THOUGHTS FROM THE FRONTLINE

The Exponential Ride

By John Mauldin | April 3, 2021

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I've got to admit it's getting better (Better)
A little better all the time (It can't get no worse)
I have to admit it's getting better (Better)
It's getting better since you've been mine
Getting so much better all the time

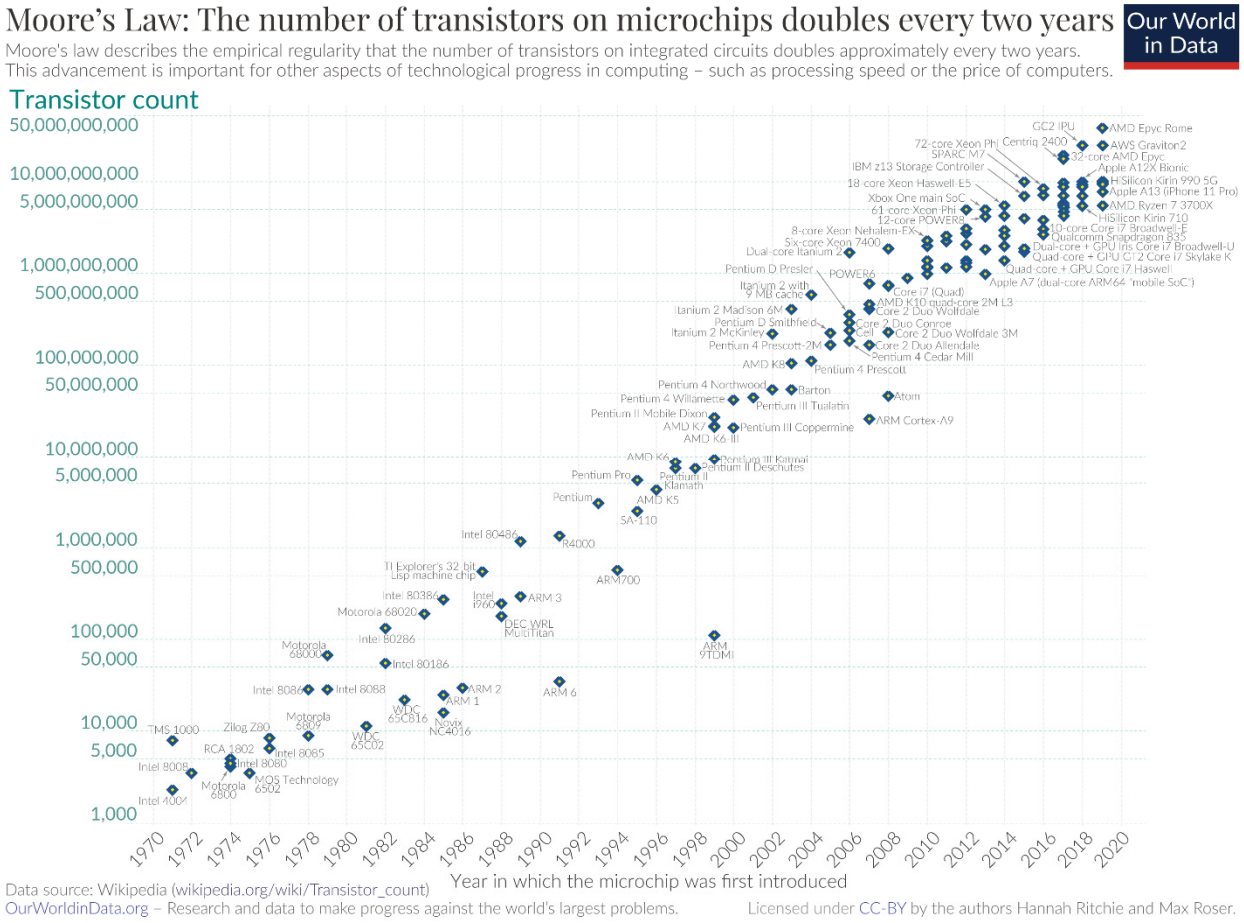
> —*Getting Better*, Paul McCartney and John Lennon, 1967, "Sgt. Pepper's Lonely Hearts Club Band" album

The last year brought exponential growth in, among other things, use of the word "exponential." It is now the go-to term when you want to say something is "growing super-fast."

As humans, we tend to think in terms of linear growth—whatever is happening immediately around us in shorter time periods. Accelerating, exponential growth is harder to grasp. Exponential growth means the rate of growth increases with time, just like a car goes faster the more you press the gas pedal.

"Exponential" has become popular recently to describe the way a virus spreads, if nothing stops it. When one person infects two others, each of whom infects two others, who each infect two others and so on, the numbers can quickly get out of hand. Exponentially so.

