacked Pearl Harbor. And we, my parents and I, lived in Hong Kong for another year after the Japanese occupied Hong Kong.

And then we went to Chongqing. At that time, it was called Chungking and now it's called Chongqing, which was then the wartime capital of Free China. And I spent my junior high years in Chongqing.

And then victory was won, the Second World War was over. And that was 1945. And we moved from Chongqing to Shanghai. And I went to high school in Shanghai, actually, and I graduated from high school in 1948. And actually, I went to college in Shanghai for a few months. By then it was obvious that the Communists were going to take over Shanghai, so we fled again, this time to Hong Kong, back to Hong Kong. My boyhood years. And I spent half a year in Hong Kong in 1949. The half year was mainly spent on applying for college in the U.S. and also getting passport and visa and so on. So, that was my youth, that was my boyhood. From 1931 to 1949 I was in the mainland.

BLANCHETTE: So, can I ask about your decision to go to the United States for college? I know you had originally gone to Harvard and then chose to transfer. What was behind the original decision to go to the United States to study? And what caused you to decide that there was some better place to be than Harvard?

CHANG: Actually, there's hardly any better place than Harvard, I would say. Now, it was really not a choice or not a deliberate choice. I really wasn't free to make that deliberate choice, either. As I said, I went to college in Shanghai for a few months and actually I studied banking. My major was banking. Of course, I was only a freshman in the Shanghai college. And the main reason was that my father was in banking. I did have an interest, it was writing—either a writer, a novelist, or a journalist, that kind of writing. But this was 1948 in China, and writers don't really make very much money. They don't really make very much salary. So, my father said, if you don't want to starve, you had better do something else, you had better learn something else. And since I'm in banking, well, why don't you study banking also? Maybe I can even help you a little bit.

That was in Shanghai. That was before the Communists were coming. Then we went to Hong Kong, as I said, we were sort of refugees in Hong Kong. And Hong Kong had only one college back then in 1949. And that was the University of Hong Kong. And it was really not a very, very good college back in that time.

So, to go to college at all, I would have to go somewhere other than Hong Kong, and China was not a choice anymore. I'm sure you know that there was literally chaos in China for 20 or 30 years after the Communists occupied China. So, the U.S. was the haven. And this was a few years after the Second World War and the U.S. was at its prime and everybody wanted to go to the U.S. Now, I, of course, as a refugee, I also wanted to go to the U.S. So that was how I went to the U.S. in 1949.

HASS: You got to Harvard, you seem to have transitioned from your ambition to be a writer to engineering. How did you make that transition and what did you expect studying engineering would lead to?

CHANG: Well, I spent only one year at Harvard. And in my autobiography, I said that it was the most enjoyable year in my life up to that point, anyway. But then my uncle pointed out to me that Harvard undergraduate was basically a general education curriculum, and it would be hard, particularly for a foreigner like me, to get a good job after just four years of general education. In fact, even when I was a freshman at Harvard, when everybody, as the young people normally did back then, asked each other, "What's your interest? What do you want to do in your life, et cetera?" And everybody in my freshman dormitory at the Harvard Yard, every one of my fellow students that was asked had a different answer: Literature or teaching or diplomacy, music, and so on. And I said "engineering." And, well, everybody was surprised. Why are you not at M.I.T.?

And then a year later, I listened to my uncle who told me that you probably need to have some specialty to get a good job, particularly as a foreigner. So, I transferred to M.I.T. As far as mechanical engineering is concerned, I really at that time did not know too much the difference between the engineering disciplines—mechanical, electrical, civil, metallurgical. I did not know, I did not really understand the differences between those different disciplines. Mechanical engineering just sounded pretty general to me. Machines were used everywhere, so. So, I said, why don't I go to mechanical engineering? So that was basically the background of my Harvard-M.I.T. mechanical engineering transition.

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BLANCHETTE: After you finished your studies at MIT, you moved over to Texas Instruments, and they sponsored your further graduate studies. You went to Stanford and finished your Ph.D. in what looks like a record time of two-and-a-half years, if I'm correct. I wanted to ask about that experience at Texas Instruments. You were there for several decades, rose very high in the ranks at the company, ultimately left. I read in an interview you said you'd been quote "put out to pasture." But I wanted to ask about that experience that at TI, how formative was that for your subsequent career and founding of TSMC? And what was the how did you get put out to pasture?

