Will deep learning help us live longer?

Solving the planet's plastic problem

Can fintech promote more equitable commerce?

A look at life and progress in 2030

Realize

The future belongs to those who use technology to address society's most pressing challenges—and the future is bright, given that the world is in the early stages of a technology-led investment cycle. Dell Technologies has a proud history of democratizing technology to advance human progress. Our next challenge is to build the platform that will collect, analyze, and draw insights from the world's data to positively impact humanity.

With new technologies continuing to evolve at a rapid pace, we have much to be optimistic about. For example, recent Dell Technologies research in partnership with Vanson Bourne revealed that 67 percent of leaders anticipate using new technologies to create more equal opportunities by removing human bias in decision-making. When I consider the fact that Dell Technologies serves 98 percent of the Fortune 500 companies, I see limitless possibilities to partner with our customers, applying our portfolio and scale to solve some of the world's largest challenges. Together, we can shape a digital future that is more equitable, sustainable, and innovative.

In this issue of *Realize*, you'll get a glimpse into the next decade—from the technological shifts that will reshape our daily lives to the commitments we are making to cultivate inclusion, advance sustainability, and transform the lives of billions. You'll find stories of the changemakers using technology to create financial equity, help us live longer and healthier lives, design digital cities for the masses, and, ultimately, shape optimism in the digital future.

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Realize

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PHOTO (LEFT) BY TONY LUONG; (TOP RIGHT) COURTESY OF MOTHERCODERS; (BOTTOM RIGHT) BY RICH CAREY/SHUTTERSTOCK

Features

The Digital Therapist Is In

Virtual, data-driven therapy is revolutionizing the mental health treatment of tomorrow.

BY ANNA CODREA-RADO

"Let's bring it back into the room" is a classic phrase therapy patients have been hearing for decades. In the mental health treatment of tomorrow, however, that "room" may be a digital one.

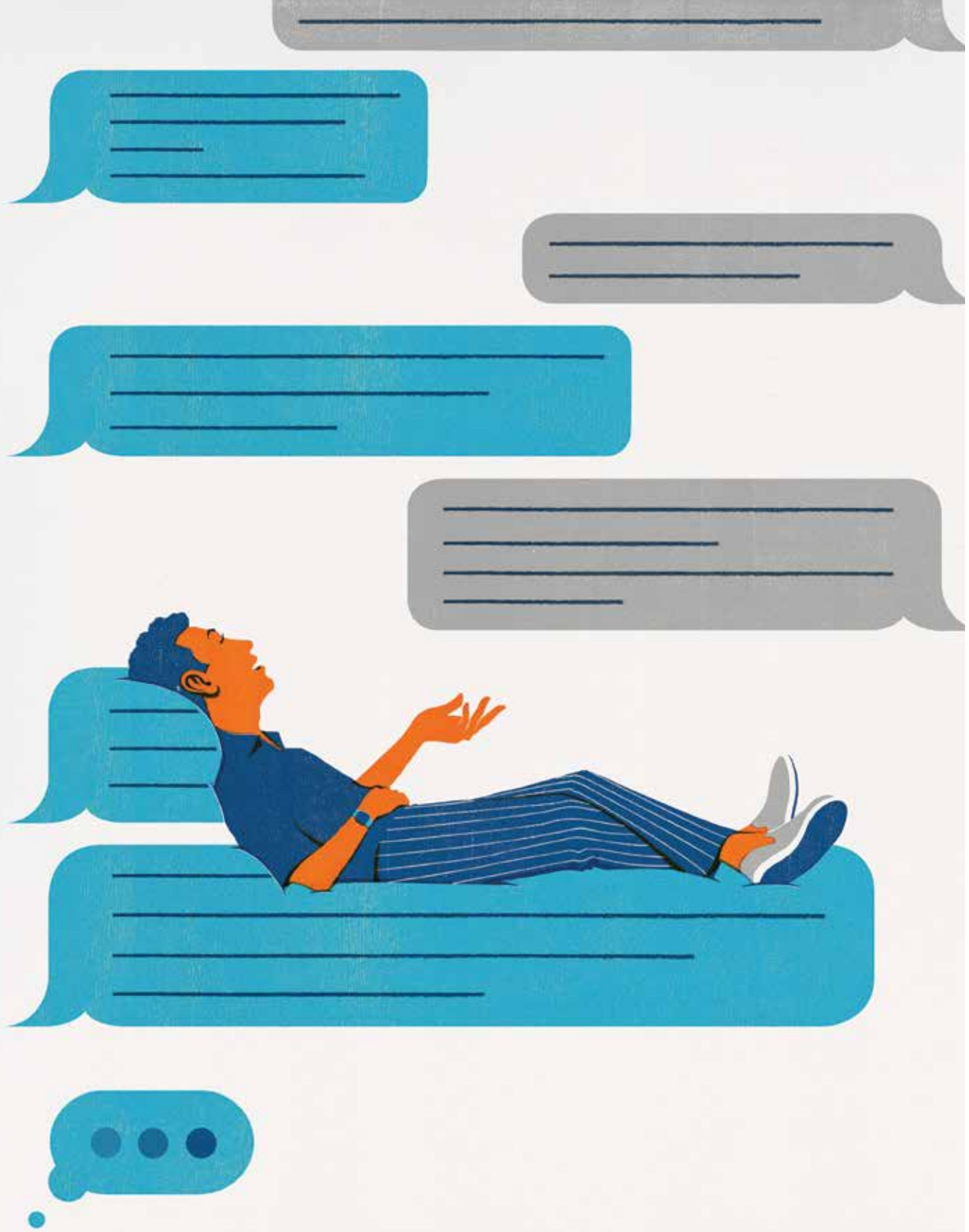


ILLUSTRATION BY DAN BEJAR

Text therapy and virtual clinicians are becoming more prevalent, delivering treatment in new, easier-to-access ways. Behind these innovations are big data sets that are transforming how mental health treatment is executed. According to some mental health experts, this data-driven therapy can be more accessible, accountable, and result in better patient treatment.

CBT 2.0

Cognitive Behavioral Therapy (CBT) is a skills-based approach to treatment, typically delivered in a short course of six to eight weeks. In these sessions, a therapist will identify patients' triggers and provide them with the tools to remodel the way they think or behave.

While CBT is one of the most widely used forms of therapy, in practice, only about half of the patients achieve full recovery. More than half of CBT users relapsed within 12 months, according to a 2017 study by the University of York in the U.K. published in the *Journal of Behaviour Research and Therapy*.

"In general, we don't have a very good system of quantifying the effectiveness of mental health treatment," says Ashley Womble, author of *Everything Is Going to Be OK*, a book about living with mental illness. "Unlike medical interventions, there are no blood tests that can measure the success of therapy."

That's where data comes in.

Will the AI doctor see you now? Find out in the AI: Hype vs. Reality podcast.
DellTechnologies.com/hypeVreality

Ieso Digital Health is a platform that provides CBT via a text-based online conversation between a therapist and the patient in a secure virtual therapy room. Commonly known as text therapy, a number of other companies, including BetterHelp and Talkspace, offer a similar service.

By the end of 2018, Ieso had treated 30,000 patients and logged 180,000 hours of therapy. Using anonymized data from the text conversations, the company has been able to improve recovery rates for its patients.

"It was through the data that we discovered that individual therapists can get into the 80 percent recovery rate," says Valentin Tablan, senior vice president of artificial intelligence (AI) at Ieso.

By running more than 90,000 hours of therapy through a deep learning model, Ieso has been able to correlate when a therapist delivers a certain type of content in a session with an improvement in the symptoms of the patient.

For example, Ieso's data analysis has shown that recovery rates are likely to increase if the patient has been given homework, such as mindfulness exercises to practice, by his or her therapist, or if the two of them have set an agenda together. "The patient needs to be involved in [his or her] own recovery," Tablan says.

