Artificial Kidneys Are a Step Closer With This New Tech

10 percent of the global population suffers from some form of kidney disease. That includes 37 million people in the US, 100,000 of whom pass away each year awaiting a kidney transplant.

Our kidneys are crucial for keeping us alive and healthy. A sort of chemical computer that keeps our blood chemistry stable—whether we're eating a sugary birthday cake or a vitamin-filled salad—they prevent waste buildup, stabilize our electrolyte levels, and produce hormones to regulate our blood pressure and make red blood cells.

Kidneys clean our blood using nephrons, which are essentially filters that let fluid and waste products through while blocking blood cells, proteins, and minerals. The latter get reintegrated into the blood, and the former leave the body in urine.

Scientists have struggled to come up with viable treatments for kidney disease and renal failure, and their complexity means kidneys are incredibly hard to synthetically recreate; each kidney contains around one million intricately-structured nephrons.

But new progress from chemical engineering researchers at the University of Arkansas has brought functioning artificial

kidneys one step closer. The researchers created a device that was able to filter blood in a way similar to biological nephrons. They described the device in a recent paper published in *Nature Communications Materials*.

There are two basic processes that take place when blood passes through the kidneys. First, clusters of blood vessels called glomeruli let small molecules, waste, and water through, while proteins and blood cells stay behind. The material that gets through this first filter then flows into the nephron network, where it's further filtered in a process called ion transport.

The researchers' work focused on the second step, ion transport. They placed a porous mesh made of platinum between two ion-exchange wafers to create a wafer that pushes ions through membranes using an electric field. The platinum meshes serve as electrodes when voltage is applied, enabling the team to select different ions and adjust their transport rates independently. They tested the technology with various ions and were successfully able to mimic the ion transport done by the kidneys.

In their paper, the team points out that other research groups have tried creating artificial nephrons using living, cell-based systems, including stem cells; but outside a native, living environment and absent the physical and hormonal signaling that control their function, biologically-based systems have struggled to replicate the nephrons' function, especially ion transport.

Christa Hestekin, Arkansas associate professor of chemical engineering and the lead author of the paper, said, "The system could work as a stand-alone device or in conjunction with peritoneal dialysis to control the chemistry of solutions used in treatment. And, minor modifications to the device could enable it to function as a wearable and potentially implantable artificial kidney."

In the US alone, over 93,000 people are currently on the waiting list for a kidney transplant. Though a fully-functioning artificial kidney is likely still years away at best, scientists are making incremental progress in recreating this vital organ; an artificial nephron like the one described here is just one piece of a complex puzzle.

Another crucial piece is a functioning network of blood vessels. In 2015, scientists at Lawrence Livermore National Laboratory created bioprinted kidney tissue that replicated some of the functions of biological nephrons. In 2016 a group at Harvard's Lewis Lab used 3D printing to re-create the nephrons' tubules, complete with a vascular network for blood flow—but they only stayed alive for a little over two months.

The fully synthetic nature of the Arkansas team's technology could thus have a leg up on biologically-based approaches. According to Hestekin, the nephron could be combined with ultrafiltration, nanofiltration, or reverse osmosis systems and integrated into an artificial kidney.

Given the vast number of people in need of them, artificial kidneys can't come soon enough, and will be a miracle of modern science when they do arrive. Though it'll be some time yet, incremental progress like this gives us the confidence to say "when" instead of "if."

Image Credit: crystal light / Shutterstock.com

This Is Our Chance to Redesign Work. Let's Make It Better

Long before coronavirus appeared and shattered our pre-existing "normal," the future of work was a widely discussed and debated topic. We've watched automation slowly but surely expand its capabilities and take over more jobs, and we've wondered what artificial intelligence will eventually be capable of.

The pandemic swiftly turned the working world on its head, putting millions of people out of a job and forcing millions more to work remotely. But essential questions remain largely unchanged: we still want to make sure we're not replaced, we want to add value, and we want an equitable society where different types of work are valued fairly.

To address these issues—as well as how the pandemic has impacted them—this week Singularity University held a digital summit on the future of work. Forty-three speakers from multiple backgrounds, countries, and sectors of the economy shared their expertise on everything from work in developing markets to why we shouldn't want to go back to the old normal.

Gary Bolles, SU's chair for the Future of Work, kicked off the discussion with his thoughts on a future of work that's human-centric, including why it matters and how to build it.

What *Is* Work?

"Work" seems like a straightforward concept to define, but since it's constantly shifting shape over time, let's make sure we're on the same page. Bolles defined work, very basically, as human skills applied to problems.

“It doesn’t matter if it’s a dirty floor or a complex market entry strategy or a major challenge in the world,” he said. “We as humans create value by applying our skills to solve problems in the world.” You can think of the problems that need solving as the demand and human skills as the supply, and the two are in constant oscillation, including, every few decades or centuries, a massive shift.

We’re in the midst of one of those shifts right now (and we already were, long before the pandemic). Skills that have long been in demand are declining. The World Economic Forum’s 2018 Future of Jobs report listed things like manual dexterity, management of financial and material resources, and quality control and safety awareness as declining skills. Meanwhile, skills the next generation will need include analytical thinking and innovation, emotional intelligence, creativity, and systems analysis.

Along Came a Pandemic

With the outbreak of coronavirus and its spread around the world, the demand side of work shrunk; all the problems that needed solving gave way to the much bigger, more immediate problem of keeping people alive. But as a result, tens of millions of people around the world are out of work—and those are just the ones that are being counted, and they’re a fraction of the true total. There are additional millions of people in seasonal or gig jobs or who work in informal economies now without work, too.

“This is our opportunity to focus,” Bolles said. “How do we help people re-engage with work? And make it better work, a better economy, and a better set of design heuristics for a world that we all want?”

Bolles posed five key questions—some spurred by impact of the pandemic—on which future of work conversations should focus to make sure it’s a human-centric future.

