

Subject: The Evolution of the Current Semiconductor Shortage

The purpose of this report is to investigate the evolution of the integrated circuit shortage, as well as the propagation of information regarding the shortage, to gain a better understanding of our options as automotive manufacturers affected by the shortage.

Rumours and Background

A semiconductor is a material which only partially conducts electricity [1]. They are components of integrated circuits, which are specialized electronic devices which contain transistors, capacitors, and other electrical components. These integrated circuits are manufactured into chips, which have found their way into all sorts of products, from vehicles to birthday cards. In this report, the “chip shortage” refers to the shortage of the components in this manufacturing pipeline.

The chip shortage originated in China in February 2020. COVID-19 lockdowns and travel restrictions, combined with the Chinese New Year at the end of January, had shut down the manufacture of integrated circuits for a few weeks [2]. This led to an interruption in the production of many electronics, and the industries that use those electronics in their products. Due to the nature of the semiconductor industry, consumers would not be affected for a few more months, as the interruption in supply happened high up in the supply chain.

Rumours started to surface during this period about a possible shortage, citing the interruption in supply and logistics in China. Influential tech reviewer Linus Sebastian published a video on his YouTube channel, LinusTechTips, urging consumers to purchase computer components sooner than later because he predicted there would be a shortage [2]. He cited the timing of the situation (as outlined in the paragraph above), and the complexity of the chip industry supply chain, among other reasons.

The semiconductor industry is quite fragile. Most of the production is done by just two companies, Taiwan Semiconductor Manufacturing Company (TSMC) and Samsung, while 90% of manufacturing is owned by just 6 companies total [3] [4]. Due to the industry’s use of Just-in-time manufacturing, a type of manufacturing which cuts down on extra expenses at the cost of production flexibility, semiconductors and integrated circuits were being produced near the maximum capacity before the shortage [2]. In addition, due to the complexity of each step of the production process, production is spread across multiple companies who each specialize in a separate step. This is why the lead time (the time between the order and the order being produced) for chips takes months, and this rigidity makes scaling up production both slow and expensive.

Not all rumours pointed towards a shortage, however. The auto industry, one of the hardest hit, incorrectly predicted that the lockdown would cause demand for vehicles to fall [5]. As a result, they scaled back production accordingly and aimed to produce less vehicles, reducing

their normal orders of integrated circuits to reduce expenses [6]. This extra stock of integrated circuits was quickly bought up by other industries, something that will be discussed more in depth later in the report.

Widespread Shortage and Media Attention

As the coronavirus spread outside of China, so did the semiconductor shortage, and the media attention it would begin to receive. As many countries in Europe and North America entered their first lockdowns, the demand for consumer electronics grew substantially. People needed new computers if they wanted to work or learn from home, and demand for game consoles grew, as it was one of the only ways for people to socialize [7]. It was the consumer electronic industry, eager to meet this new demand, who bought up the extra production allotment that the auto manufacturers had given up. [6]. During this period, integrated circuit manufacturing had almost returned to normal levels due to China's swift pandemic response.

Auto manufacturers were facing a big problem. The demand for vehicles returned to normal much quicker than they had expected, leaving them without any chips to put in their cars [3]. A CNN article from the beginning of this year explains just how hard the semiconductor shortage has affected auto manufacturing [8]. Ford had to temporarily close factories in both Germany and Kentucky, and Audi furloughed (laid off temporarily) 10 000 employees, to name a few consequences.

The shortage was starting to appear in other industries as well. The consumer electronic industry was facing unprecedented demand, coming from many sources. Steam, the most popular platform for PC gaming, saw a 25% increase in concurrent users, going from around 20 million in January 2020 to 25 million at the beginning of April [9]. The second lockdown in the fall saw a similar rise in users. Around Christmas, next-generation consoles were being released for the first time in eight years, and new, great value PC components (notably video/graphic cards) were being released in the fall [7]. These new graphics cards excelled at something called cryptocurrency mining (think of it as renting out your computer's processing power), leading to people hoarding these cards. Tariffs implemented by the Trump administration on chips from China also lead to a slight price increase.

All these aspects combined lead most retailers being out of stock for months and scalpers swiping up what was available and selling for a huge markup on sites like eBay. This problem still exists today with graphics cards, which are still being sold at outrageous prices.

Research and the Future

As the new reality of the shortage sets in, research is starting to be done to understand the causes, what can be done to solve the shortage and prevent one from happening in the future. A paper by researchers the Sun Yat-sen University in China outlines some of the causes of the

shortage, particularly in relation to the automotive industry, and why they believe that greater international cooperation with China could be the answer [6]. Another article written by Harvard Business School professor Shane Greenstein speculates that the faults in the supply chain will never be wrung out, as manufacturers will continue to capitalize on the cheap components that are available [5]. As the shortage is eventually resolved, new research will be published that gives a better overview of the situation.

What is being done to solve this issue? The most obvious answer would be expanding production, regardless of the cost. TSMC is planning to open new factories in the United States by 2023 (in part to avoid the tariffs), and Ford is working to develop their own semiconductors to use in their vehicles [7] [10].

Conclusion

In closing, the integrated circuit shortage, which was first caused by an interruption in production and shipping, has been prolonged due to the increase in demand. Both, ironically, were caused by COVID-19 lockdowns. While steps are already being taken to alleviate the shortage, it will take time. In the meantime, the auto industry has two main options: either temporarily shut down production, or replace features on vehicles with options that don't include as many integrated circuits until the shortage has passed.

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