THERAPY FOR ALL

In 2018, information gathered through Ieso's dataset was used in a landmark study published in the *British Journal of Psychiatry Open* that found technology-enabled treatment delivery facilitates access to care, while also enabling accelerated data capture for clinical research purposes.

As such, data-driven therapy may not only improve patient recovery outcomes, but also widen access to treatment.

"Tech is democratizing mental health by making it more accessible for everyone," Womble explains. "The old-school method of therapy, where you make an appointment weeks in advance and travel to see a therapist in his or her office for 45 minutes, just doesn't work for everyone."

At the Institute for Creative Technologies at the University of Southern California, researchers are looking into whether the solution to offering more accessible therapy resides in virtual therapy. Dr. Skip Rizzo, the institute's director of medical virtual reality, and Gale Lucas, research assistant professor, have developed a "virtual therapist" called Ellie.

"People prefer opening up to her instead of a human," Lucas says. "They disclose more to the virtual therapist than a real therapist."

Despite Ellie's not being a "real" therapist, patients respond well to her in large part because she's a piece of technology. "People feel safer with a machine," Rizzo says. "They aren't being judged by it."

CONNECTED MENTAL HEALTHCARE

As connected devices become ubiquitous, mental health experts expect to see data play even more of a role in treatment. "As the face of therapy changes, we will see more of an influence of big data analysis and AI extraction," Rizzo notes.

As he explains, there are currently only three data points a clinician can analyze in a therapist context: what patients self-report, their physiology, and their observable behavior in the clinical setting.

The next phase for data-driven therapy will be measuring health data when the patient is out in the real world, in between sessions. For example, using existing wearable technology that collects and stores health data, mental health professionals may be able to determine risk factors for a person's well-being.

> "As the face of therapy changes, we will see more of an influence of big data analysis and AI extraction."
>
> —Dr. Skip Rizzo, director of medical virtual reality, Institute for Creative Technologies, University of Southern California

"There is so much opportunity for ongoing monitoring," Lucas explains. "If we can get data from facial expression, vocal tone, how much someone exercises—all these factors are rich, big data to [look into] predictors of PTSD and depression."

Data analytics is revolutionizing science across the board. As this extends to mental health treatment, it will mean better access to care for those who need it the most. As Tablan concludes: "We now have a data-driven model of what actually helps patients get better." ■

What Robots Can't Grasp

These engineers are training the next generation of robots to pick up just about anything.

BY MARTY GRAHAM

There are some things robots just can't grasp. Literally.

And a team of engineers and data scientists at the University of California, Berkeley's AUTOLAB is creating more of these unwieldy objects all the time. The effort isn't an exercise in mechanical cruelty; rather, these weird-looking objects—what professors Ken Goldberg and Jeff Mahler call "adversarial" objects—are part of a trial-and-error approach to helping the robots at AUTOLAB develop the know-how to pick up a range of oddly-shaped items. And that's an increasingly important skill these days.

Demand for robots has increased every year, according to the Robotic Industries Association (RIA). While retail giants and auto manufacturers have historically represented the highest demand, more companies outside the vehicle sector are beginning to install robots. Of the nearly 36,000 robots purchased in 2018, 16,702 were shipped to non-automotive companies—a 41 percent increase compared to 2017.

With this more pervasive installation of robots comes expanded use cases beyond the repetitive, highly-controlled tasks they've been relegated to in warehouses and on factory floors. But they have their limits.

While robots are already completing precise assembly work, repeating a very limited set of tasks over and over again, situations—such as shifting rapidly to sort and pick up random objects to fill a retail order—stymie them. Consider, for example, the few seconds it takes for a human to remove a pizza from an oven and turn the oven off; uncork a bottle of wine, and find and fill a glass; grab a

PHOTOS BY JASON LACRAS

The suction arm of a robot at the University of California, Berkeley's AUTOLAB

plate and slice the pizza; then deposit a slice on the plate. This series of actions requires grasps of hard, soft, and even floppy objects, hot and cold objects, as well as liquids and solids. While humans instinctively understand how to grasp any object—even one we've never seen before—robots have to be taught this skill: The robot has to perceive the object with its sensors, model it appropriately, determine a strategy for picking it up, then execute the desired action. The extensive training required to teach commercial robots these skills is expensive. That's where AUTOLAB's work comes in.

LEARNING THROUGH FAILURE

Goldberg, Mahler, and their post-graduate students began working on AUTOLAB's Dexterity Network (Dex-Net) in 2015. The groundbreaking venture develops and refines robot "picking" strategies and, just as importantly, has improved the machine learning behind the picking calculations.

"Dex-Net can be used to train a robotic system for handling a variety of items without advance knowledge," says Mahler, citing CAD models, mass, or images as examples. "One of the advantages is that it can be rapidly adapted to different hardware systems consisting of various arms, grippers, and 3D depth cameras, enabling faster customization of robotic learning systems."

AUTOLAB's robot uses its suction arm to pick up scissors.

The first iteration of Dex-Net entailed a system for grasping one object at a time with parallel jaws—think two fingers or pliers. Their current work—Dex-Net 4.0—trains robots to grasp a wider variety of objects piled in heaps that make picking more challenging. Dex-Net 4.0 includes both the parallel-jaw gripper and a pneumatic suction arm—each with its own neural network. The robot's central programming provides size and shape information via sensors, but the two arms' separate neural networks decide whether an object should be handled by grip or suction.

While AUTOLAB researchers applaud their advances, what really interests them is the failures: the objects the robot couldn't pick up or hold on to.

"Part of the AUTOLAB philosophy is to probe for failure modes that provide deeper insight into a method," Mahler says. "That's where the adversarial objects came from. The results behind Dex-Net were only possible with countless hours of meticulous experimentation and healthy skepticism."

AUTOLAB has designed and created thousands of adversarial objects—some as virtual simulations and many others 3D-printed. Some objects look like familiar shapes, but with a peculiar twist—like a cube where part of one surface has been shaved, creating a new plane that easily slips out of the grippers of a cube-picking robot. Others seem surfaced from a nightmare: melted, twisted five-legged objects. The physical objects are small—around 10cm—as they're meant to thwart a robot with 5cm grippers, Mahler says.

QUICKER PICKING

Perhaps AUTOLAB's biggest breakthrough is that Goldberg, Mahler, and their adversarial objects have dramatically reduced robot training time by using simulations instead of painstaking labeling and image-learning.

Researcher Jeff Mahler (L) and Professor Ken Goldberg (R) organize objects for AUTOLAB's robot to grasp.

When Dex-Net first began, the source of data used to train the robot's algorithm was tediously hand-labeled images or examples collected from a physical system. Researchers collected millions of data points in a process that required a year or longer. That's no longer the case.

"The idea behind Dex-Net is to automate the collection of training data by using simulation," says Mahler. "We use analytic models based on physics and geometry to automatically determine whether or not a robotic grasp would successfully pick an object up. We also use a technique called domain randomization to randomize parameters of the simulator, such as object mass, friction, and camera parameters, which aids in transferring learning from simulation to reality."

"The result is that we can collect millions of useful data points in less than a day," he adds. In commercial settings, where time is money, that's a powerful innovation. The team makes much of the training data and tools available in an open source library for training other robots.

Last year, the Dex-Net robot won the Amazon Picking Challenge—Amazon's annual event that benchmarks picking progress—with an astonishing 200 to 300 picks per hour, a tremendous increase from the standard 70 to 95 picks per hour.

While in the midst of launching their own company, Mahler and Goldberg are still in the AUTOLAB refining what they've learned and leveraging advances in deep learning. "We are developing new methods [of teaching] robots to perform tasks, such as surgical needle insertion, rope-tying, and assembly," Mahler says.

Such teaching advances may elevate robots from repetitive tasks on assembly lines to more intricate tasks, like suturing in an operating room. And that puts entirely new use cases for these dexterous robots within grasp. ■

5G Is the Road to Tomorrow

The fifth generation of wireless technology may revolutionize how we drive and how we're driven.

