

Craftsmanship Similar to Wajima-nuri: Trust between Japan and the U.S. in Semiconductor Manufacturing

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Exploring Fault Lines: The Footsteps of the United States, Part 4 (3)

Since the end of the Cold War, the world has been in the throes of globalization, and companies have pursued economic growth on the premise of improving the efficiency of their supply chains. While enormous wealth has been created, widening disparities and the weakening of local communities have weakened democracy. The crisis brought about by the new Coronavirus signals a turning point in our times. However, protectionism confined to one country is not the answer. The "Post-Corona" world is a combination of a turbulent market and an increasingly controlled state. In this five-part series, we visit people who are searching for a way forward in the "fault lines" of the turbulent supply chain in the high tech semiconductor

Near the Minneapolis-St. Paul International Airport in the U.S. state of Minnesota, a few minutes' drive from SkyWater Technology's semiconductor fab will bring you to another fab – Polar Semiconductor LLC.



An OMRON robot carrying wafers moves around with clean-wearing workers at the semiconductor manufacturing plant of Polar Semiconductor, a subsidiary of Sanken Electric Co. in the U.S. (Photo: Naoatsu Aoyama, Bloomington, Minnesota, U.S.A., May 26)

The two factories have the same origins, but they have taken completely different paths in the rough seas of globalization. While SkyWater had the advantage of being a “fully U.S.-capitalized fab,” the other factory i.e. Polar Semiconductor is owned by Sanken Electric (a Japanese company).

The plant is operated by Polar Semiconductor, which was acquired in 2005 by Sanken Electric (Niiza City, Saitama Prefecture, TSE1st), a major manufacturer of power semiconductors and devices for power control. The plant is located near the MSP international airport and the Mississippi River, and has access to water and transportation, which are essential for the semiconductor industry.



The factory we visited during our interview in Minnesota.

The first thing we encountered upon entering the entrance of the Polar Semiconductor Fab was a place to change shoes into clean building shoes or covers, similar to a school entrance in Japan. In order to maintain a clean environment in the fab, all employees change their shoes in the shoe rack, but this is not common in semiconductor factories in the US.

When entering the production area of a building, the entire body should be covered with clean clothes, safety glasses, and a head cover (called a bunny suit). There is a detailed procedure for covering the sneakers on the jacket with a cover.

The company has been producing at full capacity to cope with the global shortage of semiconductors, which has worsened under the Covid19 pandemic. Rajesh Appat, 43, Vice President in charge of Technology and Business development, said, "It is difficult to increase production of semiconductors overnight, and we have been increasing our capacity utilization rate from about 75% in January to 90-95% in May. Now, in May, it's 90-95%, and the engine is almost running at full throttle."



Rajesh Appat, Vice President of Technology and Business development at Polar Semiconductor, Bloomington, Minnesota, U.S.A., May 26 (photo by Naoatsu Aoyama)

The white-colored factory, with its employees in white bunny suits coming and going, is like the inside of a spaceship. In the orderly factory, OMRON's industrial robots carrying wafers are moving around, "cooperating" with human workers and working efficiently.

The Corona disaster caused a major upheaval in the semiconductor industry, which is linked by supply chains around the world. The U.S. suffered the worst economic crisis since the end of World War II. The U.S. was hit by the worst economic crisis since the end of World War II, and the unemployment rate hit 14.8% in April last year. With factories either slowing or shutting down and the prospect of a prolonged decline in demand, automobile and auto parts manufacturers cut back on orders. On the other hand, demand for video games and personal computers grew due to nest egg demand, and manufacturers shifted their production to meet this demand.

However, since the second half of last year, demand for automobiles has been recovering beyond expectations. In March this year, a fire at the plant of Renesas Electronics, a major semiconductor manufacturer in Japan, combined with other factors to exacerbate the global shortage of semiconductors. The trade conflict between the U.S. and China and the water shortage caused by the

record drought in Taiwan have also heightened concerns about supply risks. According to Goldman Sachs, by the end of April, about 170 industries had been hit by the semiconductor shortage.



