The Most Transformative Technologies of 2021
By
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As a Unitarian, a liberal religion rooted in Enlightenment principles, including a belief in human goodness and human potential, I do not consider it mundane or uninspiring to speak of our human accomplishments. And most of what we accomplish is through our natural use of tools. As inventor/futurist Ray Kurzweil has said, "No other tool-using animal on Earth has demonstrated the ability to create and retain innovations in their use of tools."[1] Other animals may use natural items like sticks and twigs as tools, but the human species is Nature's toolmaker. We make our way through the world by fashioning tools, innovating them, and using them in innovative ways. Virtually everything we do or possess involves tools in some fashion, from the moment we awaken from our manufactured beds to the time we tuck ourselves beneath our manufactured blankets, every moment of our lives, including our sleep, are aided by tools. And *technology*, which comes from the Greek word meaning "craft," is just another word for "tool."

As a Unitarian, I also consider myself a humanist in the Enlightenment sense, with a small "h," not a capital "H." I am not, that is, a member of the Humanist movement that was established in the early part of the 20th century as outlined in the *Humanist Manifesto*, although I am not in disagreement with any of it. Rather, I am a humanist in the classical sense of being someone who believes, again, in the goodness and potential of humans and humanity. Hence, I ascribe to the humanistic ethic, which psychologist Erich Fromm tells us "is based on the principle that 'good' is what is good for [humanity] and 'evil' what is detrimental to [humanity], *the sole criterion of ethical value being [human] welfare.*"[2]

So, when considering what distinguishes good technologies from bad technologies, we need only turn to this guiding principle. Nuclear bombs are detrimental to humanity and human welfare. There is nothing good about them. Whereas vaccinations have improved our health, extended our lives, radically reduced child mortality rates, and prevented much suffering and sorrow. As I look back upon 2021, this is the guide by which I judge the best technologies, those that promote human welfare and individual unfolding.

Speaking of which, the top prize for the most transformative technology of the year has to go to the various COVID-19 vaccines that first rolled out exactly one year ago in December of 2020. Since then, although there are still far too many, especially in the U.S., who haven't been vaccinated, healthcare workers around the world have succeeded in administering more than seven billion doses as of October, enabling those of us who have been vaccinated to feel a lot more at ease going about our lives, in addition, of course, to protecting us from getting a severe case of the illness.

How did we accomplish this extraordinary feat in such short order? First, we should keep in mind that there are hundreds of coronaviruses, which scientists had already been studying for over fifty years. According to a recent article in *Medical News Today*, "This meant that scientists had existing data on the structure, genome, and life cycle of this type of virus."[3] So

they already knew what characteristics to target, like the viral spike, or crown, that gives these viruses their name. Recent advances in genomic sequencing also allowed researchers to sequence COVID-19 in less than two weeks following its initial cases in Wuhan, China. This, along with instant global communication technologies, allowed medical experts from around the world to share information and to cooperate with each other in unprecedented ways.

It's too bad, rather than impressing and making them happy that we don't have to wait years for a vaccine, some have taken the speed with which these marvels were developed as proof they must be dangerous. Yet for anyone following the science and listening to the experts, rather than to President Drumpf and Faux News and QAnon (three peas in a pod), the early rollout was predictable. In fact, you may recall, during my sermon in March of 2020, before lockdowns were even in place, I mentioned specifically that a company in San Francisco called Moderna had already entered into human trials with a promising new vaccine, and, throughout the following months mentioned several times we'd have an approved vaccine before Christmas. I'm not a soothsayer, but I do follow science and technology, and I'm happy to have received my Moderna booster shot earlier this month.

So, again, given its impact on human welfare and individual wellbeing, I consider the COVID-19 vaccines the most transformative technologies of the year and wish to publicly thank the good people at Moderna, Pfizer, Johnson & Johnson, as well as those organizations working on other cutting-edge vaccinations to help aid us in this crisis.