1. What does an inclusive world of work look like? Rather than seeing our current systems of work as immutable, we need to actually understand those systems and how we want to change them.

2. How can we increase the value of human work? We know that robots and software are going to be fine in the future—but for humans to be fine, we need to design for that very intentionally.

3. How can entrepreneurship help create a better world of work? In many economies the new value that's created often comes from younger companies; how do we nurture entrepreneurship?

4. What will the intersection of workplace and geography look like? A large percentage of the global workforce is now working from home; what could some of the outcomes of that be? How does gig work fit in?

5. How can we ensure a healthy evolution of work and life? The health and the protection of those at risk is why we shut down our economies, but we need to find a balance that allows people to work while keeping them safe.

Problem-Solving Doesn't End

The end result these questions are driving towards, and our overarching goal, is maximizing human potential. "If we come up with ways we can continue to do that, we'll have a much more beneficial future of work," Bolles said. "We should all be talking about where we can have an impact."

One small silver lining? We had plenty of problems to solve in the world before ever hearing about coronavirus, and now we have even more. Is the pace of automation accelerating due to the virus? Yes. Companies finding more ways to automate their processes to keep people from getting sick. But we have a slew of new problems on our hands, and we're not going to stop

needing human skills to solve them (not to mention the new problems that will surely emerge as second- and third-order effects of the shutdowns). If Bolles' definition of work holds up, we've got ours cut out for us.

In an article from April titled *The Great Reset*, Bolles outlined three phases of the unemployment slump (we're currently still in the first phase) and what we should be doing to minimize the damage. "The evolution of work is not about what will happen 10 to 20 years from now," he said. "It's about what we could be doing differently today."

Watch Bolles' talk and those of dozens of other experts for more insights into building a human-centric future of work here.

Image Credit: www_slon_pics from Pixabay

4 Non-Obvious Trends That Matter During This Pandemic

Last year at South By Southwest, author and entrepreneur Rohit Bhargava spoke to a packed auditorium about trends that, though they may not be obvious, are playing a serious role in shaping the future. Each year Bhargava spends untold hours figuring out which trends are going to be the most relevant and impactful, then puts out a book on them as part of his

“Non-Obvious” series.

He was planning to speak about 2020 trends at this year’s SXSW festival—but like every other large in-person event, it was canceled. And like every other thing in our lives, the pandemic has turned most of Bhargava’s 2020 trends on their heads.

But not all of them. In fact, a select few trends that were already on the rise have been amplified by Covid-19, and now they’re even more significant. In a virtual SXSW session streamed from his home last week, Bhargava talked about these trends, how we can make the most of them, and how to find meaning amid chaos and confusion.

We’re in a time of extreme disruption—that much is obvious. The places we’re used to going, which are normally full of people, are empty. We’re all at home trying to figure out how to pass the time productively. And we all have big questions about how the new normal—even once our states and cities start to reopen—is going to change the way we do everything. Will students go back to school in the fall? Will we be working from home indefinitely? Will we always have to wear a face mask to go to the grocery store? What’s safe and what isn’t?

Bhargava emphasized that he’s not here to predict the future. Rather than being focused on where the world will be 5 to 10 years from now, he said, “I focus on trying to observe today to figure out what to do today.” Also, tech on its own doesn’t intrigue him as much as the human response to tech and how it’s impacting our lives. “I’m more interested in how human behavior is evolving,” he said.

But how do you figure that out when there’s so, so much information coming at us from all sides? “The big problem right now is that we just don’t know what to believe, and so we don’t believe anything,” Bhargava said. “The world seems untrustworthy and we don’t know what to pay attention to.”

Parody videos and articles have popped up poking fun at the confusion around coronavirus, but it's disconcerting to realize how much misinformation has been flying around, and how little we know about this virus even after two and a half months of lockdowns.

Misinformation is, of course, not a new problem. And it's impossible to consume all the information out there to try to figure out what's real. Instead of attempting to digest and make sense of all the news, tweets, memes, podcasts, articles, shares, retweets, and videos out there, Bhargava said, we should devote more time to trying to understand people. "How do we become people who understand people?" he asked. "What motivates them to believe something, what gets them to act, what engages them?"

Bhargava's own people-understanding process involves what he calls the haystack method. Rather than searching for a needle in a haystack, he gathers 'hay' (ideas and stories) then uses it to locate and define a 'needle' (a trend). "It's really easy to read the same media that reinforces what you already think over and over," he said. But a key part of gathering valuable information is looking for it in places you wouldn't normally think to look. That means taking in media that's targeted to different demographics than those you fall into.

Once you look across a wide variety of channels, common themes emerge. Bhargava groups those themes together and tries to elevate them into a bigger idea; that's where his trends come from.

He defines a non-obvious trend as a "unique curated observation of the accelerating present." "We're in a moment now where the present is accelerating even faster," he said. Here are the four trends he's pinpointed that have been amplified by the current situation—and how we can make the best of them.

Revivalism

Overwhelmed by technology and a sense that life is too complex, people seek out simpler experiences that offer nostalgia and remind them of a more trustworthy time; we revive habits, media, or connections we find comforting or reassuring. This trend was already in place before the pandemic; Bhargava included a variation of it in his 2019 SXSW talk. The breakneck speed of technology made many of us want to slow down and reconsider the role we want our phones and computers to play in our day to day lives.

But now, Bhargava said, revivalism is gaining even more momentum; if the world seemed complex and overwhelming before, that sense has multiplied by an order of magnitude now that we're in a global health crisis. Rather than drowning in too much conflicting information, people are consciously cutting back on the amount of news and social media they consume each day (not least because it's just. so. depressing.) and seeking out forms of entertainment that were cast aside long ago: books, puzzles, classic video games, board games. We're reconnecting virtually with friends or relatives we haven't spoken to in a while. We're trying out old family recipes in the kitchen since we can't go to restaurants.