But exponential growth isn't always scary. Compound interest is exponential and we all enjoy it (when we're the lender, at least). Moore's Law, which says the number of transistors on integrated circuits doubles approximately every two years, is another example of extremely useful exponential growth. The chart below starts in 1970, but Moore made the observation in 1965.



Source: Our World in Data

The number of transistors on a microchip "only" doubles every two years. But that took it from 1,000 transistors to 50 billion in 50 years. Literally, 50 million times more powerful.

But it's even better. If you go back to the late 1940s when transistors were first being developed, having 1,000 transistors on something called a microchip was barely a dream. But with time and literally tens of thousands of patents and innovations, etc., we got to 50 billion. People have been proclaiming the end of Moore's law for decades. I'll take the other side of that bet and we are just exploring the edges of quantum computing.

Read a little about the chip industry's growth and you'll see words like "surprise" and "accidental" discoveries. You'll also see that it didn't happen in one place at one time but was literally exploding all over.

But the exponential growth of the microchip would not have been possible without the exponential growth of all sorts of technologies and innovations developed over the previous 100 years. That's the amazing thing about innovation. Or, more broadly, we could just call it "progress."

Humanity is constantly learning and improving. These improvements build on themselves in an exponential process. That's why daily life changed far more in the last 200 years than it did in the prior 20,000 years. The rate of growth accelerated. And that's why we will see more change in the next 20 years than we have seen in the last 200.

Today we enjoy living standards far higher than even royalty did not so long ago. Yes, we have problems, serious ones, but we also have advantages. We know we can make the world better because it *is* getting better. And it's getting better all the time, at least over time.

Occasionally I devote a letter to highlighting good news—positive things that are happening all around us, often unnoticed or unappreciated. The last one was in January 2020, just before the pandemic consumed our attention (see Looking on the Bright Side). We'll get back to the problems of the day later, but today I want us to appreciate the positive. There's a lot of it out there. And any serious investor should pay attention because technological innovation is where the real financial upside is (along with, admittedly, a lot of dead-end alleys).

Before we begin, I'm very happy to report that our second all-virtual Strategic Investment Conference is shaping up to be one of the most star-studded SICs we've ever had. We have confirmed close to 40 speakers now, and many are celebrities in their respective fields. And yes, we will be devoting some time to some of the technological innovations that are just now appearing, with some of the people who are making them appear.

We haven't unveiled the full list of speakers yet but for more details, I invite you to watch a short personal video message I recorded a few days ago. On the same page, you can also pre-order your SIC 2021 Pass at a 50% discount (or more, if you are one of our Alpha Society members). I hope to see you in May!

Pandemic Pluses

This year's top good news, by far, is the COVID-19 vaccines. It was a mind-boggling scientific, manufacturing, and distribution achievement. To have a vaccine at all is amazing; to have several of them only a year after the virus was identified is unprecedented. This kind of work once took decades. Operation Warp Speed was indeed a triumph of human work, cooperation between the private and public sectors, effort, and ingenuity.

This happened in part because scientists had been working on the underlying methods and technologies for a long time, not knowing they would be useful in a pandemic. You can read the whole gripping story in *The Atlantic* by Derek Thompson.

Briefly, “messenger RNA” (ribonucleic acid) is a genetic substance that tells your cells which proteins to make. Researchers in various places realized long ago that manipulating RNA could be quite useful, but exactly how to do it was elusive.

It turns out that Hungarian scientist Katalin Karikó discovered mRNA back in 1978. She eventually ended up at the premier epidemiological university in the United States, the University of Pennsylvania, where she worked on her discovery with other scientists. Eventually in 2000 they began to see some success. (I have probably walked past what was once her office on my tours of the facility.)

Private companies began working on mRNA products, with Moderna in the US and BioNTech in Germany eventually cracking the code. US pharmaceutical giant Pfizer had made a deal with BioNTech in 2018 to develop an mRNA flu vaccine. When SARS-CoV-2 struck, they pivoted quickly. The result went into my arm a month ago and again this week (and I hope yours as well). The technology they developed may well lead to other life-saving medicines, like a malaria vaccine (with a variation of mRNA technology) and individually tailored cancer treatments.