BY RUSS BANHAM

Few things in life are certain, but one of them appears to be the inevitably of self-driving cars. Although some disparage this possibility because of safety concerns and the possible loss of personal freedom, others can't wait to hop into an autonomous car and say, "Home, please."

This latter group may get their wish sooner rather than later as mobile 5G network services become more widely available. 5G—the fifth generation of wireless technology—promises significantly faster transmission speeds than 4G platforms, in addition to latency (the time lag between the initiation and reception of communications) as low as one millisecond. This near-instantaneous delivery of information will be crucial for the multiple sensors in autonomous cars and trucks to rapidly respond to an imminent danger like a giant pothole—or a pedestrian.

ILLUSTRATION BY HELEN MUSSELWHITE

"The speed at which all this data flows to a remote human pilot operating an autonomous truck is fundamental to avoiding a collision," says Steve Viscelli, senior fellow at the University of Pennsylvania's Kleinman Center for Energy Policy and author of *The Big Rig: Trucking and the Decline of the American Dream.*

MAXIMUM SPEED AHEAD

Autonomous cars and trucks are those in which automated driving systems (ADS) do some, most, or all of the driving. There are five levels of autonomous driving, as outlined by the National Highway Traffic Safety Administration (NHTSA). These levels capture a progressively increasing use of ADS in driving a vehicle, with Level 4 describing a vehicle that is capable of performing all driving functions under certain conditions, and Level 5 describing a vehicle capable of performing all driving functions under all conditions.

When Levels 4 and 5 will occur in great numbers on the road has long been a matter of debate, though many experts believe that fully autonomous commercial vehicles like trucks will hit the roads first. "Large numbers of unmanned trucks will be on highways and other roads before we see fully self-driving cars," says Kartik Tawiri, co-founder and CTO of Starsky Robotics, a leading manufacturer of autonomous trucks.

LEVELS OF AUTONOMOUS DRIVING

HUMAN MONITORED

LEVEL 0
No Automation
All driving functions are manually controlled by driver.

LEVEL 1
Driver Assistance
The vehicle features a single automated function, such as cruise control or lane detection.

LEVEL 2
Partial Automation
The vehicle can automate multiple functions in limited situations, such as limited-access freeways.

MACHINE MONITORED

LEVEL 3
Conditional Automation
The vehicle can control most driving functions in some situations, but human override is still required.

LEVEL 4
High Automation
The vehicle can control all driving functions under certain conditions. Human override is optional.

LEVEL 5
Full Automation
The vehicle controls all driving functions without a human driver.

GRAPHICS BY RANDALL MARTIN

While some of these trucks will involve passive drivers, others will be completely unmanned, using a combination of autonomous driving technologies and remote piloting by humans to control the vehicle. "Fully autonomous trucks that are unmanned and remotely piloted [offer] too many economic benefits … for the trucking industry to ignore," Viscelli says.

Chief among these is the precipitous decline in people willing to drive trucks long-distance: The American Trucking Association posits an urgent need for 60,000 drivers. "Long-haul driving is a fun thing to do in your early 20s, but after that, no one wants to spend their life in a metal box roaming the country," says Tawiri. "The turnover of drivers is huge."

> "Long-haul driving is a fun thing to do in your early 20s, but after that, no one wants to spend their life in a metal box roaming the country. The turnover of drivers is huge."
>
> —Kartik Tawiri, co-founder & CTO, Starsky Robotics

Autonomous trucks would solve the human labor dilemma, assuming legislators and regulators are willing to designate a dedicated lane on highways to accommodate driverless trucks. Aside from addressing the driver shortage, the concept would increase safety: By limiting the use of autonomous trucks to a single lane and restricting non-autonomous vehicles from driving in this lane, the risk of a collision with non-autonomous vehicles is greatly reduced.

A designated lane also fits well with current autonomous technology: Driverless trucks can be remotely controlled through geo-fencing, which involves the use of global positioning (GPS) or radio frequency identification (RFID) to create a virtual perimeter in a dedicated lane, limiting automotive autonomy to this geographic boundary.

In this regard, the agriculture industry is instructive. "We're seeing quite a bit of autonomous equipment on farms in India, where tractors geo-fenced into a particular agricultural area drive around freely without anyone on board," says John Simlett, consulting firm EY's Future of Mobility leader.

Another factor encouraging long-haul autonomous trucks is online retail. Expectations are for the trucks to pick up consumer products purchased online at ports and rail depots, and transport these goods on dedicated lanes to smaller vans and trucks that deliver the products.

"We'll begin to see what the industry calls 'platooning,' in which the first truck in a queue of trucks is driven by a human being, and the remainder use automated driver support systems, in addition to remote piloting in the first and last miles of travel,

> Decades passed before people agreed on an acceptable level of risk when flying in a plane. We're in a phase now where we're trying to define what is acceptable and unacceptable risk.
>
> —Kartik Tawiri, co-founder & CTO, Starsky Robotics

to maintain a specific distance behind the leader, accelerating and braking as the computer dictates," Viscelli details.

This possibility bodes well for all of us. Highway accidents generally are the most catastrophic, causing an estimated annual 40,000 U.S. roadway deaths in 2016, 2017, and 2018, according to the National Safety Council. Autonomous trucks traveling in a dedicated lane away from other vehicles theoretically would enhance safety by removing "human error from the crash equation," the NHTSA states.

THE MISSING LINK?

Despite the varied benefits, the year that fully autonomous vehicles take over the roads remains uncertain. A major stumbling block is safety, insofar as a clear and mutually agreed upon understanding of acceptable risk by governments and the public.

"No critical system of transportation can claim a zero percent level of risk," Tawiri says. "Decades passed before people agreed on an acceptable level of risk when flying in a plane. We're in a phase now where we're trying to define what is acceptable and unacceptable risk."

This effort has not stopped scores of autonomous test vehicles from practice runs on the nation's roads, most unnoticed by the public. So far, 29 U.S. states have passed legislation allowing specific uses of self-driving vehicles. Obstacles remain, with both autonomous technology providers and carmakers conceding the difficulty of developing a car that avoids every possible collision without constantly braking.

5G is a possible solution to this dilemma. At the 2019 Consumer Electronics Show, the 5G Automotive Association, an organization composed of more than 110 automotive, technology, and telecommunications companies, unveiled Cooperative Intelligent Transportation Systems—an autonomous vehicle system comprising vehicle-to-vehicle, vehicle-to-infrastructure, vehicle-to-network, and vehicle-to-pedestrian communications. Such vehicle-to-everything wireless communications (dubbed V2X) can handle enormous data volumes, reducing latency risks.

5G networks are expected to reach half the world's population by 2024. "My perspective is that we will begin to see Level 4 autonomous vehicles on the road in much greater numbers by 2030, with Level 5 vehicles following relatively soon thereafter," EY's Simlett says.

That's roughly 10 years from now. As NHTSA stated, "Fully automated cars and trucks that drive us, instead of us driving them, are a vision that seems on the verge of becoming a reality."

Home, please. ■

Find more stories of how 5G will enable everything from self-driving cars to telemedicine.
DellTechnologies.com/Perspectives

Reimagining the Cities of the Future

Amit Midha, president, Asia Pacific & Japan, Global Digital Cities at Dell Technologies, shares his experience of partnering with governments worldwide to build digital cities.

BY AMIT MIDHA

We are living during one of history's most prominent inflection points. According to the United Nations, by 2050, almost 70 percent of the world's population will live in urban areas, compared to 55 percent today and 30 percent in the 1950s. This massive urbanization has a direct impact on public safety, citizen services, environment, transportation, and energy, among other living conditions.

Beyond the obvious physical limitations to growth, today's cities face challenges of aging populations, overstretched infrastructure, declining public budgets, and sustainability. Top that with the "digital native" generation's expectations for engaging, digital-first experiences, and it's no wonder these urban clusters are turning to digital technologies to become smarter and more efficient. But the pace of change creates yet another—and perhaps the greatest—challenge: How do governments create a digital city with data at its heart, while still running that city with limited resources? It's much like fixing the train tracks while the train continues to chug along.