It's time, Bhargava said, to rediscover the analog; "We can do these things outside of technology." Now that we've been forced to find substitutes for many components of our daily routines, maybe we'll learn that we don't need to be as dependent on our devices as we thought.

Human Mode

The second trend is essentially a more nuanced variation of the first. Tired of technology that isolates us from one another, people are seeking out and placing greater value on physical, authentic, and imperfect experiences delivered by humans. In a time when we can't hug our friends and families

or even speak to store clerks without masks and plastic dividers, we're craving empathetic, human experiences big-time.

The aforementioned dependence on digital devices as a way to interact with other people seems reprehensible now that we don't even have the in-person option. Before the pandemic we relied on social media to connect us, texting to communicate with each other, "like" buttons to share our opinions and preferences, and algorithms to streamline and improve our shopping, transit, and other experiences.

While all of that isn't going to go away—and may double down in a world where physical contact is now perceived as dangerous—we're realizing how crucial and irreplaceable our human connections are. "We need to focus on empathy first," Bhargava said. "An empathetic approach (whether in business or simply with our families and friends) is most likely to provide value to people in the current situation." And probably always.

Instant Knowledge

Have you picked up some new skills during lockdown? Tried your hand at some fancy recipes? Learned hard pieces on the guitar or piano? How likely is it that the skills or habits you've picked up will persist after this is all over?

As we consume bite-sized knowledge on demand, Bhargava said, we benefit from learning everything more quickly but risk forgetting the value of mastery and wisdom. It's become really easy to watch a YouTube video to learn just about anything; during the pandemic, views of cooking tutorial videos have skyrocketed, and it's likely the same has happened for instructional videos of all types (including how to cut your own or your partner's hair!). Since we now have access to information more readily than ever before, we expect to be able to learn things faster. But it still takes a lot of time

and dedication to get really good at a skill or become an expert in a given field.

While it's great to learn new skills quickly, let's not forget to zoom out and look at the bigger picture. Bhargava recommends finding ways to connect people with knowledge to inspire beliefs, expanding our worldviews and building towards a greater vision—whether for ourselves, our families, or the collective future.

Flux Commerce

The lines between industries are eroding, leading to a continual disruption of business models, distribution channels, and consumer expectations. This was happening before Covid-19 broke out; Apple was getting into financial services, banks were opening coffee shops, Crayola started making makeup, and Taco Bell opened a hotel (I know right- WHAT?! It's true though).

Now that everything is closed and we're confined to our homes, businesses are having to adapt in ways they never imagined—and those that can't adapt are, unfortunately, in trouble. "Everything about how we do business is shifting," Bhargava said. And that disruption is happening at an unprecedented pace. Even once the economy opens again—which for many states in the US is happening this week—we won't go back to how things were in 2019. The only way forward is to adapt.

"We don't know what's coming next," Bhargava said. "But we know that people who can adapt best are non-obvious thinkers who pay attention to what's happening and try to continue to change."

Image Credit: Rohit Bhargava by Brian Smale

Forget Exercise—These Mice Got Ripped With Gene Therapy

Trying to hack fitness is a multi-million-dollar industry; we've all seen at least one ad featuring a purported miracle product that claims it can make people lose weight and look great—without even trying. From low-effort exercise machines to strange-ingredient diets to fat-burning belts and bands, there's no shortage of attempts to make it easy to be fit.

A gene therapy trial performed on mice may foreshadow yet another way to hack fitness. In a study done by a team at Washington University in St. Louis' medical school, mice quickly built muscle mass and reduced obesity after receiving the therapy, even while eating a diet high in fat and not exercising. The results were published last week in a paper in *Science Advances*.

Sound appealing? Here's how it worked.

The gene targeted was FST, which is responsible for making a protein called follistatin. In humans and most other mammals, follistatin helps grow muscle and control metabolism by blocking a protein called myostatin, which acts to restrain muscle growth and ensure muscles don't get too big.

The researchers injected eight-week-old mice with a virus carrying a healthy FST gene (gene therapy involves adding

healthy copies of a gene to cells, usually using a virus as a deliveryman).

Over a period of 18 weeks, or about 4 months, the team observed that the muscle mass of the treated mice more than doubled, as did their strength level. They also experienced reduced damage related to osteoarthritis, less inflammation in their joints, and had healthier hearts and blood vessels than mice that didn't receive the gene therapy—even though all the mice ate the same high-fat diet and did the same amount of exercise.

Going into the study, the researchers worried the muscle growth catalyzed by the gene therapy could harm the heart, mainly through thickening of the heart's walls. Surprisingly, though, heart function and cardiovascular health of the treated mice actually improved. In subsequent studies, the team will continue to monitor the treatment's effect on the heart, as complications could emerge over time.

Talk about a fitness hack; imagine being able to build muscle and maintain a healthy metabolism while lounging on the couch eating burgers and fries. There have been similar studies to replicate the effects of exercise by commandeering the genetic instructions that control the way cells interact with proteins; though various "exercise pills" have successfully mimicked the effects of regular cardiovascular activity in mice, scientists still don't fully understand how, at a molecular level, exercise has the effects it does on the human body.

This may change in the next couple years, though; a National Institutes of Health consortium called the Molecular Transducers of Physical Activity is in the midst of an in-depth study on the molecular effects of exercise on tissues and organs in 3,000 people.

If the muscle-building gene therapy eventually reaches a point

where it can be used in humans, though, the research team isn't viewing it as a quick-fix health hack. Rather, it would be used to help get people with conditions like muscular dystrophy or severe obesity to a baseline from which they could adopt tried-and-true muscle-building practices like weight lifting or physical therapy.