Inside the semiconductor manufacturing plant of Polar Semiconductor, a subsidiary of Sanken Electric.

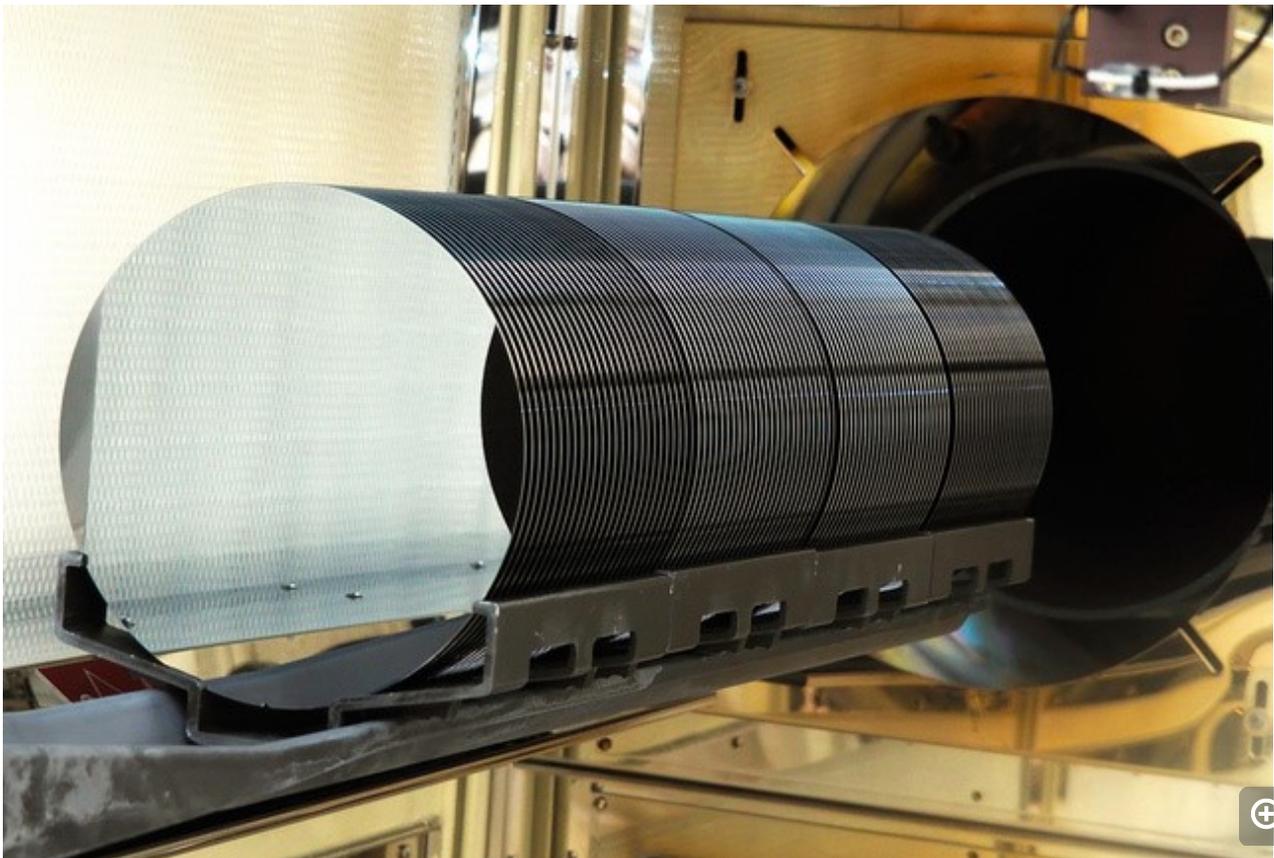
The mainstream of Polar’s semiconductors are used for automotive applications. Mr. Appat said, “When the Corona disaster hit, we were running at about 70% capacity until mid 2020. [But even in the worst period last year] we did not lay off anyone. Not a single person was laid off.” We wanted to give everyone the financial security, and our thinking was “Don’t worry about your job. Your jobs are safe.” We wanted to take care of people’s philosophical needs first. They have other things to worry about – COVID, well-being, health and all that.”