SOLVING TOMORROW'S PROBLEMS WITH YESTERDAY'S SOLUTIONS WILL NOT WORK

Conversations about making cities "connected" or "smarter" have been happening for over a decade now, and we have made reasonable progress. These smart city implementations have largely been about optimizing city infrastructures and processes. At Dell Technologies, we believe the new direction is building "digital cities"—in which digital and data are at the core of how cities operate—to make them intelligent, inclusive, efficient, entrepreneurial, secure, and sustainable.

By 2020, a city of 1 million people will generate 200 million gigabytes of data per day. To extract value from that data, cities will need to evolve from building siloed intelligent systems to scaling up into an intelligent "system of systems." This more holistic view of the city's transformation leverages cross-departmental data, interoperability, and analytics to drive more effective and efficient outcomes.

"By 2020, a city of 1 million people will generate 200 million gigabytes of data per day. To extract value from that data, cities will need to evolve from building siloed intelligent systems to scaling up into an intelligent 'system of systems.'"

Cities across the world are not the same; there is no singular winning approach to becoming a digital city. However, in our many engagements with local governments, we have gained a deep understanding of common challenges cities are facing, among them: Speed to execution is slow, often taking two to three years; data silos are a significant drag on innovation; and stakeholders lack clarity about the desired outcome and flexibility about the technology used to get there.

> As digital technologies are being integrated into every building, sidewalk, car, home, lamppost, and garbage can, data will be at the heart of the city of the future.

Dell Technologies is partnering with cities around the world to address these challenges head-on—creating an encompassing digital city roadmap that enables them to move beyond siloed use cases, while providing a strong foundation that allows flexibility to start small and scale. Here is a glimpse of just a couple of the cities we have partnered with for their digital city initiatives:

- The City of Las Vegas, Nevada, is increasing public safety and reducing response times for first responders by using machine learning to analyze real-time data from sensors and devices across the city and alert authorities of abnormal patterns.
- In the Netherlands, the City of Delft aims to alleviate city center truck congestion and reduce carbon emissions by using semi-autonomous, hydrogen-powered river barges that are connected and controlled by a mobility cloud.

THE CITY OF THE FUTURE

As digital technologies are being integrated into every building, sidewalk, car, home, lamppost, and garbage can, data will be at the heart of the city of the future. In the recent Future of Connected Living report from Dell Technologies and Institute for the Future, researchers forecast that the vision of the digital city will, once again, shift to one of a sentient city—a city that can remember, correlate, and anticipate its citizens' needs.

In the sentient city, the intersection of 5G, wireless networks, the Internet of Things, and AI-powered analytics will intrinsically link humans, machines, and everyday objects, creating new data about how we engage with the city's infrastructure and services. Governments will be able to create intelligent, data-driven city services, design safer transportation systems, and increase sustainability through more efficient resource allocation.

Achieving this vision will require us to reengineer our relationships with our governments, infrastructures, and one another. When we succeed, our cities of tomorrow will become a vibrant platform for innovation, inclusion, and community. ■

Amit Midha serves on the World Economic Forum Global Future Council on Cities and Urbanization.

THREE KEY TENETS OF DIGITAL CITY SUCCESS

1. Outcome focus
   Lead with the problem to be solved.
2. Collaboration
   Form citizens, public, and private partnerships.
3. Technology map
   Adopt a platform that is scalable, future-proof, and open.

PHOTO BY TONY LUONG; LETTERING BY JOEL HOLLAND

Envisioning Progress Made Real in 2030

BY ANNA-LEE MUCK

Dell Technologies Chief Responsibility Officer Christine Fraser, in conversation with Realize, shares her renewed optimism of the future with tech.

What was the path that led to your role as chief responsibility officer (CRO) at Dell Technologies?

It's probably a non-traditional path. I've spent my career embedded in the business across a variety of functions: strategy, operations, marketing, business development, partner development, and leading the Integration Program Office on behalf of EMC.

Through these leadership positions, I found myself with platforms to deepen my personal engagement in programs that matter to me. I became involved in mentorship and sponsorship programs, particularly for women, and later in programs for professionals of color. I've had teams that are dispersed across the globe and saw firsthand the impact of community engagement initiatives led by our team members. And I have also experienced increased expectation from our customers and partners related to social impact, whether that's corporate social responsibility, or diversity and inclusion.

So when the CRO role presented itself, I was excited about the opportunity to apply my experience and business acumen to the commitments Dell Technologies makes to our team members, our customers and partners, the environment, and communities.

How has this role impacted your life outside of the office?

The greatest impact has really been a heightened awareness and a renewed sense of optimism. The role exposes me to the magnitude of the environmental and social issues that are facing humanity. But even as these issues seem very daunting, I also get to witness the remarkable initiatives that are being led both

formally and informally by Dell Technologies through business commitments and the efforts of the thousands of team members across the globe. Seeing that complete picture—and also being able to direct the focus areas—makes me eternally optimistic that technology and people can solve some of the biggest challenges facing humanity.

Is there a particular area of social impact you are most passionate about?

What I'm most passionate about is ensuring that we're affecting real change and material outcomes, which requires locking our focus on initiatives adjacent to who we are—and who we are is one of the largest technology providers in the world. That means we've got to invest in programs that leverage the use of our technology to solve complex issues. And it also means we need to recognize that we are one of the largest employers of technology jobs, so we have to broaden the aperture and affect the changes of inclusiveness required to attract, develop, and reflect the workforce of the future. To me, it's about leading by example.

As one of the largest tech companies, we recognize we produce and ship a lot of "things." And as such, we need to be committed to maximizing every opportunity to recycle and reuse materials, and we need to hire more diversity in our own business to ensure we're building technology solutions that reflect the diversity of society.

Dell Technologies reported meeting its 2020 social impact goals early. What were some of those accomplishments?

The Legacy of Good 2020 plan was established in 2013, and through the hard work and commitments of our global team members, and the business, we're in the fortunate position to have reported early achievement of many of the 2020 goals.

We reused 100 million pounds of recycled content in Dell Technologies' new products, and we reduced the energy intensity of our product portfolio by 64 percent. Our team members delivered 5 million service hours to communities globally. We've enabled 60 percent of eligible team members to participate in flexible work options. We've created STEM educational opportunities for thousands in communities around the globe through programs like our solar-powered learning labs. And we've rolled out MARC—the Many Advocating Real Change program focused on mitigating unconscious bias—to 100 percent of our executives, and now we're moving it down throughout the organization.

We're humbled to continue to receive recognition from organizations like LinkedIn as a 2019 top company, from the Human Rights Campaign 2019 Corporate Equality Index as one of the best companies to work for LGBTQ equality, and to be included on Ethisphere Institute's list of the world's most ethical companies. So, we've had a little bit of an early victory with 2020 goals, but beyond the celebration, we're now able to extend our commitments to 2030.

What were some of the lessons that came out of that work that you are applying to your 2030 goals?

There were a few. The first was reinforcement of what we've known all along: our team members are incredibly passionate about social impact. We need to find more ways to harness their talents and capabilities because their ideas can make a really big difference.

We've learned that many of our customers and partners care about this now more than ever. They have increased expectations of us. Perhaps most exciting, many are eager to consider partnering around shared goals. This dynamic is presenting the opportunity for us to harness our relationships for greater impact.

We've learned that real progress requires deep alignment with our business priorities and understanding the role our technology can play in solving complex problems. We need to be very clear about where Dell Technologies can apply its resources—the breadth of our portfolio, the passion of our team members, and the commitment of the business—for impact.

And we've learned that innovation is really important. Not everything we do is going to be executed at scale. But if we continue to invest time and resources into innovation, it can lead to really significant change.

So our focus for 2030 is to harness the resources and the talent that we have throughout Dell Technologies. It's about the passion of our people, passion of our customers, the commitment to innovation, and deep alignment of our social impact initiatives with the business strategy.