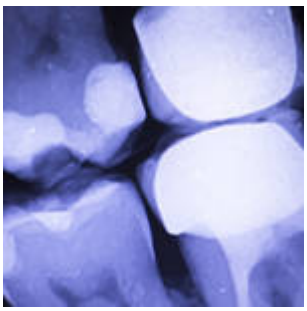
"In cases of severe obesity or muscle loss, it is extremely difficult—if not impossible—to lose weight or improve muscle strength through normal exercise and diet," said Farshid Guilak, orthopedic surgery professor and director of research at Shriners Hospitals for Children in St. Louis. "The goal of this study was to show the importance of muscle strength in overriding many of the harmful effects of obesity on the joint."

If every condition, process, and trait in our bodies is tightly linked to our genes, it's conceivable that almost any aspect of our health could be manipulated using gene therapy and related tools. Maybe one day there will indeed be a pill we can take or a shot we can get to give us svelte, muscular bodies without any of the effort.

The fact that this would ruin the pleasure and satisfaction of a good workout is another conversation—and one not everybody would be interested in having. But even if genetic or chemical exercise-replacement tools become safe to use in humans in the foreseeable future, they'll likely be limited, at least at first, to those who need them due to debilitating health conditions.

That said—for the time being, keep hitting the treadmill, the weight room, or your other off-the-couch, effort-intensive workout of choice.

Image Credit: Aberro Creative from Pixabay

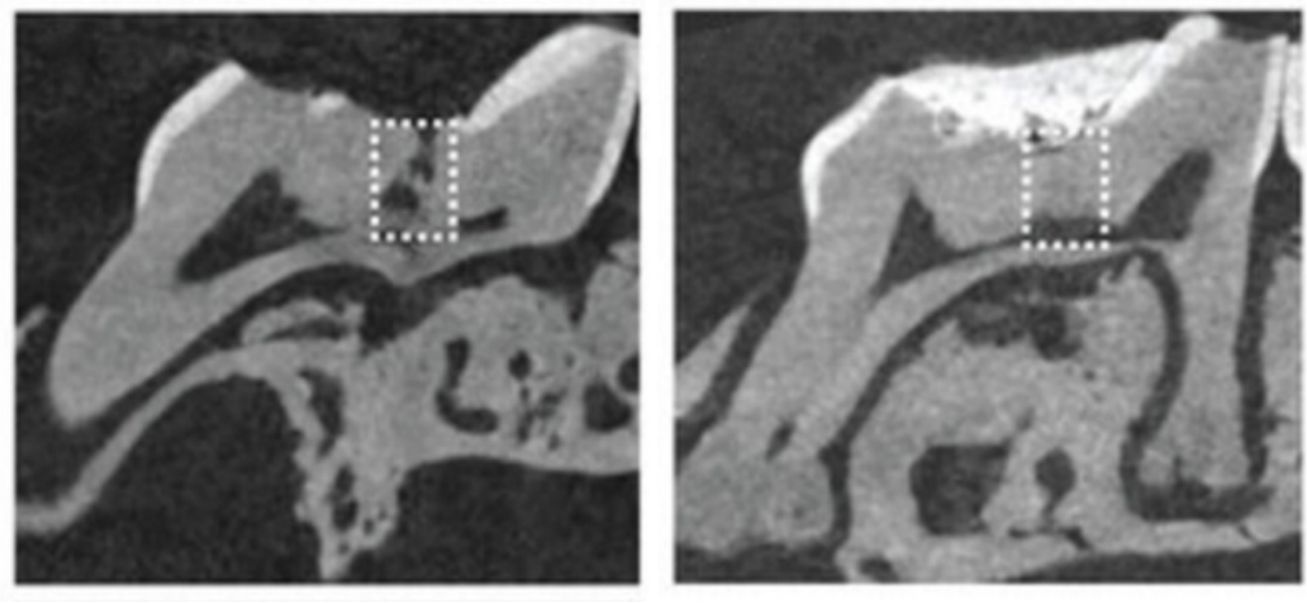


Forget Fillings: New Study Shows How to Regrow Teeth

Few of us are graced with a perfect mouthful of teeth. If it's not braces or cavities, it's wisdom teeth or root canals. Adding injury to insult, while medicine has made a lot of progress in multiple fields over the years, dentistry has remained stubbornly stuck to the same painful, outdated techniques.

I was lucky enough not to need braces as a kid, but a persistent sugar addiction meant every time I visited the dentist I had at least one cavity. To this day, I can't hear the sound of a drill—or even think about going to the dentist—without cringing.

A study published in Scientific Reports last week may be good news for fellow dentist-fearers. The study details the success of trials in which a stem cell treatment was used to repair tooth decay in mice.



Tooth repair after four weeks (left) and six weeks (right). Image Credit: Kings College/Scientific Reports

Normally, when our teeth get cavities the dentist clears out the decayed material then fills in the empty space with one of various materials, including porcelain, silver amalgam, or composite resin. These fillings work well enough, but after a few years they typically need to be replaced, and can end up weakening teeth to the point that they need to be extracted.

What if teeth could instead repair themselves, independently regenerating decayed material?

To some extent, teeth already do this. When the inner pulp of a tooth is exposed, mesenchymal stem cells—which can differentiate to become cartilage, bone or fat cells—mobilize to form tooth-specific cells called odontoblasts. These secrete dentine, a reparative substance that seals off the tooth pulp from the external environment.

This natural process is enough to repair minor fissures below the tooth's surface enamel, but doesn't cut it when it comes

to cavities. The new treatment involves accelerating the tooth’s natural dentine production to repair larger defects.

Scientists found that *tideglusib*, a drug typically used to treat neurological conditions like Alzheimer’s and autism, can be used to stimulate stem cell differentiation in the tooth’s pulp. These create more odontoblasts, which create more dentine.

In the study, scientists inserted a biodegradable collagen sponge soaked in tideglusib into mice’s teeth, then sealed the teeth with a dental adhesive. Over the course of a few weeks, the sponges degraded and were replaced by newly-produced dentine.