CHANG: First of all, the TI years were indeed very formative. To me, they were crucial. Without my TI years, I would not have founded TSMC. And I did rise to a very high position at TI. I became the group vice president that was in charge of TI's worldwide semiconductor business. I was exactly actually two levels below the CEO. There was a CEO, and there was a COO, and then I was below the COO. But I was the third highest paid person at Texas Instruments for a number of years while I was in charge of their worldwide semiconductor business.

Now, how was I put out to pasture? Well, TI missed its way, in my opinion, by entering the consumer products business. And the consumer product TI actually started with were calculators, and then digital watches, and then home computers. And all those things frankly had relatively little value added. TI actually lost a lot of money in those consumer products. And not only did TI lose a lot of money in those consumer products, the semiconductor business of TI had to serve TI's consumer business. So, the semiconductor business was losing ground also competitively.

Well, anyway, under those circumstances, my career in TI was in jeopardy. And so they transferred me to the new group, the consumer products group. In fact, I was in the semiconductor business for about 20 years from the time I started to the time I was transferred to be the head of the consumer products group. And that was pasture as far as I was concerned. Well, I stayed there for another five years or so in the hope that maybe there will be a reversal of fortune for me, but there wasn't after five years. And that was when I decided to quit. I was only 52 years old at that time when I quit.

After I left TI, there were a lot of offers. The one I accepted, and that was 1983, the one I accepted was General Instruments, the presidency of General Instruments in New York, New York City. And actually, it was a very different life, a very different job than the one I had at TI. The good part about it was that I realized part of my youthful dream when I first arrived in the U.S., and that dream was to live in a good apartment in New York and walk a few blocks to my office.

Well, I did that as the president of General Instruments. I lived in Trump Tower. And in fact, I met Mr. Trump a couple of times in the elevator during that time. I lived in Trump Tower, and every morning I only had to walk three or four blocks to the General Motors building where General Instrument's offices were.

But General Instruments was a very different company from Texas Instruments. And I found that out only after staying a year in General Instruments. At Texas Instruments, I learned how to build a company from the ground up. But General Instruments did not want to do that. General Instruments was basically a buyer and seller. They bought small companies, small businesses, and then they improved the small businesses, and then sold them. So, after about a year at General Instruments, I found out that wasn't what I wanted to do. So, I quit there also. And that was 1985.

HASS: So, Doctor Chang, take us from Trump Tower to Taiwan. How did you make that transition?

CHANG: Yeah, well, I had established some connections with Taiwan while I was at Texas Instruments. I was the head of worldwide semiconductor business at Texas Instruments. And in that capacity, I started an assembly and test plant in Taiwan. And I got to know a few Taiwan government officials, principally K.T. Li.

HASS: K.T. Lee was a Taiwan economist and politician known as the father of Taiwan's economic miracle and the godfather of technology in Taiwan.

CHANG: I knew him while I was setting up the TI assembly and test factory in Taiwan. We remained in touch for a number of years while I was with TI and then with GI, General Instruments. And then when I quit GI, of course both my resignation at TI and my resignation at GI were widely reported in Wall Street Journal and the New York Times. And so, when Mr. Li and a few other people and a few other government officials in Taiwan saw that, they decided to recruit me, and I was recruited. This was 1985.

BLANCHETTE: I wonder if you can talk to us a bit about what Taiwan's technology scene was like in the 1980s when you arrived there? Can you just give us a snapshot of how advanced it was, what other players were out there in the market?

CHANG: Well, basically, it was monitors as far as technology industry was concerned. Taiwan had a number of monitors companies and a number of PC companies. Now, Taiwan at that time, or even now actually, had an Industrial Technology Research Institute, I-T-R-I, "ittrie." I was recruited to be the head of the Institute, and that Institute had the mission of leading Taiwan's industry into a more progressive era.

Now in that Institute, there was a major scale integrated circuits project involving hundreds of engineers. But they had a still rather limited budget, and they were not under any competitive pressure. And therefore, even as they worked very hard every year, they kept falling behind more and more when compared with the real companies that were doing semiconductors, companies like Texas Instruments or Intel or Motorola at that time in the United States. And in Japan there were quite a few Japanese companies that were quite successful.