Another technology worth mentioning, though much less on our radar, is continued advances in Artificial Intelligence and its applications. I recall when I first started talking about AI not too many years ago, most people still looked at is as a technology that didn't exist yet and might not for many years to come, if ever. But it didn't take long for us to start hearing about AI services offered in advertisements, though most of us still aren't sure what AI is for. AI presents us with the ability to quickly gather divergent pieces of information to develop solutions to many problems that will otherwise take us years to understand and resolve. Although AI is not self-aware, it can help us gather and decipher information at computer speed. Think of a calculator than instantly calculates all sorts of information instead of just numbers.

Artificial Intelligence is a term coined by computer scientist John McCarthy at Dartmouth in 1956. Like all technology, AI has evolved slowly since then, although exponentially, so that it's emergence as a powerful technology has snuck up on us. You may have recalled hearing the phrase, "Powered by Watson," on radio adds, referring to IBM's AI computer that famously competed on *Jeopardy* in 2011, defeating the TV quiz show's top players. Since then, Watson has been used to help businesses and organizations better determine strategies and outcomes, including in the medical field.

But an exponential leap in AI technology began about five years ago, in 2016, when Google's deep learning computer, AlphaGo beat the world's champion at a game of Go, "a board game more complex than chess by one million trillion trillion trillion trillion times."[4] But the way

it went about mastering the game was even more stunning than its victory, in which AlphaGo used an unthinkable maneuver that no human would ever have tried. AlphaGo, which had not been programmed with its rules, taught itself to how to play Go and become the world champion in just a few short hours. As AI expert, Kai-Fu Lee explains in his latest book, *AI 2041*, "Deep learning was invented many years ago, but only recently has there been enough computing power to demonstrate its efficacy, and sufficient training data to achieve exceptional results."[5]

Lee goes on to explain this recent shift is because computing power is a trillion times more powerful and data storage fifteen million times cheaper than they were when AI scientists got started decades ago. More importantly, he provides us with a succinct explanation of what this transformative tech is now doing for us, (besides beating us at our own games):

> AI solved a fifty-year-old riddle of biology called protein folding. The technology has surpassed humans in speech and object recognition, served up "digital humans" with uncanny realism in both appearance and speech, and earned passing marks on college entrance and medical licensing exams. AI is outperforming judges in fair and consistent sentencing, and radiologists in diagnosing lung cancer, as well as powering drones that will change the future of delivery, agriculture, and warfare. Finally, AI is enabling autonomous vehicles that drive more safely on the highway than humans.[6]

During the past year, Deep Learning AI has also been used to predict potential mutations in COVID-19 that would allow the virus to go undetected by our vaccinated immune systems.[7] And the European Union started an AI project using massive amounts of genomics data to predict diseases and prevent them from happening.[8] In 2021 AI has been used to improve the function of prosthetics for amputees, find new treatments for allergies, to create better gene therapies, MIT announced its work on an AI for predicting and diagnosing cancer faster than current methods can, to kill weeds on farms with targeted lasers that eliminate the need for pesticides, identified drugs already approved by the FDA that can also be useful in the treatment of Alzheimer's, and for the first time outperformed humans in natural language understanding. These are just a few of the thousands of applications AI is already being used for and that indicate a world that is going to look as radically different to us in the next five years as the world now looks to those of us who were around just a few short years ago that existed without personal computers, the Internet, and smartphones. Because of its potential for improving the lives of so many, I consider Artificial Intelligence one of the breakthrough technologies that began coming into its own in 2021.

Coupled with AI is an even newer technology that's been talked about for years but has only become a reality withing the past few months: quantum computing. It was in October of 2019 that Google announced the advent of its quantum computer, called *Sycamore*. But in July of this year, researchers from the University of Science and Technology of China (USTC) announced the development of a quantum computer that's a million times faster than Sycamore.[9] Although its currently believed our conventional computers will remain with us for a long time to perform conventional computer tasks, quantum computers perform special calculations using qubits rather than bits. What does that mean? It means they

calculate utilizing weird quantum states that can be both 1 and 0 at the same time, rather than 1 or 0. Calculating and processing at this level, the physics level, is expected to give us major breakthrough in material science.