In the wake of the Corona disaster, many U.S. companies decided to lay off workers temporarily, resulting in a continuing employment crisis with 10 million unemployed. There are both advantages and disadvantages to the U.S. way of doing things, which makes it easy for human resources to move with the rise and fall of industries and for companies to lay off workers. However, Polar has been able to cope with the increase in production this year as a result of retaining an “excess” workforce in the short term.

Looking at the employment-oriented culture, the “wafer boxes,” and the literally “particle-free” factories, it seems as if the Japanese style of “monozukuri” has been directly transplanted. However,

Yoshihiro (Zen) Suzuki, 63, is a director of Sanken Corporation and has been involved in the U.S. business for a long time and is a member of the Board of Directors of Sanken (and also Polar), did not aim for such a direction. Rather, he spent his days in trial and error learning from the failures of his transplant.

The two “sibling” factories, Polar and Skywater, which are now split between Japan and the U.S., both trace their origins back to Control Data, a U.S. computer company that once built an era in Minnesota. During World War II, the company was led by William Norris, who was in charge of developing equipment to decipher Japanese and German codes for the U.S. Navy, and at one time was in a fierce competition with IBM.



Wafers are laid out in the middle of a process at the semiconductor manufacturing plant of Polar Semiconductor, a subsidiary of Sanken Electric Corporation (May 26, Bloomington, Minnesota, U.S.; photo by Naohiro Aoyama)

Sanken was also established by Tetsuji Kotani, an engineer who yearned for the future of the semiconductor industry, taking over the laboratory that was dissolved after the war. In 1958, Tetsuji Kotani visited Bell Laboratories in the U.S., and received a “revelation-like suggestion” on how to manufacture silicon rectifiers, which would become the company’s main product, and gained a foothold for the future growth of Sanken. The semiconductor industries in Japan and the U.S. have had a strong influence on each other, and have expanded their networks of human resources and supply networks.

In 1990, Sanken acquired the semiconductor division of a U.S. business partner and established a U.S. subsidiary, Allegro Microsystems. There were strong expectations that mergers and acquisitions

(M&A's) of technologically advanced U.S. companies would enable the company to ride the wave of globalization after the end of the Cold War and expand its business. However, they were unable to fully grasp the actual state of Allegro's management and fell into a vicious cycle of growing distrust between Japan and the U.S., resulting in continued poor management in the 1990s.

In November 1999, Sanken sent Suzuki, who was in his 40's at the time, and four others, who had gained experience as engineers at a plant in Yamagata Prefecture, to Japan, taking the reconstruction of Allegro as a matter of life and death. At the plant, the American executives continued to rebel against the plant management methods and sales plans that were unilaterally given to them by Japan. Suzuki thought that it was necessary to have a frank discussion with the American employees about the future vision of the company.



An OMRON robot carrying wafers moves around with clean-wearing workers at the semiconductor manufacturing plant of Polar Semiconductor, a subsidiary of Sanken Electric Co. in the U.S. (Photo: Naoatsu Aoyama, Bloomington, Minnesota, U.S.A., May 26)

“At the time, there were still tensions between Japan and the U.S. due to trade frictions, and many people didn't take me seriously because they thought I was a young Japanese man. But as I talked to them about my dream, saying, 'I want to make this company better together,' some of them began to understand.”

Suzuki realized that once Americans were convinced, they would move forward with their own creativity and ingenuity. While adopting the good points of the American way, such as the personnel policy of “trust, honor, and punishment,” he also tried to promote improvements at the production

site through the ingenuity of Americans. The wafer box is said to be a result of a series of American ingenuities, such as slanting the top of the box to prevent dust from accumulating.