What is Dell Technologies' social impact vision for 2030?

Our 2030 vision, which we call Progress Made Real, is rooted in three core pillars that we believe best represent our commitments for

social impact: advancing sustainability, cultivating inclusion, and transforming lives—all with the power of technology. Foundational to the vision is our commitment to upholding ethics and privacy.

We're going to continue to commit to areas like the circular economy and protecting human rights, including the rights of our own team members, as well as the many people in our extended supply chain.

We will up-level our focus on empowering the future workforce and expanding access to the tech jobs of the future. That doesn't just mean programs for students, but also supporting the re-entry of those who have temporarily stepped away and the re-skilling of those already here. The jobs of the future will require skills that we have to ensure our existing team members develop. And it also means building a culture of inclusion where everyone feels a sense of belonging.

We are also making a concerted effort to scale our impact through collaboration with our customers, partners, and peers across our industry because we recognize that no one of us is going to do this on our own.

You described ethics and privacy as foundational to the 2030 vision. Why did Dell Technologies specifically outline ethics and privacy as part of social impact?

We did a lot of work in developing our goals, and that included a company-wide survey asking team members what they feel are important initiatives for Dell Technologies to commit to for 2030. We also surveyed many of our leaders and conducted external analysis. One thing that surfaced consistently was concern around ethics and privacy. While ethics and privacy have always been core to everything we do at Dell—it's part of our ethos and our culture—it's also becoming increasingly important as we build emerging technologies that are intimately connected to our daily lives. It's really a concern for the entire tech industry, and we recognized the need to specifically call it out as a way of reinforcing our commitment to operating with the highest ethical standards.

With so many social and environmental issues to address, what is your advice to business leaders about how to choose the right social impact initiatives?

My advice is to start with your overall business strategy and your core strengths, then create a social impact agenda that is adjacent to those. I'm a "less-is-more" person, so I believe that when you select impactful initiatives that are core and adjacent to your business, it's easier to mobilize people and resources to support success. For us at Dell Technologies, we want to harness our technology and our team members for the greatest benefit, and we want to make sure that our team members reflect the diversity of our society and feel that they can be their authentic and best selves at work.

How have you rallied Dell Technologies team members to take part in social impact initiatives?

Our success is directly tied to how we engage and mobilize our 150,000+ team members, so we focus on fostering an environment where volunteering and giving back is valued and encouraged. Great ideas can come from anywhere within the organization, so we look for ways for our team members to voice their opinions and provide their input on our social impact agenda, on what they are passionate about, and where they think Dell Technologies should be focusing our initiatives. And then we do a lot to communicate examples and celebrate the kinds of work that people are doing to support us.

Our leadership plays a critical role in not only defining our priorities, but also aligning their particular interests or leadership agendas to those priorities. Many of our leaders recognize that they have a platform, and that if they model the commitments we are making at a corporate level, it matters to their teams and people will follow.

You mentioned having renewed optimism. How do you define optimism in the digital future?

Optimism underpins all innovation; it's that core belief that there is always more we can do. And optimism sustains our belief that we can influence the outcome—that technology can solve problems, that people can solve problems, and that regardless of how challenging the problems are, there are innovations and commitments we can make to solve them. Optimism is the single greatest force in achieving social impact. ■

Read more about Dell Technologies' vision for social impact in 2030.
DellTechnologies.com/ProgressMadeReal.

The Future of Connected Living

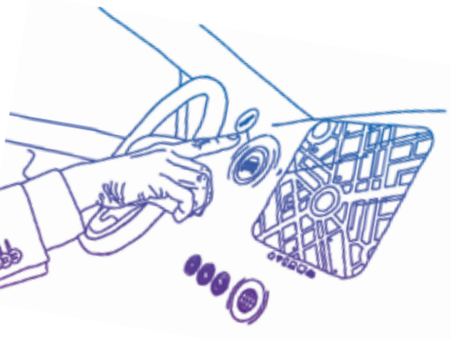
Over the next decade, an array of emerging technologies will reshape our daily lives. From autonomous vehicles to smart homes to digital cities, we won't just live with our machines, but rather become more immersed and work in partnership with them. Dell Technologies has partnered with Institute for the Future to explore the key shifts that will shape how we live in the coming decade.

Five Shifts to 2030

1. Networked Reality

Our digital environment will become more immersive and interactive than ever before—extending across our homes, vehicles, workplace, and our bodies.

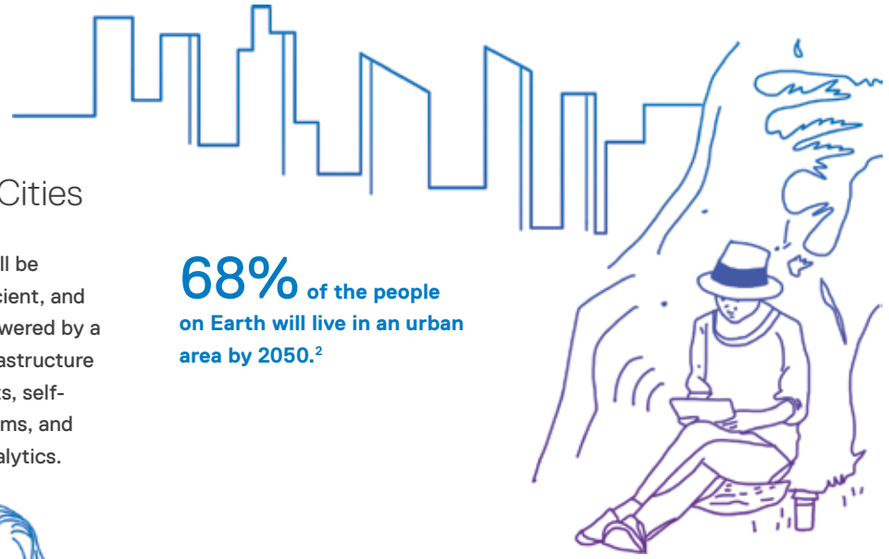
56% of leaders say they would welcome day-to-day immersion in virtual and augmented realities.[1]



2. Connected Mobility and Networked Matter

Transportation systems will resemble the packet-switched networks underlying the internet. Autonomous vehicles will act as nomadic sensors on the Internet of Things.

50% of leaders believe they will travel in a self-driving car.[1]



3. Sentient Cities

Digital cities will be intelligent, efficient, and sustainable, powered by a networked infrastructure of smart objects, self-reporting systems, and AI-powered analytics.

68% of the people on Earth will live in an urban area by 2050.[2]

4. Agents and Algorithms

Highly personalized intelligent agents will serve as our "operating system for living," anticipating our needs and taking action to meet them.

50% of leaders expect they will rely upon their virtual assistant.[1]

5. Robots With Social Lives

Robots will be socially engaged with humans, but also with each other—sharing knowledge through a social (robot) network.

70% of leaders would welcome people partnering with machines to surpass our human limitations.[1]

Read the full Future of Connected Living report at DellTechnologies.com/FutureOfLiving

1. Dell Technologies research, "Digital Transformation Index," conducted by Vanson Bourne, August 2018, www.delltechnologies.com/DTIndex.
2. United Nations, 2018 Revision of World Urbanization Prospects, December 2018, https://population.un.org/wup/Publications/Files/WUP2018-KeyFacts.pdf.

Can Games Outsmart Fake News?

In the era of deepfakes and digital provocation, gamified simulations may help people spot and thwart the spread of disinformation.

BY PRAGATI VERMA

These headlines and social media posts are pulled directly from or inspired by the *Bad News* game developed by the University of Cambridge in collaboration with Dutch media platform DROG.