Okay, that's as boringly technical as I'm going to get. Let me give you a practical example. Just this week I had the opportunity to attend an online Zoom meeting with Peter Diamandis, an entrepreneur, philanthropist, techno-geek, bestselling author, and all-around great guy. During his monthly, "ask-me-anything," meeting for members of his Abundance Digital community, I had the opportunity to ask him what he believed are some of the most promising new technologies for combating global warming. To my surprise, he gave an answer I did not expect and have not heard from anyone else. He said he believes AI combined with quantum computing is going to help us fashion materials in the near future that we can't currently imagine, materials that will help us repair the environment a lot faster than we can expect, without many of the unforeseen consequences current technologies risk. This is because these combined technologies will be able to simulate countless scenarios in a shorter time than it took AlphaGo to learn to master Go, chess, Atari, or some other game. So, because of its potential for the betterment of our planet and, thus, human welfare, the advent of Quantum Computing is also on my best of 2021 list.

Self-Driving vehicles have also made major advances during the past year, which is *good* news considering all the major automobile companies are moving toward all electric vehicles. But it's not yet *great* news because the electricity generated to power them is still not entirely clean energy. But it's a major step in the right direction, driven by corporate responsibility, consumer demand, and, of course, recent innovations in technology that make this transition possible.

Remember, the humanistic ethic is not anthropocentric. Human welfare requires a healthy planet; and developing and demonstrating compassion and empathy for other creatures is part becoming a fully developed human being. In the near future, autonomous vehicles, fully powered by green energy, will put a stop to a large portion of our carbon emissions, will eliminate our need for parking spaces, and car ownership for that matter, will know the best routes to take and which speeds to travel to avoid traffic jams and reduce energy consumption, and will free millions of people shut-in at home because they are or have become unable to drive themselves.

We've been hearing about and talking about autonomous vehicles for a number of years, but 2021 has been the year they started being deployed on our streets. In January, Starship Technologies became the first company ever to make over a million deliveries using autonomous vehicles.[10] If Starship's small, slow, sidewalk traversing vehicles don't impress you, that same month Singapore became the first city to charge passengers to ride on a driverless bus, for about 20 cents a ride.[11] It was also when China became the first country offering public rides in driverless robotaxis.[12] Toyota is impressed and smart enough that it recently announced its own intention to compete with big tech companies by launching a new division to develop self-driving connected cars of its own.[13] In Tokyo, Honda launched

its own high-tech autonomous model.[14] In Phoenix, Waymo's self-driving taxi service now allows passengers to make various stops in order to run errands without having to keep ordering another car. This service doesn't charge passengers while the vehicle is idle.[15] In March, Waymo also began testing long-haul anonymous trucking.[16] Hyundai, another major automaker, unveiled its Ioniq 5, a new electric self-driving vehicle that will be used in Lyft's coming fleet of robotaxis.[17] FedEx began using autonomous trucks for some of its deliveries.[18] Even Dominos began delivering pizzas in Houston using autonomous vehicles,[19] and Walmart invested billions in this emerging technology, its CEO declaring, "it is no longer a question of if … but when."[20] Cruise began operating its autonomous cars in California, and countries around the world made way for allowing self-driving cars on their roads. Self-driving boats and airplanes also made lots of headway in 2021. I could go on and on with examples, but the point is, the future is here. Self-driving, AI guided transportation has become a reality that I believe will prove to be one of the most transformative technologies we've seen in years.

There have been a lot of other positive technological advances in 2021, but I'll begin to conclude by mentioning two more that I consider to be tremendous steps forward for human welfare and individual unfolding. The first involves some of the medical achievements that have been made thanks to the gene editing technology known as Crispr. As recently as September, Researchers at Washington University School of Medicine announced they have developed a means of editing cells to release a drug to treat arthritis.[21] Also in 2021, the FDA approved human trials for testing a Crispr cure for HIV.[22] Researchers in Australia were able to use the gene editing technology to block the transmission of COVID-19 in infected human cells.[23] This incredible tool, often described as genetic scissors because it can cut out bad sections of genetic code and insert good code, has been used to treat cancer, rare and otherwise untreatable genetic maladies, heart defects, and so on.