So the good news is, signs point to teeth being able to repair themselves, no need for artificial fillings.

The bad news is, a dentist would still need to use a drill to get rid of the decayed part of a tooth. Dentist-fearers could take some comfort, though, in knowing the process would be a one-time thing, with no need for filling replacement or tooth extraction down the road.

Scientists are currently moving to testing the procedure in rats, whose teeth are bigger than those of mice. If successful, human trials could start later this year.

It’s possible our teeth are too big for the treatment to work. Mouse teeth are much smaller than ours, so the spaces filled by the stem cell treatment were significantly smaller too.

If the treatment does work in humans, I'll be one of many people grateful to know that my visits to the dentist's chair could soon be fewer and farther between.

Banner Image Credit: Shutterstock

By Vanessa Bates Ramirez

This article originally appeared on Singularity Hub, a publication of Singularity University.

If Energy Becomes Free in the Future, How Will That Affect Our Lives?

Technology is making the cost of many things trend towards zero. Things we used to have to pay a lot for are now cheap or even free—think about how much it costs to buy a computer, make long-distance calls, take pictures, watch movies, listen

to music, or even travel to another state or country. Down the road even more of our day-to-day needs will join this list—including, possibly, electricity.

That's great, right? Because, free stuff! Who doesn't love free stuff?

The energy case, though, is more complex.

The cost of burning coal can only go so low, but the cost of harvesting energy from the sun just keeps dropping. October 2017 saw bids for a Saudi Arabian solar plant as low as 1.79 cents per kilowatt hour, breaking the previous record in Abu Dhabi of 2.42 cents/kWh. Granted, it's no coincidence that these uniquely low prices are coming from some of the sunniest parts of the world. For comparison's sake, the average residential price for electricity in the US in 2017 was 12.5 cents/kWh.

Just when we think prices can't go any lower, they do—and perhaps the most amazing part about the continual price decline is that it's in spite of, not thanks to, batteries. Cheap, efficient batteries are still the biggest bottleneck for renewables, but once we figure them out, the sky—or, in this case, the floor?—is truly the limit. It's also only a matter of time until transparent solar cells become a reality and turn every outdoor glass surface into a small-scale power plant.

So what would a world of free energy for all look like?

Electricity would become ubiquitous in the many parts of the world where that's not yet the case. In other places, electric bills would disappear—but that would be the least of it. Manufacturing costs would plummet, as would transportation costs, as would, well, pretty much all costs.

The money we'd save on energy could be put to use on social programs, maybe even spawning a universal basic income that would help bring about more just and equitable societies. If everything cost less, we wouldn't need to work as much to earn as much money, freeing up our time to pursue creative endeavors or other personal passions.

There's a flip side to every coin, though, and the old adage about the best things in life being free unfortunately doesn't necessarily hold true in this case. Let's look at what's happened when we've made other resources free or cheap.

In the US we made food cheap and abundant by learning how to process it and manufacture it at scale—and now we're fatter and sicker than we've ever been. We figured out how to produce plastic bottles and bags for pennies, and now the oceans are choked with our abundantly cheap, non-biodegradable garbage.

The Jevons Paradox holds that as technological progress increases the efficiency of a product or resource, the rate of consumption of that resource rises because of increasing demand, effectively canceling out any savings in efficiency. That's right—humanity appears to be, at our core, a species that takes, and free electricity would be no exception.

Middle Eastern countries, where electricity prices are the

cheapest in the world, present a telling example. Excessive use of energy is commonplace, and there's no incentive to rein in use. Ideally, energy use per capita should be reflected in GDP per capita, but countries like Kuwait, Bahrain, and Saudi Arabia all have an imbalance in this metric, using much more energy than is needed to achieve their GDPs.

As energy becomes cheaper in other parts of the world, people will use more of it, and the first victim will be the planet. Even though the energy will be renewable, that doesn't mean there won't be environmental costs; there could be repercussions we haven't even imagined yet, just as whoever invented plastic probably never envisioned it poisoning marine life.

So as energy gets cheaper and ultimately moves toward being free, how do we handle its abundance wisely? Government regulation will play a role, as will market forces, despite the absence of economic impetus. As with any new technological development, we may have a phase of adjustment where we go too far, catch ourselves, and swing back the other way.

Free, clean energy will undeniably bring many benefits with it. But we can't afford to forget that there's usually a price to pay, too—it's just not always obvious from the outset.

Image Credit: Len Green / Shutterstock.com

By Vanessa Bates Ramirez

This article originally appeared on Singularity Hub, a

publication of Singularity University.

Pop-Up Labs and a 5-Minute Test: The Latest in US Coronavirus Testing

Two and a half months after the first confirmed novel coronavirus case in the US, the virus has invaded the country's east and west coasts and is quickly making its way into the center of the country. As the case tally swells and hospitals brace themselves for surges, one factor has remained stubbornly, ludicrously constant: we don't have enough tests.

In fact, far from simply not having enough tests, we have a massive and debilitating shortage of them. Widespread testing was a key piece of the strategy used by countries most successful in combating the virus, like Korea, Taiwan, and Singapore. If we knew who was sick and who wasn't, or where the infection clusters were located, we'd be able to more selectively shut down the economy rather than using the blanket approach we're currently employing. We're essentially making decisions in an information vacuum when we should be making them based on thorough analytics.

But there's hope this could soon change. Academia and private

industry have moved to fill the testing void, with two particularly encouraging developments announced this week. Here are the details.

Pop-Up Labs

Jennifer Doudna is widely considered the "founder" of gene editing technique CRISPR. She's now leading a pop-up testing lab at UC Berkeley that's pulling together over 100 scientists and volunteers from Berkeley's Innovative Genomics Institute and nearby institutions.

To be able to test patient samples, labs and scientists need to meet federal requirements under the Clinical Laboratory Improvement Amendments (CLIA) program. Thanks to an acceleration of the certification process by the FDA, the lab should be fully certified by next week, and can start testing patient samples at that time.

