O P I N I O N

We can do better than Moore's Law

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We shouldn't write off electronics just yet. In fact, there are plenty of opportunities to pick up the pace, argues Bram Nauta.

Moore's Law will come to an end soon. We must find alternative technologies to invest in. And hurry! Let's do photonics! Yeah! Photons travel at the speed of light, so photonics is faster than electronics. Moreover, light doesn't get warm, so no more cooling problems! Electronics is so old school, we need photonics.

Oh no, wait! Let's do nanotechnology. Microelectronics is so micro. Nano is smaller than micro, so nanotechnology is better. Let's invest in nanotechnology! Let's make a thousand stand-alone nanostructures, measure them all under the very practical boundary condition of 4 kelvin and take an electron microscope photograph of the one working sample. One sample, who cares! Wasn't the first transistor also not just one working sample?

Hold on… Quantum computers! Of course, how could we forget? Quantum is faster than nano, so much better. A quantum computer can generate all possible answers. All our questions will be answered. We just have to figure out which questions belong to which answers, but who cares? It's just so cool!

Calm down, folks. Let's see what's going on in old-school silicon first. Memories have a low dissipation, so some years ago, the race upwards has started: NAND flash memories have gone 3D. We all expected four levels to start with, but the engineers didn't want to be second best, so they aimed at sixteen levels. Today it's about a hundred levels. That's 100 times more memory on the same area than in a flat 2D design. 100 is in the order of 2^7, so NAND manufacturers realized the equivalent of 2 x 7 = 14 years of Moore's Law in just a couple of years.

The crisis in the semiconductor market – symptoms, diagnosis, forecasts

You must have heard about it already, that the car manufacturers are unable to produce new cars due to the crisis in the semiconductor market. Modern cars are full of electronics but is it really bad enough to halt production? Does the semiconductor crisis only affect the automotive industry and is there no cure or at least a vaccine for it? Read about it here.

We can repeat this trick in standard CMOS. The fins of FinFETs are reaching their physical minimum sizes. Transistors have a length of around 20 nanometers. Smaller is possible, but then you can't switch them off sufficiently and leakage of all those billions of transistors will drain your power supply. The fin width is set at 7 nanometers – that's fifteen atoms wide. And yes, we can make them narrower, but then the current densities go down the drain.

Given the abovementioned dimensions of the fins and the fact that leading-edge chips have about 10 billion transistors per square centimeter, it's clear that they're actually quite sparsely filled with useful fins. A quick calculation shows that we should be able to squeeze sixteen times more fins on that same chip. We can remove all those dummy fins, which control the mechanical stress, because a useful fin can do that just as well. Also, we don't have to put the gate terminal contact next to the transistor; it can be placed on top. All this gives us eight more years of cramming more transistors on a chip according to Gordon Moore's prediction.

We can move up, just like the memory folks did
Next, we can move up, just like the memory folks did! Thanks to better process control and machines, the yield per layer will go up, so there's no fundamental reason why the total yield of a big stack can't be acceptable. What about power, then? We need to control the heat, right? Well, we can solve that by design. In the meantime, AI software can floor-plan a big digital design in a split second. So, we can very quickly design dedicated hardware for specific tasks that were done in software until now. From software to hardware? That's a power saving of 1000 times (that's my official estimate). In case we have a yield issue, who cares, as long as we use neural networks in hardware. After every glass of wine I drink, I also kill some thousands of neurons, and I'm still perfectly capable to write this sensible article.

Of course, we must solve some practical issues to go 3D, like growing vertical metals. But we have time for this; we only need to double the transistor count every two years. And looking at the learning curve from the NAND flash memories today, it will likely go faster. Moore's Law isn't about making transistors smaller, it's about making more transistors on a chip.

So, is the end of Moore’s Law near? Yes, it is! But something with an even faster innovation pace will take its place.