Having gained a good response to the recovery of Allegro's business performance, Sanken acquired Polar, which had been Allegro's contract manufacturing partner, in July 2005. Suzuki's expertise in human resource management and production sites, which he had cultivated in the United States, was also utilized in the process of integrating Polar.

What strongly impressed me during my visit to the plant was the high quality and diversity of human resources that the openness of the United States attracts. Surya Iyer (52), Vice President of Manufacturing (Plant Manager), is originally from India like Appat. After graduating from the Indian Institute of Technology, one of India's top universities, which has produced Google CEO Sundar Pichai and others, he received his doctorate from Washington University in St. Louis. D. from Washington University in St. Louis, U.S.A. After that, he gained experience in production at Applied Materials, Inc. and Cypress Semiconductor Corporation.



A worker operates inspection equipment at the semiconductor manufacturing plant of Polar Semiconductor, a subsidiary of Sanken Electric. The factory, lined with manufacturing equipment, resembles the inside of a spaceship.

In the U.S., there has long been a trend to shift semiconductor manufacturing to Asia, but Iyer says that the essence of the semiconductor industry lies in the “craftsmanship and skill (art)” of production sites.

It is estimated that there are 400 to 1400 detailed processes in wafer production alone. First, an oxide film is applied to the surface, and then a photosensitive agent is applied. Next, using the principle of photography, the circuit pattern on the glass plate is exposed to ultraviolet light and burned onto the wafer. Unnecessary oxide films are then removed (etching). In addition, impurity ions (such as boron and arsenic) are implanted. The part of the wafer where silicon is exposed becomes a semiconductor. These processes are repeated incessantly to create the electrical pathways that connect the transistors. While this is the core of the digital industry, I felt that the process was similar to that of Wajima lacquerware, which I covered when I was just starting out as a reporter.

Without this craftsmanship, the puzzle of semiconductor manufacturing would not be complete. Why, for example, has China’s semiconductor industry not become more competitive, even though China has spent a lot of money on talented people and huge subsidies to support the industry? It is because the craftsmanship that takes decades to develop has not been nurtured.

Furthermore, what is the foundation of this craftsmanship? According to Iyer, it is a culture of free ideas and collaboration with others and other countries based on trust. When Iyer was in graduate school in the U.S., he was impressed by the environment where he could openly disagree with his professors.



Yoshihiro (Zen) Suzuki, CEO of Polar Semiconductor, left, gives a certificate of appreciation to an employee for 45 years of long service. CEO Yoshihiro Suzuki (left). He was joined by Vice President Surya Iyer (second from left) and President Kurt Walter (far right), June 28, 2017, Bloomington, Minnesota, USA, courtesy of Suzuki.

For example, in the area of silicon wafers, Japan has maintained its unique “craftsmanship” and Shin-Etsu Chemical and SUMCO have a high market share. For example, in silicon wafers, Japan maintains its own “craftsmanship” and Shin-Etsu Chemical and SUMCO have high market shares. In the supply chain, it is important to have trust that if you buy from Japan, it will be of high quality, and that they will not suddenly say, ‘We will not supply this to your country. This is less of a problem in a free and democratic trade, and the supply chain is more flexible and resilient.

The semiconductor industry is now at the center of the battle for supremacy between the U.S. and China. China has used the size of its market as a “weapon” to force foreign companies to transfer technology and infringe on intellectual property, which has damaged trust between the US and China. IP violations such as cyber attacks and corporate espionage were also the direct cause of the “trade war” by the former Trump administration.

Suzuki says, “In the end, it’s all about the trust between people. The hard work seems to have paid off. Allegro has grown to account for 40% of Sanken’s consolidated sales, and was listed on the NASDAQ market last October, just as the semiconductor market was beginning to recover rapidly.

Since then, the company's market capitalization has grown to about \$5 billion (about 550 billion yen), which is about four times that of its parent company, Sanken. (Bloomington, Minnesota: Naoatsu Aoyama)

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