I want to focus a little bit on how incredibly successful the actual vaccine is, and to highlight some of the misinterpretations of statistics by the public. I get a long email from Justin Stebbing every day discussing the massive amounts of research on COVID that came out in just the recent few days. This crossed my desk this week:

> So, with a 50% effective vaccine, we have a 50% chance of contracting COVID-19, and with a 95% effective vaccine, we have a 5% chance… right?
>
> Actually, the news is much better. Consider what that “95% effective” statistic actually means. As *The New York Times’* Katie Thomas explained, the Pfizer/BioNTech clinical trial engaged nearly 44,000 people, half of whom received its vaccine, and half a placebo. The results? “Out of 170 cases of COVID-19, 162 were in the placebo group, and eight were in the vaccine group.” So, there was a 162 to 8 (95% to 5%) ratio by which those contracting the virus were unvaccinated (albeit with the infected numbers surely rising in the post-study months). Therein lies the “95% effective” news we’ve all read about. Or the 90% real world stuff I sent round yesterday.
>
> So, if you receive the Pfizer or equally effective Moderna vaccine, do you have a 5% chance of catching the virus? No. That chance is far, far smaller: Of those vaccinated in the Pfizer trial, only 8 of nearly 22,000 people, less than 1/10th of one percent (not 5%), were found to have contracted the virus during the study period. And of the 32,000 people who received either the Moderna or Pfizer vaccine, how many experienced severe symptoms? The grand total, noted David Leonhardt in a follow-up *New York Times* report: one.
>
> [German Scientist] Gigerenzer says that his nation suffers from the same underappreciation of vaccine efficacy. “I have pointed this misinterpretation out in the German media,” he notes, “and gotten quite a few letters from directors of clinics who did not even seem to understand what’s wrong.” “Be assured that YOU ARE SAFE after vaccine from what matters—disease and spreading,” tweeted Dr. Monica Gandhi of the University of California, San Francisco.

Of 74,000+ participants in one of the five vaccine trials, the number of vaccinated people who then died of COVID was zero. The number hospitalized with COVID was also zero:

Vaccine trial	Approximate # of people who received the vaccine	Of people vaccinated in the trial		
		# hospitalized for COVID	# who died from COVID	# who died from the vaccine
Moderna	15,000	0	0	0
Pfizer	18,600	0	0	0
Novavax*	13,000	0	0	0
Astra-Zeneca	5,800	0	0	0
J&J*	22,000	0	0	0

This is simply mind-boggling, in terms of not just the speed at which the vaccines were developed but also their efficacy. But just like the 442,000 Teraflop per second computer (the world's fastest computer now in Japan), the successful vaccine would not have been possible without the multiple decades of work developing it, let alone the even longer period of research prior to the discovery of mRNA. Moderna literally had a working vaccine model within 48 hours after learning the DNA sequence. Six weeks later, it shipped its first vaccine batches to laboratories in Maryland to begin human trials. The summary from *The Atlantic* article mentioned above?

> The triumph of mRNA, from backwater research to breakthrough technology, is not a hero's journey, but a heroes' journey. Without Katalin Karikó's grueling efforts to make mRNA technology work [in 1978], the world would have no Moderna or BioNTech. Without government funding and philanthropy, both companies might have gone bankrupt before their 2020 vaccines. Without the failures in HIV-vaccine research forcing scientists to trailblaze in strange new fields, we might still be in the dark about how to make the technology work. Without an international team of scientists unlocking the secrets of the coronavirus's spike protein several years ago, we might not have known enough about this pathogen to design a vaccine to defeat it last year. mRNA technology was born of many seeds.

The vaccines may be what gets us out of the pandemic, but the experience drove some other unintentional innovation, too. One was remarkably simple: Remote doctor visits. Many medical issues can be handled with a simple conversation, but (at least in the US) it rarely happened for legal, liability, and insurance reasons. The pandemic compelled all the players to cut through those barriers. I don't think we will be going back.

This also illustrates the exponential growth principle. Now that remote medicine is allowed and people (both providers and patients) are getting comfortable with it, we will expand the range of services delivered that way. Technology will be the key—or rather, a bunch of technologies working together. Virtual reality cameras and visors, 5G bandwidth, haptic sensors to convey "touch" without being there—all will speed up the process and should lead to better outcomes.

But even as the pandemic unfolded, other innovation continued. Let's look at some more examples.

Food Future

The last year also gave many of us a new relationship with our food. With restaurants closed or limited, we did more of our own cooking.

In fact, our food habits and methods are always changing. Many plants we eat simply didn't exist in their current form even a century ago. They have been cross-bred and manipulated into what we know now. That process is continuing as several companies now offer plant-based meat substitutes. As often happens with new technologies, prices are falling and people are finding new uses for the products.

My friend Professor Jesse Ausubel at Rockefeller University wrote to me last week about a joint venture between US and Chinese companies making a new "single-cell protein" substance called FeedKind. It is manufactured by fermenting natural gas with naturally occurring bacteria. The resulting pellets are used to feed fish. Used instead of soy, it will free up huge quantities of land and fresh water.

Material Factors

Some of the most amazing breakthroughs are also the most basic: the materials we use to build everything else. Hydrogen, for instance, is the most abundant element in the universe yet we have long struggled to isolate and make use of it. This is changing.