The team will use a polymerase chain reaction test (more on that later) run on machines that can analyze over 300 samples at a time. They plan to process 1,000 tests per day to start, eventually going up to 3,000 per day. Estimated time from receiving patient samples to having a definitive diagnostic is a mere four hours, aided by robotic sample handling and automated test-running.

Given that California currently has the country's biggest testing backlog, Doudna and her team have their work cut out for them. Similar labs have popped up at Harvard/MIT, the Mayo Clinic, University of Iowa, University of Washington, Ohio State University, and other locations around the country.

Abbott Labs' 5-Minute Test

Illinois-based Abbott Labs' ID NOW platform—a toaster-sized machine that quickly analyzes patient samples to detect illnesses—is already used in urgent care clinics and emergency

rooms across the country. Normally used to detect conditions like strep throat or the flu, the system was cleared to test for Covid-19 by the FDA last week. A week prior, the company also launched Covid-19 testing on a platform that's used in hospitals and labs.

Abbott has a test delivery target of 50,000 per day, and with positive results showing up within 5 minutes and negative results within 13 minutes, it's the fastest test we've seen; compared to the 7-day turnaround time of the initial test produced by the CDC, this seems quasi-miraculous. Between its two platforms, Abbott plans to produce a total of five million tests in April.

Is that enough for what we need to effectively fight this virus and get society up and running again as soon as possible? Not even close. According to the *Washington Post*, as of March 28 the US was testing at a rate of 2,249.9 tests per million people; South Korea was at more than triple that rate with 7,576.7 tests per million people.

But Berkeley's, Abbott's, and all the other tests springing up from research centers and private companies are something—which is better than the gaping void of nothing we've had up until now.

Virus Detection 101

So how do these tests work? What happens during the minutes or hours it takes for a sample to be analyzed and a diagnosis produced?

In brief, the tests are looking for viral genetic material, and if it's present, they use chemicals to multiply it and make it detectable in a fail-safe way. Picture the coronavirus as a pincushion full of needles. Chemicals called reagents are added to a patient sample, and these reagents get past the needles and cause the pincushion to crack open, releasing the

virus's RNA.

Adding an enzyme to the RNA causes it to convert to DNA, which is then replicated using additional reagents, enzymes, and temperature changes in a process called polymerase chain reaction (PCR). Two DNA strands become four, which then become eight, and the cycle continues until there are around *100 billion* copies of the viral DNA. Each time a strand is copied, a fluorescent probe appears; a sample glowing with fluorescence, then, is unmistakably full of viral DNA—and that means a positive test result (and immediate isolation of the person who was just tested!).

Hurdles to Clear

Despite this commendable work by scientists and a necessary loosening of government regulations, it's unfortunately likely that testing shortages will continue. We've never before been in a situation where so many people needed to be tested so quickly, and thus demand for items like reagents and swabs is far outpacing the supply chain's ability to deliver.

In addition, the tests discussed here can only detect Covid-19 in people who have the virus at the time of testing; in other words, a different test (called an antibody test) is needed to identify people who had mild or asymptomatic cases of the virus—these people could be immune without even knowing it.

There's no easy answer to this virus, a fact we've become painfully aware of over the past few weeks. But if all we can do is take baby steps towards a solution, it should comfort us to know that the best scientific minds among us are doing just that.

Image Credit: Michal Jarmoluk from Pixabay

Do We Have to Give Up Some Personal Freedoms to Beat Coronavirus?

In late December 2019 Dr. Li Wenliang, an ophthalmologist at Wuhan Central Hospital, sent a WeChat message to his medical school alumni group telling them that seven people with severe respiratory and flu-like symptoms had recently been admitted to the hospital. One thing they had in common, besides their symptoms, was that they'd all visited a local wet market at some point in the previous week.

The illness bore an uncanny resemblance to SARS, but with a novel aspect as well; could it be an outbreak of a new disease? If so, what should be done?

But before any of the doctors could take action or alert local media outlets, the chat thread was shut down by the Wuhan police and Li was accused of spreading rumors. Mind you, the chat wasn't in a public forum; it was a closed group exchange. But the Chinese Communist Party (CCP) is able to monitor, intercept, and censor any and all activity on WeChat; for the Chinese people, there's no such thing as a private conversation.

The police gave Li an affidavit stating he'd spread false information and disturbed public order. He was instructed to

sign this document retracting his warning about the virus and to stop telling people it existed, otherwise he'd be put in jail.

So he did. A little over a month later, on February 7, Li died of the novel coronavirus in the same hospital where he'd worked—he'd been infected with the virus while trying to treat sick patients, who'd continued pouring into the hospital throughout the month of January.

By this time the CCP had leapt into action, unable to deny the existence of the virus as hundreds then thousands of people started getting sick. Travel restrictions and quarantines went into effect—but it was already far too late. As of this writing, the virus has spread to 168 countries and killed almost 21,000 people. Schools and businesses are closed. We're in lockdown mode in our homes. And the economy is taking a massive hit that could lead to a depression.

How different might our current situation be if the CCP had heeded Li's warning instead of silencing it—or if the virus had first been discovered in a country with a free press?

"People are arguing that China has done a good job of handling the virus. I disagree," said Alex Gladstein, chief strategy officer at the Human Rights Foundation. "The reason we have this global pandemic right now is because of Chinese censorship and the government's totalitarian nature."

Last week at Singularity University's virtual summit on COVID-19, Gladstein pointed out what we can learn from various governments' responses to this pandemic—and urged us to keep a close eye on our freedoms as this crisis continues to unfold.

Open, Competent, or Neither?