So, after I was recruited to be the president of ITRI, my main mission for the next two or three years was to get this IC integrated circuits project out of the Institute and make a business out of it. And that was how TSMC came in to being.

HASS: So TSMC has grown to become the world's largest and most advanced semiconductor foundry. Why? Why has it outperformed all of its competitors?

CHANG: Well, first, it was its business model, it was a very innovative business model, and I innovated it. Now, first, let me explain what I mean by business model. It's not about business model of a company. It's not about its products. It's about who its customers are. And it's about how this company plans to make money. Now, all along, in Taiwan and elsewhere in the world, people think of the Taiwan IC activity as really a backward thing, completely uncompetitive with the leading semiconductor companies in the world. But the business model of a pure-play foundry, which TSMC became, really turned the semiconductor business on its head.

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BLANCHETTE: A brief interjection here to explain some technical jargon. Dr. Chang just referenced a pure-play foundry. Pure play here refers to a semiconductor company that does not produce its own designs, but instead operates a foundry, or a fab, focused on producing chips for other companies.

There are a few other terms you're going to hear throughout the rest of the interview that may be unfamiliar. The first is a node which refers to the newest generation in chip manufacturing, enabling more efficient and better performing chips. You'll also hear Dr. Chang referred to a yield or a device yield. This is simply the number of working chips or dies on a wafer. Finally, Dr. Chang was referring to the IC. This is just short for integrated circuits, which is another fancy word just for chips.

[music]

CHANG: Now, TSMC as a pure-play foundry with its new business model, we did not compete with the other semiconductor companies. We did not compete with Intel, we did not compete with TI. We became their suppliers; they were our customers. Suddenly, we formed a new company when everybody expected that this new company to be a weak competitor—well, they found this new company, TSMC, to be a strong supplier. And also, of course, I had advantage of knowing my semiconductor colleagues very well. As I said, I almost grew up at TI, and actually while I was growing up at TI, the founders of Intel were my contemporaries. We went to technical meetings together, we drank beer together, we sang songs together, et cetera. And likewise, with quite a few other semiconductor company CEOs. And so, they became my customers.

Now, I also skipped over the weakness of the ITRI IC project. There were actually two weaknesses. One weakness was that they were behind in the technology node.

For instance, we are now in three nanometers, three nanometer node. And Intel got into trouble because they were late in their 10-nanometer node. And they haven't caught up yet. So, node became smaller and smaller as years went by and that showed improvement in technology.

Anyway, at any rate, TSMC when it started it was behind in technology nodes. But as we wanted to grow and as we wanted to make money, we worked very hard on improving the nodes. And we suddenly had more budget, and we could attract more talents to improve our nodes more than ITRI could in their fixed budget project. One weakness was that that Taiwan was behind in nodes. And the other weakness was that Taiwan did not have IC semiconductor design at all.

But there was one big strength: that is, while our nodes were behind, our yield was very good. Taiwan yield was very good.

So, by being a foundry, we kind of skipped over the weaknesses and used our strength. A foundry did not need design strengths. The customers do the design and just let the foundry manufacture.

While the lack of advanced nodes technology is a shortcoming for a foundry, there is a lot of foundry business on the mature nodes still. Well, everybody still wanted our products, and TI and Intel and Motorola, they were so busy trying to advance their nodes that they really didn't care about the mature nodes, but they still sold a lot of mature nodes products. And if somebody, if a foundry was willing to build mature nodes for them at a advantageous cost to them, then they'd be very happy to let this foundry do the mature nodes. And TSMC fulfilled that role.

BLANCHETTE: One of the other factors in TSMC's success that I've heard you speak about frequently is the talent pool that the company was able to draw on: engineers, technicians, factory workers. Taiwan has a population of 23 million. It's quite surprising it was able to produce so much talent. How do you think Taiwan was, and with TSMC, able to develop and concentrate such a such a massive amount of talent in such a small population?

CHANG: Well, 23 million, it's not exactly very small population. Even today, TSMC has only 50,000 employees in Taiwan. It has a few thousand in other countries. But in Taiwan, yeah, there's only 50,000.