The current process for producing hydrogen consumes a lot of energy itself, and also emits large amounts of greenhouse gases. Another method called electrolysis is simpler and cleaner. All you need is water and electricity. The electricity can come from renewable sources. That means hydrogen can (in theory) be produced almost anywhere, reducing the need to haul fossil fuels around the world.

Beyond hydrogen, other materials science breakthroughs are brewing everywhere. My friend Peter Diamandis recently talked about graphene, which is basically a sheet of carbon just one atom thick, nearly weightless but 200 times stronger than steel. He calls it a "super-material" for obvious reasons. The applications are endless.

He also wrote about nanotechnology—manipulating matter at super-microscopic levels. This is a bit unbelievable so I'm just going to quote him directly.

> Progress has been surprisingly swift in the nano-world, with a bevy of nano-products now on the market.
>
> Never want to fold clothes again? Nanoscale additives to fabrics help them resist wrinkling and staining.

Don't do windows? Not a problem! Nano-films make windows self-cleaning, anti-reflective, and capable of conducting electricity.

Want to add solar to your house? We've got nano-coatings that capture the sun's energy.

Nanomaterials make lighter automobiles, airplanes, baseball bats, helmets, bicycles, luggage, power tools—the list goes on.

Researchers at Harvard built a nanoscale 3D printer capable of producing miniature batteries less than one millimeter wide.

And if you don't like those bulky VR goggles, researchers are now using nanotech to create smart contact lenses with a resolution six times greater than that of today's smartphones.

And even more is coming. Right now, in medicine, drug delivery nanobots are proving especially useful in fighting cancer. Computing is a stranger story, as a bioengineer at Harvard recently stored 700 terabytes of data in a single gram of DNA.

The applications are endless. And coming fast. Over the next decade, the impact of the very, very small is about to get very, very large.

Again, all this is coming *now*. And as I described above, the real impact is exponential. Using nanotechnology to solve these problems will free up the productivity currently being applied to them, so it can be multiplicatively used for something else. What would that be? Probably things we can't presently imagine.

While we are approaching the limits of lithium-ion batteries, there are literally scores of new technologies being developed which will far surpass current technology. The ultimate green energy, fusion energy, is fast becoming more than a pipe dream. There is a revolution in agricultural production (I am somewhat involved with it) that will completely disrupt current production cycles over the next 20 years. A little slower than Moore's Law, but just as powerful.

You may have missed that last year Brown University scientists began wirelessly connecting the human brain in quadriplegics. An electrode array is attached to the brain's motor cortex and then high-speed networks allow the patient to communicate. We are not all that far from the day when, if you choose, you will be able to "talk" directly to your computer simply by thinking.

Entrepreneurial Shifts

Our most important natural resource, by far, is the human mind. Any one of them has astonishing potential all by itself. When we put them together, true magic happens.

As you know (because I and others have lamented it), this pandemic/recession has destroyed hundreds of thousands of small businesses all over the world. But it didn't destroy the entrepreneurs who founded them. I believe many will do what comes naturally to them and start more businesses—hopefully better than those they lost.

Transitions are hard but often lead to a better place. I believe some wonderful new ideas—and very successful businesses—will emerge from this time. I can't wait to see what they are.

We literally live in one of the most exciting periods in all of human history. Oh, did I not mention the possibility that we might live a great deal longer than previous generations? Maybe in the next positive letter…

Root Canals, Travel, and Some Speculation on the Future of COVID

Over the last 40+ years, I have had maybe 4–5 root canals. They are never pleasant. I have another tooth which is beginning to become a nuisance, so I went to my local dentist, Carlos Martinez, and he took an X-ray, which he then shared electronically with another doctor a few miles away as they discussed my prognosis. (I have to admit the technology he uses is far superior to whatever the dentist I used in Dallas had.) Basically, it is going to become a problem at some point. So next week I get a root canal, and I hope the technology has improved so that it will go a little less painfully.

I am looking forward to being able to travel after the SIC. I truly hope that more of the country opens up, including Puerto Rico. But to do that we really need to encourage everyone to get their vaccinations. Then we can relax these intrusive precautionary measures and people will get on with their lives, both personally and professionally.

That being said, we will probably face versions of COVID-19 for years. New variants will develop in countries that have not been able to vaccinate and achieve herd immunity. The doctors and scientists I talk with fully expect that we will need periodic booster shots for a few years at least. But I know of several companies working on a "universal" vaccine.

Beyond vaccines, technologies are being developed that will constantly clean viruses and bacteria from our homes and gathering places, with no harm to human beings. Further innovations of that technology will be available before the end of the decade and I think will become ubiquitous.

A quick reminder to those who aren't yet in the club: Follow me on Twitter.

And with that, I will hit the send button and wish you a great week!

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