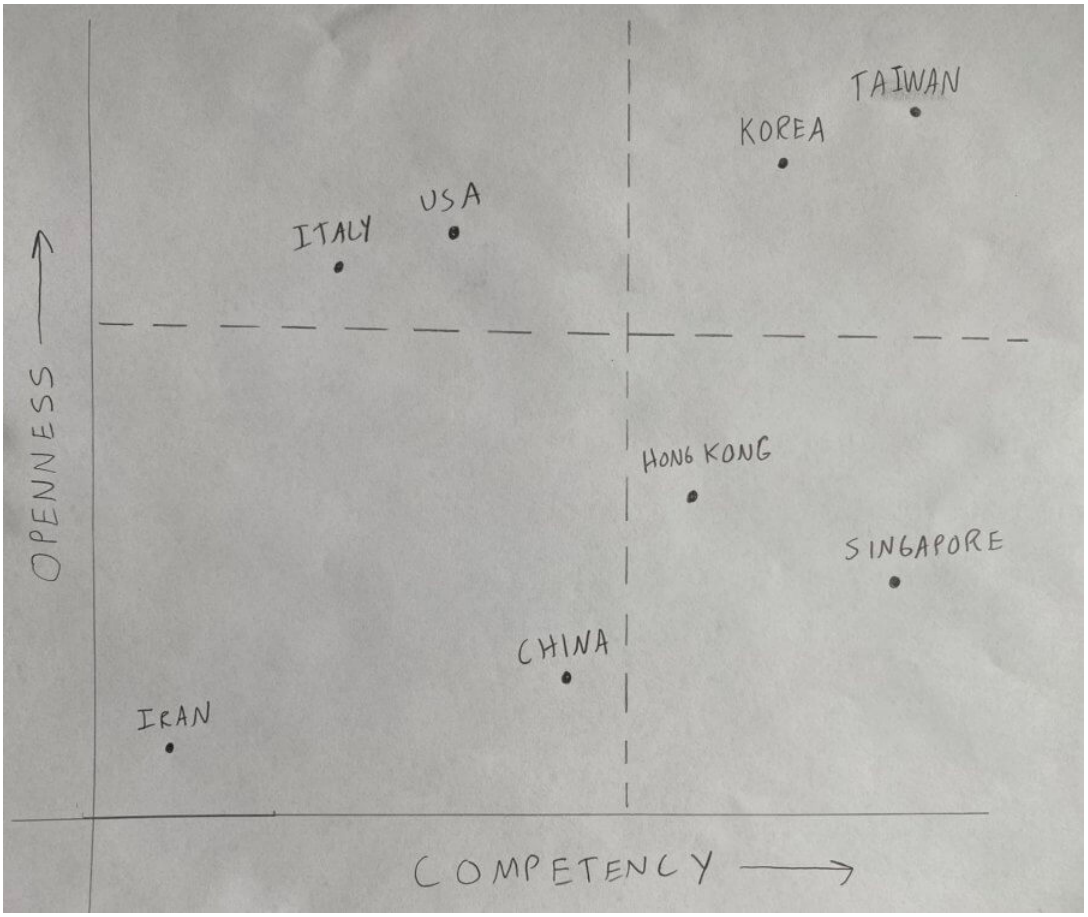
The rate at which this disease has spread in different countries has varied wildly, as have the numbers of deaths vs. recoveries. Western Europe houses some of the wealthier and

more powerful countries on Earth, but now isn't a great time to be living there (and we're not doing so hot in the US, either). And though Singapore is known for its rigidity, it was a good place to be when the virus hit.

"Given a half-century of research, the correlation is strong: democracies handle public health disasters much better than dictatorships," Gladstein said, citing a February 18th article in *The Economist* that examines deaths from epidemics compared to GDP per person in democracies and non-democracies.

Taiwan has also fared well, as has South Korea, though their systems of government function quite differently than Singapore's. So what factors may have contributed to how fast the virus has spread and how hard the economy's been hit in these nations?

There are two axes that are relevant, Gladstein said. One is the openness of a society and the other is its competency. An open but less competent government is likely to perform poorly in a public health crisis (or any crisis), as is a competent but closed government.



“Long-term, some of the best-performing societies are open, competent democracies like Korea and Taiwan,” Gladstein said. Taiwan is a somewhat striking example given its proximity to China and the amount of travel between the two.

Success Here, Failure There

With a population of 23 million people and the first case confirmed on January 21, as of this writing Taiwan has had 235 cases and 2 deaths. They immediately started screening people coming from China and halted almost all incoming travel from China within weeks of the outbreak, creating a risk-level alert system by integrating data from the national health insurance database with the immigration and customs databases (this did involve a degree of privacy infringement that we probably wouldn’t be comfortable with in the US; more on that later). High-risk people were quarantined at home, and the government quickly requisitioned the manufacture of millions of masks. “There was less panic and more belief in the

government, and this paints a picture of what we should all aspire to," Gladstein said.

Iran is on the opposite end of the spectrum in both competency and openness; they've recorded over 27,000 cases and over 2,000 deaths. "Thousands have died in Iran, but we'll never know the truth because there's no free press there," said Gladstein.

Then there's China. In addition to lockdowns enforced by "neighborhood leaders" and police, the government upped its already-heavy citizen surveillance, tracking people's locations with apps like AliPay and WeChat. A color-coding system indicating people's health status and risk level was implemented, and their movement restricted accordingly.

"They've now used the full power of the state to curtail the virus, and from what we know, they've been relatively effective," Gladstein said. But, he added, this comes with two caveats: one, the measures China has taken would be "unthinkable" in a democracy; and two, we can't take their data at face value due to the country's lack of a free press or independent watchdogs (in fact, the *New York Times, Wall Street Journal*, and *Washington Post* were expelled from China on March 17; this may have been a sort of retaliation for the US State Department's recent move to cap the number of Chinese journalists allowed to work in the US for a handful of Chinese state media outlets).

Surveillance = Success?

