As Washington prepares for conflict with China, US confronts major labor shortages in semiconductor manufacture

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The manufacture of semiconductors has become a central focal point of the escalating conflict of the Biden administration with China. The Biden administration is also seeking to ramp up the domestic manufacture of semiconductors to reduce reliance on imports, but the ruling class is confronting significant obstacles in implementing this plan.

A report released last year by the Center for Strategic & International Studies (CSIS), *Reshoring Semiconductor Manufacturing: Addressing the Workforce Challenge,* warns that the United States faces a major shortage of skilled labor as it tries to move semiconductor manufacturing onshore.

Semiconductors are a vital component in every aspect of the modern economy. Logistics networks and machine tools rely on large amounts of raw computing power, as do end products like automobiles, home appliances, and of course consumer electronics. The supply chains for semiconductors sprawl across continents and bring together the labor of millions of workers. Ongoing shortages caused by the refusal of capitalist governments to deal with the pandemic have had ramifications throughout the global economy.

The US government is concerned that these shortages will impact its ability to deploy its military. Stocks of military hardware have been poured into Ukraine. Washington is worried about its ability to continue to escalate its conflict with Russia, as well as opening up a new front against China.

Semiconductors are as essential to modern militaries as they are to every other part of the economy. Much of the practical effect of countries joining NATO is the integration of software systems used to coordinate the actions of troops and other military assets. Semiconductors are likewise essential to the production, use and maintenance of planes, tanks, ships and other weapons systems.

This is the background to the US decision to impose new export controls aimed at crippling China's ability to procure or manufacture advanced semiconductors. Washington has long indicated that it would go to war to prevent Beijing from achieving its 'Made in China 2025' goals, and these latest measures are a marked escalation of this conflict.

As the United States launches these measures against China, it is deeply concerned that Taiwan, critical to the production of advanced semiconductors as the home of Taiwan Semiconductor (TSMC), will be caught up in the war that Washington is provoking. Such an outcome would jeopardize US access to the critical technology they are seeking to deny to China. These concerns drive the attempt to create a base of advanced semiconductor production in the United States.

However, as the CSIS report outlines, the US confronts a major stumbling block in trying to move production within the US: a lack of skilled labor. According to the report, new fabs (the facilities that turn raw silicon wafers into functional chips) being built by TSMC in Arizona and Intel in Ohio are already facing construction delays due to labor shortages. The Intel project will require 7000 workers just for construction.

The report continues, “U.S. chipmakers are already grappling with a talent shortage, and according to some estimates, when the new U.S. fabs now being planned come on stream, an additional 70,000 to 90,000 fab workers will be needed. Some suggest that if the United States were to seek to become self-sufficient in chips, the number would rise to around 300,000.”

These workers would require many specialized skill sets, which would consequently require more labor for their training. Syed Alam, global lead of Accenture’s semiconductor practice, explained the problem: “You need the PhDs in materials sciences and electrical engineering for some advanced silicon technology work, you need electrical engineers for manufacturing and other things, and then you also need a lot of people who will be working on the software, or as print technicians, factory supervisors, or factory machine operators.”

The subordination of semiconductor manufacture to the needs of private profit and nation-state conflict means that this supply chain, the most sophisticated process humanity has ever devised, is mired in secrecy, with companies desperate to gain a competitive advantage with each new generation of hardware. This has made talent shortages a problem globally. Often the knowledge of how a key manufacturing step works is isolated within a single firm or university department.

The latest generation of chips, TSMC's 5nm process node, requires the use of extreme ultraviolet lithography (EUV) to etch a pattern with the required resolution on each silicon wafer. (The actual feature size is approximately 30nm, or roughly a thousandth the thickness of a human hair and close to the size of viruses and cell walls.) This pattern is the basis for all subsequent steps where various materials are added to the wafer according to this pattern to create the final device with its billions of transistors in the desired arrangement.

One of the central challenges is creating the light in the first place. In order for the image to be sharp, the light must be tightly monochromatic, centered around 13.5nm. Producing the required light was the central challenge in developing EUV. Tiny droplets of tin are released into a chamber where they are struck precisely in rapid succession by two high-powered laser pulses. The first pulse deforms the droplet into a platter, while the second vaporizes this platter, producing a flash of light that is then passed through a mask of the circuit and a series of mirrors to focus it down to the required size before producing an image on the silicon wafer.

There is only one company in the world that currently produces EUV machines, ASML in the Netherlands. Each machine weighs 200 tons and is the size of a school bus, costing over $1 billion. The knowledge to design, build and run these machines is concentrated in the Netherlands at ASML and its partners at Eindhoven University of Technology. While the Netherlands is currently a US ally, growing tensions between the US and Europe mean that this technology or potentially one of its successors will at some point be caught up in imperialist conflict.

Further, lithography is just one of many steps in producing a semiconductor. Growing the silicon monocrystals that are cut into wafers is largely concentrated in Japan. After lithography, there are many steps that add electrically active materials according to the etched pattern to produce working transistors. Among the many technologies involved is atomic vapor deposition, capable of building up single layers of atoms on a surface. The degree of precision required by these machines means that they require skilled operators, and often a full-time engineer to supervise their installation and use.

The US, along with other countries, has hollowed out education over many decades to satisfy the demands of Wall Street. The CSIS report outlines that universities confront outdated curricula, a lack of teachers, facilities and equipment, and even a lack of students, as they try to meet the demands of the US government.

The CSIS report makes clear that the production of semiconductors faces shortages of talent at every level. "At present, in the U.S. semiconductor industry, a 'skills gap' exists in virtually every job category. As one chip start-up CEO [Mark Granahan] asserts, 'it's not like there's a specific type of person or function missing. It's across the board.'"

The process behind this has led to a shortage of skilled workers in a variety of industries, beyond just semiconductors. The US government has long been aware of this problem, as can be seen through the relentless promotion of STEM and vocational programs (at the expense of pursuits that the financial philistines view as worthless or even dangerous, like the arts, literature and history).

However, most of the money thrown at STEM quickly finds its way to paying the salaries of administrators hired to oversee new facilities and programs. Little goes to paying actual educators or lessening the burden of tuition on students. This has led only to more money being thrown into the pit of private profit, as well as the poaching of skilled individuals from other countries, often on a scale that devastates local economies.

The desperate position of global capitalism gives the US and other governments little room to make the necessary investments to further develop semiconductor technology, let alone to take complete control of it within their national borders. The more they fight to protect their national interests, the more those interests come into conflict with the objective needs of production and society.