Now I started in the semiconductor industry in 1955. Now, in the '50s and '60s, and the very early part of the '70s, the U.S. was very strong in manufacturing talents. Now, in a speech that I made in Taiwan about a year ago, I said Taiwan had certain competitive strengths in semiconductor manufacturing, and those strengths mainly almost entirely were people related, talent related. Now, the U.S. in the '50s, '60s and the early part of '70s also had these strengths. But then, of course, talents usually migrated to higher profit occupations. And so, the manufacturing talents in the U.S. started to migrate to design aspects, design profession if they stay in the industry.

Of course, a lot of them went into the finance industry. And 1980 was actually the watermark, the dividing line, when banks started to be deregulated and so on in the '70s, then after 1980 a lot of young talents went into the finance industry. You could just tell from where the business school graduates went. They used to go to big industrial companies, the GEs, the IBMs, and so on. Some of them used to go there. But now the big companies couldn't attract very many business school graduates. Business school graduates went to either consulting houses or to Wall Street.

Anyway, my point is that back in the ‘50s, ‘60s, and the early part of the ‘70s, the U.S. had these manufacturing talents too. But then starting in the ‘70s, the manufacturing talents migrated to higher paying professions—design, if they stay in the semiconductor industry and otherwise, or they migrate to other internet industry and the finance industry. And I really think that’s a good thing, it’s not a bad thing at all.

JACKIE NORTHAM, NPR: *“There was great excitement recently at the State Department after the Taiwan Semiconductor Manufacturing Company, TSMC for short, announced it would build a $12 billion computer chip facility in Arizona. State Department spokesperson Morgan Ortagus.*

MORGAN ORTAGUS: *“The TSMC deal is a game changer for the U.S. semiconductor industry that will bolster American national security and our economic prosperity.”*

HASS: So even in spite of the transition of top talent to these other sectors, TSMC has decided to invest in a $12 billion foundry that is under construction outside of Phoenix. You’ve made headlines in the past talking about the challenges that the United States may have developing a semiconductor supply chain of its own that is competitive with those in Taiwan and in Asia. What do you see as some of America’s top limitations in its ability to ramp up domestic semiconductor production right now?

CHANG: There’s a lack of manufacturing talents to begin with. I don’t really think it’s a bad thing for the United States, actually, but it’s a bad thing for trying to do semiconductor manufacturing in the U.S. We have actually had a manufacturing plant in Oregon for 25 years—and 25 years, that’s a long time. And we send all kinds of people, we change the managers, change the engineers, we use both America, local engineers, we also send engineers from Taiwan to Oregon to try to improve the performance. But improvement in its performance has happened.

However, the cost difference between Taiwan manufacturing and Oregon manufacturing has remained about the same. The same product, the Oregon cost, is about 50 percent more than the Taiwan cost. Well, of course for us, the Oregon product is still profitable, although not nearly as profitable as the Taiwan product. So still we have maintained it. We started it in 1997. Initially it was chaos, it was just a series of ugly surprises because when we first went in, we really expected the costs to be comparable to Taiwan. And that was extremely naive. But after a few years of trying to make it work, we had to settle down, we had to accept it. And since it was still profitable, of course, we still accepted it, but we didn’t expand it. That was Oregon. We still have about a thousand workers in that factory, and that factory, they cost us about 50 percent more than Taiwan costs.

Now, Arizona: that will be a bigger scale venture, a bigger scale manufacturing than the one in Oregon, much more advanced technology, et cetera. And of course, we did it at the urging of the U.S. government, and we felt that we should do it. Basically, I was already retired at that time the decision was made. So, the decision was made by the current chairman.

But anyway, we think that the recent effort of the U.S. to increase onshore manufacturing of semiconductors, right now you’re talking about spending only tens of billions of dollars of money of subsidy. Well, it’s not going to be enough. I think it will be a very expensive exercise in futility. The U.S. will increase onshore manufacturing of semiconductors somewhat. But all of that will be very high-cost increase, high unit cost. It will be noncompetitive in the world markets where you compete with factories like TSMC.

Right now, I think the U.S. has a very good position in semiconductor technology—design, the U.S. has got most of the design capability in the world, the best design capability in the world. Taiwan has only a little, TSMC has none. But there are a few companies in Taiwan that also do design, but they are not nearly as advanced as some of the US companies.

