

# *Science You Can Use*

Jack K. Horner

**Dear Science:** I heard there is a global shortage of computer chips (“chips”). What does this mean and why should I care? -- Buck R.

**Dear Buck:** The short answer to your question is that (a) for several years, chip manufacturers have not been able to keep up with demand, and (b) every aspect of life in the industrialized world deeply depends on an adequate supply of chips.

Let’s look at what is affected by the shortage, how big the shortage is, how the shortage came to be, and what can be done about it.

*What is affected by the shortage?* Everything. In the industrialized world, every supply and operational chain for

1. food
2. water
3. medicine
4. communication
5. education
6. banking
7. transportation
8. national defense

critically depends on computer chips. For example, over 99% of the food we eat in the US is produced with the assistance of machines such as tractors, harvesters, packagers, temperature-controllers, clocks, and trucks, to name just a few, all of which depend heavily on computer chips. Every other item in (1) – (8) has similarly critical dependencies on chips. To put the point in perspective, if the production of computer chips worldwide ceased for one year, the major world economies would crash, and widespread starvation and disease would follow. The Great Depression would be child’s play in comparison.

*How big is the shortage?* There are many ways to represent the chip shortage. One is the average chip lead time – the time between when an order is placed for chips and when it is received. That lead time has been exponentially increasing since about March 2020. It is now over 20 weeks – just short of half a year.

Not all sectors of the economy have suffered equally from the shortage. The automotive industry has been particularly hard hit. In 2000, chip-dependent automotive electronics accounted for about 20% of the manufacturing cost of a car; today, that fraction is 40%. GM says that starting about 1 May 2021, it will cut production (and with that, jobs) at several of its plants worldwide, including Fairfax KS, Lansing MI, and Spring Hill TN because of the shortage. Ford has already implemented chip-shortage-driven production cuts in its Kansas City (about 2000 jobs are directly affected), Chicago, and Flat Rock MI plants.

The cutbacks in auto and truck production have driven vehicle supply down and vehicle prices up. Those increases are being passed onto consumers across the economy.

As a rule-of-thumb, every dollar that comes into a local economy from the outside (for example, from the sale of products manufactured locally but sold elsewhere) generates five dollars in the local economy. For example, factory workers spend part of what they earn to buy food, housing, and clothing locally, the merchants use part of what they make to buy the same, and all pay to sustain local tax-supported infrastructure (streets, public safety, education, etc.) Based on that rule-of-thumb, the loss of 2,000 manufacturing jobs in the Kansas City Ford plant is, all else being the same, the dollar-equivalent of the loss of about 10,000 jobs in the greater Kansas City area.

*How did this happen?* Although the COVID-19 pandemic has exacerbated the chip shortage, the roots of the problem extend to at least March 2017. Between March 2017 and July 2018, many chip buyers placed orders for about twice the number of chips they needed in the near term. This resulted in a surplus inventory for the buyers. The buyers let production essentially exhaust the surplus inventories, and only then (about July 2019) began to place new orders. The chip manufacturers could not keep up with the resulting demand. Then, in early 2020, the COVID-19 pandemic drove chip production below March 2017 levels.

If chip manufacturing could be ramped up in a few weeks to meet the demand, the shortage could be avoided. That won't happen for two reasons. First, two chip producers – Taiwan Semiconductor Manufacturing Company (Taiwan) and Samsung Electronics Company (South Korea) -- account for about 90% of the world's chip production, and they are operating at capacity. Second, chip production would have to roughly double to meet the current demand. To double the current chip production rate, at least four new chip-fabrication factories (called "chip foundries") would have to be built. The cost of a chip foundry is 5 – 10 billion dollars, and each takes several years to build.

*What can be done about the shortage?* The only solution is to build more foundries. US and European officials have pleaded with Taiwan officials to address the problem. But given new-foundry costs and lead times, there isn't anything governments can do in the short run that will make a significant difference. The chip shortage will be with us for at least two more years.

For further information, see Ian King, Debby Wu, and Demetrios Pogkas, "How a chip shortage snarled everything from phones to cars", *Bloomberg*, 28 March 2021, <https://www.bloomberg.com/graphics/2021-semiconductors-chips-shortage/> .

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*Jack Horner is a systems engineer.*