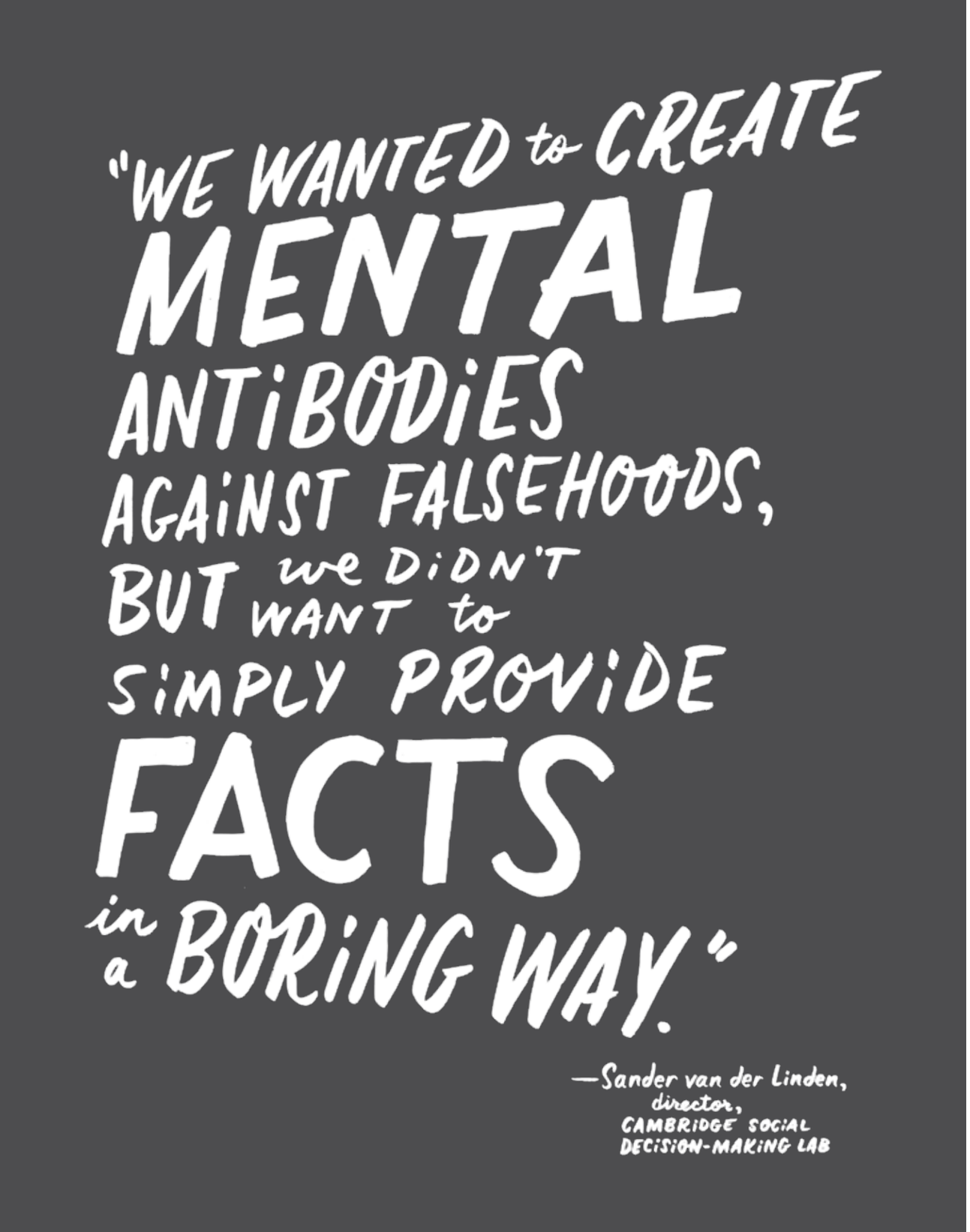


PHOTO PREVIOUS PAGE ELENA FEDORINA/ADOBE STOCK; LETTERING AND ILLUSTRATIONS BY JOEL HOLLAND

In early 2018, University of Cambridge researchers built an online game that puts players in the role of a propagandist. In one round, players can opt to impersonate the president of the United States and declare war on North Korea while tweeting from a fake account. In another round, they distort truth to incite conspiracy theories about vaccines with emotionally charged headlines, while deflecting fact-checkers.

Along the way, players impersonate celebrities, manipulate photos, create sham news sites, and build an army of Twitter bots to stoke anger and inflame social tension. They are rewarded with badges for completing certain tasks and identifying misinformation techniques commonly seen in false and misleading news stories—impersonation, conspiracy, polarization, discrediting sources, trolling, and emotionally provocative content. To excel in the game, players need to keep an eye on their followers and credibility meters at all times. The more unscrupulous and devious they are, the greater their chances of winning.

Putting people in the position of fake newsmongers might sound sinister, but game designers have legitimate reasons for walking people through the process of creating fake news. "It trains people to be more attuned to the techniques that underpin most fake news," says Sander van der Linden, director of the Cambridge Social Decision-Making Lab, which created the game *Bad News* in collaboration with DROG, a Dutch media collective.

VACCINE AGAINST DISINFORMATION

Inspired by the concept of vaccines using weaker or attenuated viruses to generate immunity, Linden and his team created the game to see if they could preemptively debunk fake news by exposing people to a weak dose of the methods used to create and spread disinformation. They knew that they needed some creativity to make it work. "We wanted to create mental antibodies against falsehoods, but we didn't want to simply provide facts in a boring way," he says.

Initially, they created a board game where players competed to spread fake news by using shady practices—such as conspiracy theories and inflammatory headlines—to polarize people. They soon realized that the game needed a social media component and created the online browser-based game with a simulated Twitter feed. Next, they added a follower meter and a credibility meter, and now they provide instant scores of players' performance. To gauge the effects of the game, players are asked to rate the reliability of a series of different headlines and tweets before and after gameplay.

About half a million people have already played the initial English version of the game that is now available in 14 languages. And about 15,000 players agreed to share their information with Cambridge researchers.

Their study, published in the journal *Palgrave Communications*, shows that the gamified simulation increases "psychological resistance" to fake news. Players were found to be 21 percent less likely to believe fake news after completing the game. The impact of impersonating celebrities and other personalities went down by 24 percent, and deliberately polarizing headlines by 10 percent. Effectiveness of discrediting tactics—attacking a legitimate source with accusations of bias—reduced by 19 percent, and conspiracy

theories that spread false narratives blaming secretive groups for world events were 20 percent less effective after people played *Bad News*.

FOLLOW THE MONEY

While many spread false stories and polarizing content to push a political agenda, others are there for ad dollars. "Disinformation has moved, in the last few years, from being a propaganda to a business model," says Clare Melford, co-founder of Global Disinformation Index (GDI), a global coalition aiming to rate media sites on their risk of carrying disinformation.

Today, most online ads are placed automatically in real time, she explains, and advertisers have no way of stopping their ads from going to publishers that spread disinformation. "Companies, often without realizing, purchase ads that end up on sites generating low-quality and false news," she says. Eyeing these ad dollars, several low-quality news websites publish emotionally charged, false narratives to maximize engagement. "The more outrageous your content, the more clicks you get. And more clicks mean more ads," Melford explains.

GDI is currently working on building a prototype disinformation index that would give a risk rating to the online news domains in the United Kingdom and South Africa. They plan to classify their websites in two ways. First will be an automated machine learning assessment that can classify large volumes of low-quality but high-volume sites in real time. Second will be a manual assessment of higher-quality disinformation outlets that may not be easily identifiable by automated means. These may include indicators such as whether a domain has been involved in a disinformation campaign in the past.

Eventually, GDI plans to create a global index and cut off the funding to disinformation while providing advertisers control over how their brands would be seen. "We will feed these risk ratings directly into ad exchanges so that advertisers can decide in real time whether they want to put their clients' money on sites that spread false news," Melford says.