Now, of course, there are people who point out that maybe Taiwan is not safe. Now, that's of course another topic. Now, I'm assuming that there will not be any war. Frankly, if there is a war in Taiwan Strait, then I think the United States will have more than chips to worry about. Now, if there's no war, then I think the effort to increase onshore manufacturing of semiconductors is a wasteful and expensive exercise in futility, if there's no war. If there is war then, my goodness, we all have a lot more than just chips to worry about.

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HASS: Dr. Chang, we want to let you go, but before we do have one last question that we would like to pose to you. The United States and Taiwan are close friends and partners, share many common values and interests. Is there anything more that the United States and Taiwan should be doing together to pool resources to strengthen the human talent that exists in both of our economies?

CHANG: Now, I think this gets into politics, and I do not want to be involved in that topic. Actually, of course, it's pretty delicate. I hope that everybody remains friends. In fact, that's how TSMC prospered, by being a semiconductor supplier to everybody, I mean everybody.

HASS: And do you think that that will be tenable going forward? Will TSMC be able to continue to straddle these geopolitical divides and be able to service clients, including in Mainland China?

CHANG: No. But I hope it will change. Right now, we are already under embargo orders to Haowei. We have been for more than a year now, TSMC has been for more than a year now. And so those good days when we can serve everybody in the world, those good days are gone. I just hope that they don't get any worse.

HASS: We're very grateful for the wisdom that that you've shared with us, your experiences, your insights. It's been a really rich conversation, and I thank you for your time.

CHANG: Well, thank you. Thank you, Ryan, thank you, Jude, it has been a pleasure.

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BLANCHETTE: Ryan, I thought that was a great conversation. I thought Dr. Chang brought up a number of points I hadn't expected him to and also emphasize some of the initial conclusions you and I had come to when we when we thought about starting this podcast, what did you think?

HASS: Yeah, I just as I was listening to Morris Chang, I couldn't help but come to the conclusion that he is the living embodiment of what it means to have America benefit from brain gain, from being able to attract the best ideas and the brightest minds to want to come to our shore. Our country was strengthened by him, and I really hope that we're able to attract the next generation and the generation after that of Morris Changs—people who have big ideas, big dreams, and big talent that they want to apply here.

BLANCHETTE: The thing that stuck out to me was it was as much an ecosystem that helped propel his individual talent forward. So, the end the brain and the talent that the human has and are able to develop is the necessary condition. But if you want to get it the full way you saw in his own personal journey, it was access to the best higher education in the world here in the United States: Harvard, MIT, Stanford. When he went back to Taiwan, it was a supportive government that understood the importance of intentionally developing technologies. So, he was clearly in an ecosystem there in Taiwan which understood the benefit of investment.

And then, of course, there's a strong private sector role as well, both in terms of his formative experience at Texas instrument, but then his own ability to create, start, and make TSMC the leader in in semiconductor. So, it's that sort of iron triangle of education, private sector, and government that came together here. And I think there's a valuable lesson for thinking what the United States can do to better capture and cultivate talent.

HASS: I think that's exactly right, Jude. Another thing that really struck me as we were listening to Dr. Chang share his views was his faith in the value of efficient markets. This idea that it's okay to have goods produced in areas where they're most efficient to be produced, and that government subsidies can be an expensive exercise in futility, I think, were his words. It'll be interesting to see, you know, as we go forward, there's a lot of pressure against globalization these days to see if global value chains, and that's that efficient allocation of capital labor, will continue to be the driving force of global commerce.

BLANCHETTE: Yeah, absolutely, I think that was an important and one of the unexpected comments that he made and certainly goes against the grain here where industrial policy is the idea that seems to be winning out. So, look forward to future discussions where we can explore this in more detail.

HASS: And to our audience, please join us for the next installment of the series one month from now. And for more information about this project, please check out our website at Brookings Dot Edu Slash Vying for talent.

BLANCHETTE: I'm Jude Blanchette at the Center for Strategic and International Studies.

HASS: And I'm Ryan Hass at the Brookings Institution. Vying for Talent as a co-production of the Brookings Institution and the Center for Strategic and International Studies, and is brought to you by the Brookings Podcast Network. Learn more at Brookings Dot Edu Slash Podcasts and follow us on Twitter at PolicyPodcasts. Send feedback to Podcasts at Brookings Dot Edu.

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