2021 was a tremendous year for Crispr, when it first reached the milestone of having been used to systemically deliver medicine into the human body.[24] You may recall a story just a couple months ago in which Crispr was used to cure blindness in a handful of volunteers who allowed researchers to use the tech to alter their DNA.[25] The age of gene therapy is upon us, allowing us for the first time ever to go in and target health problems where they begin, often before they begin, in noninvasive ways that don't require surgery or poisoning our healthy cells with toxic chemicals and drugs. I consider this another major breakthrough for humanity.

Finally, I want to talk briefly about meat production, which is one of the largest contributors of greenhouse gases, deforestation, and the horrific suffering of tens of billions of creatures on our planet. A solution to this problem is going to be lab grown meat that will dramatically reduce greenhouse gases, both carbon dioxide and methane, the destruction of carbon sequestering trees and forests, and the suffering of our fellow creatures. This is why I consider several 2021 technological advances in meat production among the year's most transformative.

In Chicago, Aqua Cultured Foods made headlines after developing lab-grown seafood alternatives for tuna, whitefish, calamari, and shrimp, based entirely on the fermentation of microbes, no sea creatures at all, that offers up to 20 grams of protein, 12 grams of fiber and omega-3 fatty acids, and has no sodium, saturated fat or cholesterol, or starches.[26] Earlier in the year, a Barcelona based company, Novameat, began 3D printing meat that looks, feels, and tastes like the real thing.[27] A company based in Israel, Future Meat Technologies, opened the world's first lab-grown meat facility near Tel Aviv, that's capable of producing 5,000 lab-grown hamburger patties a day,[28] as well as 1,100 pounds of chicken, pork, and lamb grown from cells instead of butchering animals.[29] After an impressive tasing event, CellX, a Shanghai-based startup raise $4.3 million to start 3D printing cell-based pork for Chinese consumers.[30] Scientists at Japan's Osaka University unveiled their 3D printed steaks, made from stem cells, that actually look like steaks complete with a marbled texture.[31] Startups and researchers aren't the only one's interested in this tech: Earlier this year the Swiss-based company, Nestle, best known for its chocolate products, announced that even it's getting into what it expects to be the booming lab-grown meat business.[32] 2021 was also the year lab-grown meat was approved for consumers for the first time in history, in Singapore, followed by Israel and Brazil, and very likely the U.S. in the coming months. This is no longer future tech. It too is here.

It cannot be denied that nature's toolmakers have gotten our planet into a lot of trouble, but ours is a species that can also learn from our mistakes and use our same technological wits to solve many of the problems we've created for ourselves and the rest of the planet. Toward this end, 2021 has been a transformative year that gives us lots of reasons to believe things are already improving and that the near future will be better than we might think. But no matter what technological advances we achieve, the best humanity will always have to offer is our innovative spirit coupled with human compassion and kindness. May our desire for human well-being and individual unfolding be our guide in the year and years to come.

[1] Kurzweil, Ray, *The Age of Spiritual Machines*, Viking Press, New York, NY, 1999, p. 23.

[2] Fromm, Erich, *Man for Himself*, An Owl Book, Henry Holt & Co., New York, NY, 1947, p. 13.

[3] https://www.medicalnewstoday.com/articles/how-did-we-develop-a-covid-19-vaccine-so-quickly#Other-coronaviruses

[4] Lee, Kai-Fu; Qiufan, Chen. AI 2041 (p. xi). Crown. Kindle Edition.

[5] Ibid., p. xii.

[6] Ibid.

[7] https://singularityhub.com/2021/01/19/a-language-ai-is-accurately-predicting-covid-19-escape-mutations/

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