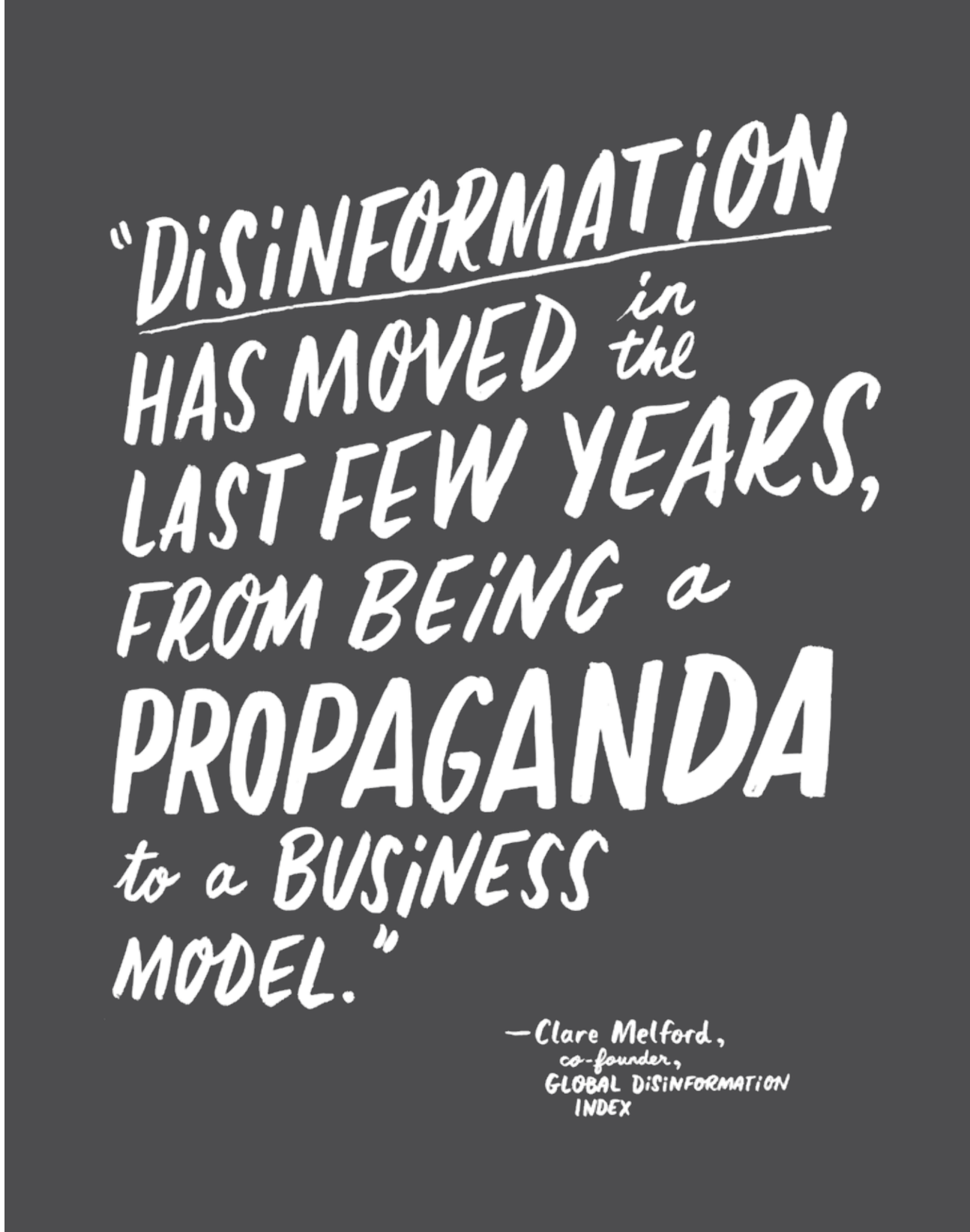
GDI is not alone. Several entities, such as Credder and NewsGuard, are working on providing scores to news publishers so that both audience and advertisers can judge their credibility.

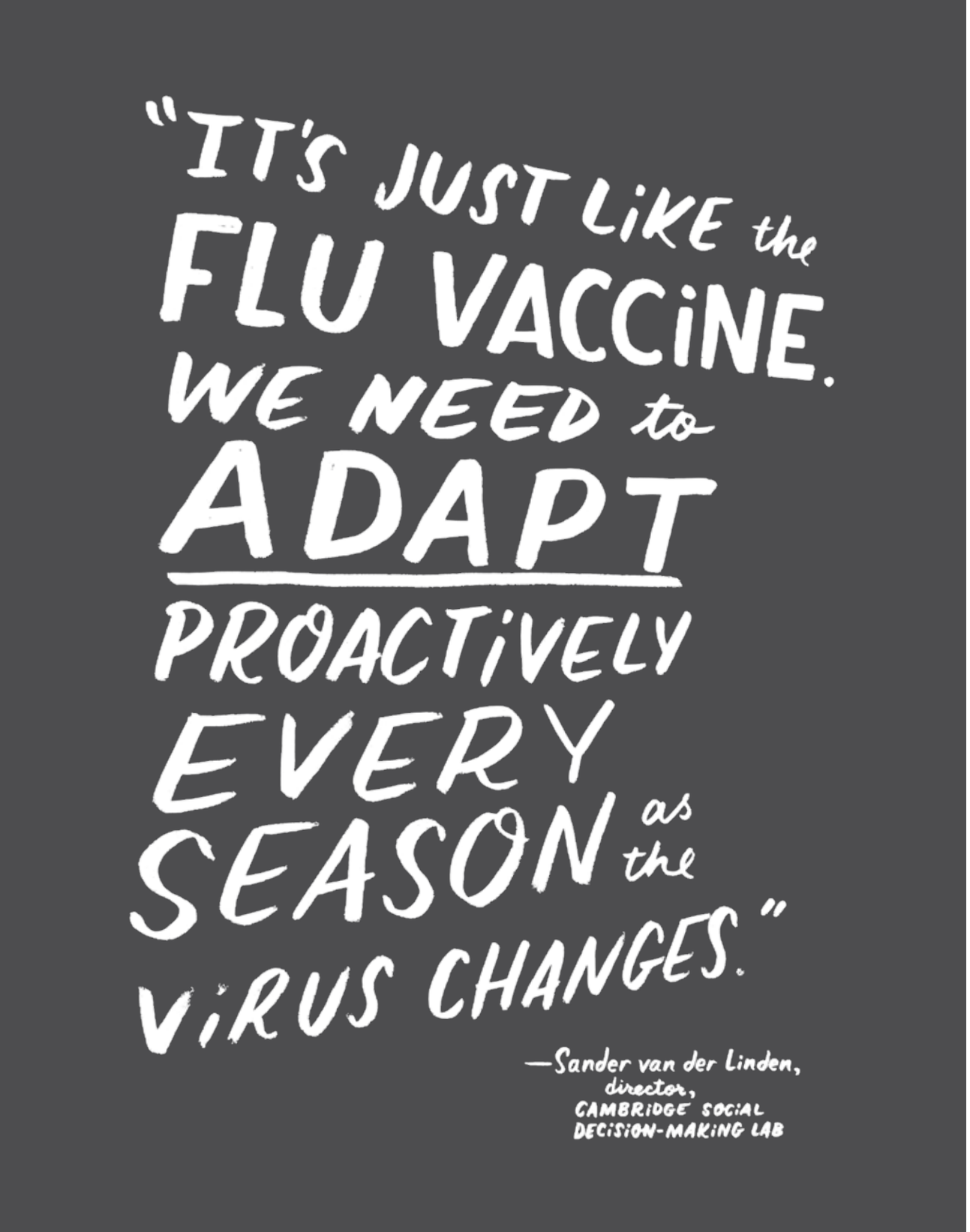
FIGHTING MOB VIOLENCE

Fake news is not just misleading voters and influencing elections; it's killing people in India. Several deaths and mob lynchings have been linked to videos and messages—often fake or edited—spreading on WhatsApp.

The Facebook-owned messaging app, with more than 1.5 billion users globally, is restricting message forwards to crack down on the spread of rumors. It is also giving 20 different research groups $50,000 to help it understand the ways that rumors and fake news spread on its platform.