South Korea and Singapore, the world's other two containment success stories, both used some form of surveillance to fight the virus. In Korea, the 2015 MERS outbreak resulted in a law that lets the government use smartphone and credit card data to see where people have been then share that information (stripped of identifying details) on apps so that people they may have infected know to go get tested.

In Singapore, besides launching a contact tracing app called TraceTogether, the government sent text messages to people who'd been ordered to stay at home and required them to respond with their live GPS location. As of this writing, Singapore had reported 631 cases and 2 deaths.

Does the success of these countries and their use of surveillance mean we need to give up some of our privacy to fight this disease? Would Americans and Europeans be willing to do so if it meant this terrible ordeal would be over sooner? And how do we know where to draw the line?

Temporary May Be Tricky

To Gladstein, the answer is simple. "We don't need a police state to fight public health disasters," he said. "We should be very wary about governments telling us they need to take our liberties away to keep us safe, and that they'll only take those liberties away for a limited amount of time."

A lot of personal data is already being collected about each of us, every day: which ads we click on, how long we spend on different websites, which terms we search for, and even where we go and how long we're there for. Would it be so terrible to apply all that data to stemming the spread of a disease that's caused our economy to grind to a halt?

One significant issue with security measures adopted during trying times is that those measures are often not scaled back when society returns to normal. "During the 2008 Olympics in Beijing, the government said the new security measures were temporary, but they turned out to be permanent," Gladstein said.

Similarly, writes Yuval Noah Harari in a *Financial Times* piece (which you should read immediately in its entirety if you haven't already), "Temporary measures have a nasty habit of outlasting emergencies, especially as there is always a new

emergency lurking on the horizon." Many of the emergency measures enacted during Israel's War of Independence in 1948, he adds, were never lifted.

Testing, Transparency, Trust

This is key: though surveillance was a critical part of Taiwan, Korea, and Singapore's success, widespread testing, consistent messaging, transparency, and trust were all equally critical. In an excellent piece in *Wired*, Andrew Leonard writes, "In the United States, the Trump administration ordered federal health authorities to treat high-level discussions on the coronavirus as classified material. In Taiwan, the government has gone to great lengths to keep citizens well informed on every aspect of the outbreak."

In South Korea, President Moon Jae-in minimized his own communications with the public, ceding the sharing of information to those who actually knew it: health officials updated the public on the state of the pandemic twice a day. Singapore's government provided consistent, clear updates on the number and source of cases in the country.

Gladstein re-emphasized that democracies are better suited than dictatorships at handling public health crises because people need to be able to innovate and collaborate without fear.

But despite a high level of openness that includes democratic elections, some of the heaviest emphasis on individual rights and freedoms in the world, and a free press, the US response to coronavirus has been dismal. As of this writing, more than 25 US states have ordered residents to be on lockdown. But testing, trust, and transparency are all sorely lacking. As more people start to fall seriously ill in the coming days and weeks, what will the US do to stem Covid-19's spread?

"Secrecy, lies, and censorship only help the virus," Gladstein

said. “We want open societies.” This open society is about to be put to the test—big-time.

For more from Gladstein on this topic, read his recent opinion piece in Wired.

Image Credit: Brian McGowan on Unsplash

Elon Musk’s Boring Company Finishes First Tunnel for 155mph Vegas Loop

Last month I attended the Consumer Electronics Show (CES) in Vegas. I had a list of all the tech I wanted to see, talk to someone about, or try for myself, and I spent two days speed-walking between buildings and booths, scrambling to cram it all in: a 360-degree hologram, an exosuit, a flying taxi, haptic gloves—I didn’t want to miss any of it.

By the end of each day, my legs and feet ached—and I hadn’t come close to seeing everything I wanted to. I’m not a step-counter, but other attendees claimed to be walking several thousand steps more than their daily averages.

If Elon Musk’s new project pans out, next year’s CES will look totally different, for me and all the other (175,000+) attendees—and it will involve a lot less walking.

Last week, Musk's Boring Company finished excavating the first of two tunnels for a new transportation system that will run underneath the Las Vegas Convention Center (LVCC). The second tunnel will run parallel to the first, creating a loop to carry people back and forth in modified Tesla Model 3 and Model X cars.

There will be one station at the convention center's south hall, another between the central and north halls, and a third at the west hall, which is currently under construction. It takes about 15 minutes to walk from one hall to another (more if there are super-cool things like Avatar concept cars to see along the way). According to Musk, the underground cars will move at speeds up to 155 miles per hour, taking people between stations in just one minute.

The Las Vegas Convention and Visitors Authority awarded a $48.7 million contract to the Boring Company last year; it's the company's first commercial contract, and they're required to test the system for three months before opening it for public use. Their goal is to move a whopping 4,000 vehicles per hour.

It took three months to excavate the first tunnel, with work taking place 40 feet underground. Musk hopes to eventually expand the transit system to other parts of Las Vegas, including the Strip and the airport, and even to have a connecting tunnel running all the way to Los Angeles; LA residents may one day be able to hop over to Vegas for an afternoon (or Vegas residents go catch a glimpse of the ocean for a few hours).

Musk has a similar project planned in Chicago, where his company won a contract to build a high-speed transit system between the city center and O'Hare airport, which are 16 miles apart. That trip will allegedly take 12 minutes at speeds up to 150mph.

That sort of speed makes a little more sense when you're covering a longer distance (though 16 miles is still not terribly far). But when the total distance you're going is under a mile—the completed Vegas tunnel is slated to be 4,300 feet long—how do you accelerate from 0 to 155mph then decelerate back down to 0? This would require one heck of an engine, some super-strong brakes, and an enormous amount of energy. For such a short distance, it seems like 60mph, or even 30, would be plenty fast.

No matter the speed, though, tech like exosuits and haptic gloves may be left in the dust at next year's CES, with its shiny new transit system taking over as one of the convention's main attractions—and attendees' step counts back down to their typical daily averages.

Image Credit: The Boring Company