One of them is Cambridge's Social Decision-Making Lab, which is building a new version of *Bad News* for WhatsApp users in India. "We will use the same principles, but the engine will be slightly different," says Linden. For one, they will simulate WhatsApp instead of





Twitter as a tool to spread false information. Another difference, he points out, will be how people win or lose the game. "Instead of gaining followers and losing credibility, they will lose 'lives' when someone in their network reports or blocks them," he adds. They will work with India-based Digital Empowerment Foundation to translate the game, adapt it to the local cultural context, and test it in rural areas.

Linden expects the testing to be complete by the end of this year and to release the game early next year.

FIGHT FIRE WITH FIRE

Several researchers are trying another interesting tactic in the war against fake news—make more of it. One such example is Grover, an AI model created by University of Washington and Allen Institute for Artificial Intelligence computer scientists. They claim that their neural network is extremely good at generating fake and misleading news articles in the style of actual human journalists and is equally good at spotting AI-written online propaganda.

The idea of using AI to both generate and identify fake news is not new. AI research company OpenAI's natural language model GPT-2 created a controversy earlier this year, when they decided that their text-generating AI tool was too dangerous to release publicly.

But Grover's creators believe that it's the best tool against AI-generated propaganda. "Our work on Grover demonstrates that the best models for detecting disinformation are the best models at generating it," said University of Washington professor and research paper co-author Yejin Choi in a press release. "The fact that participants in our study found Grover's fake news stories to be more trustworthy than the ones written by their fellow humans illustrates how far natural language generation has evolved—and why we need to try and get ahead of this threat."

WHEN SEEING IS NO LONGER BELIEVING

These new technologies have accelerated ongoing discussions about the potential dangers of AI-generated content, especially deepfakes—AI systems that adapt audio, pictures, and videos to make people say and do things they never did. By creating realistic representations of events that never happened, they are threatening to take the war of disinformation to another level. "Everyone is worried about deepfakes. We were at the European Commission a few months ago and the first question they asked was about deepfakes," says Linden. "It is on our to-do list."

Linden and his team now plan to enhance *Bad News* to add deepfakes to the round where players are asked to impersonate an authority figure. "We will upgrade our impersonation badge to include tricks to spot fake videos, such as [the] fake Obama or Mark Zuckerberg videos that went viral recently," he says.

Deepfakes are horrifying everyone today, but do researchers like Linden have a silver bullet solution for the crisis? Probably not, but they plan to step up their game, as malicious actors adopt new and more vicious propaganda techniques. "It's just like the flu vaccine," he says. "We need to adapt proactively every season as the virus changes." ■

MotherCoders students and their families celebrate the launch of MotherCoders in New York at City Hall.

PHOTO COURTESY OF MOTHERCODERS

All for One and Tech for All

These organizations are equipping communities with the innovative technology and skills they need to build a more equitable planet.

BY BLAKELY THOMAS-AGUILAR

In 1987, journalist Daniel Ben-Horin came up with the idea to create a technology mentoring system to help nonprofits and schools in the Bay Area. Now known as TechSoup, Ben-Horin's idea was born from his experience witnessing two simultaneous challenges: Social activists were desperately lacking access to new technologies and the skill sets needed to apply them to their work, while the area's techies desired to contribute to social change, but didn't know where to start. So Ben-Horin set out to make connections between these groups of people. That connection is still part of TechSoup's mission today.

"TechSoup is a network of international nongovernmental organizations (NGOs) all working on a common mission. We use technology to help communities connect and develop innovative solutions, so we have a more equitable planet," says Rebecca Masisak, CEO of TechSoup.

The nonprofit organization collaborates with 61 of the world's leading civil society organizations to improve lives with technology. These partners serve communities in nearly every region of the world. There are 12 million nonprofit organizations globally today, and TechSoup's Global Network has reached 1.2 million of them—delivering greater

The TechSoup Global Network, made up of nonprofits from over 50 countries, gathered for three days in San Francisco, March 2019.

"The key to our mission is to enable all those other missions out there." —Rebecca Masisak, CEO, TechSoup

than $12 billion market value of in-kind tech and funding. "The key to our mission is to enable all those other missions out there," Masisak says.

IN THE COMMUNITY

While education is still fundamental to TechSoup's outreach—through trainings, blogs, events, and webinars that help nonprofits learn how to leverage technology to power their causes—TechSoup has expanded its services beyond mentorship to address technology accessibility, affordability, and support.

"Over the course of time, we found that when we were helping local organizations, they often could make a plan for technology, but they couldn't get the funding and resources they needed," Masisak says. "So, we came up with some ideas for how to better provide services, [reach out] to corporations and others who might be able to provide products, and expand [our offerings] to a broader set of products and services [using] an e-commerce platform to do it."

Through TechSoup's e-commerce platform, NGOs, nonprofits, and charities have access to 375 products and solutions from more than 100 companies, such as VMware, Dell, Microsoft, Adobe, and Zoom. In some cases, nonprofits are eligible to receive donated or discounted software and hardware. TechSoup also provides service and support capabilities, including managed IT services, help desk support, and access to a network of technology consultants with nonprofit expertise.

"We are always trying to help make it easier and have less friction for nonprofits to connect with offers, and for corporations to meet their philanthropic objectives. That is the secret sauce," Masisak says.

Masisak points out that technology is not itself the end goal. The goal, rather, is to connect people to the resources they need to help citizens at the local community level. "There's much about nonprofit work that is hyperlocal," she says. "[For example], if you're an elderly person, and you need to go somewhere for a service, you need it to be convenient and right in your neighborhood. So, I think hyperlocal really matters."

That's why TechSoup has historically served the smallest organizations. "We have a value around inclusivity, and we don't want to leave organizations behind," Masisak says.

One of these small organizations is MotherCoders, a nonprofit located in the San Francisco Bay Area and New York City.

CODE LIKE A MOTHER

Tina Lee was a long-time contributor to the technology industry before giving birth to her second daughter. Faced with the reality of working full-time while parenting two children, she saw a need for helping moms keep up with fast-paced market changes in tech. There weren't any tech meetups or skills classes designed to help women with children stay current, let alone get ahead. So she founded MotherCoders, a training program to help moms jump-start their careers in tech.

"Our mission is to grow and diversify the tech talent pool by activating mothers with college degrees and work experience who are ready to contribute," says Lee.

Lee saw firsthand mothers wanting to break into the tech industry because they understood that's where the career advancement opportunities are and where they could earn enough money to support their families. "In a lot of instances, childcare for one kid costs more than rent and college tuition," Lee says. "So we had a lot of moms who looked at technology and said, 'Yes, I want a piece of it.' But they didn't know how to access the industry."

To date, MotherCoders has trained more than 300 moms through events, workshops, and a signature nine-week technical training program. The tech training program, which offers onsite childcare, is an immersive learning experience that helps students gain the skills, knowledge, and professional network needed to move into careers in tech. Each training program wraps with a visit to a tech company—host companies have included Airbnb and Lyft—to learn the inner workings of tech teams.

Some of the women who come to MotherCoders are already working full-time, but want to transition into a more technical role. Others have stepped out of the workforce and want to reenter in tech. And some are entrepreneurs who have an idea for a tech-involved business and need foundational knowledge to take the next step.

MotherCoders counts on TechSoup for the technology that makes it possible for the organization to do its work, including accounting and cybersecurity software, laptops, and other hardware that help streamline operations for its distributed team and enable students to achieve their goals. "The greatest thing about TechSoup is that it makes technology accessible to everyone,

MotherCoders Founder, Tina Lee, interacts with students at a data science workshop.

PHOTOS COURTESY OF TECHSOUP (LEFT) AND MOTHERCODERS (RIGHT)

MotherCoders students engage in a career mapping exercise.

especially nonprofits, where every dollar counts," says Lee.

The respect is mutual. "I love MotherCoders' mission—the idea of taking an important part of the workforce that is underutilized and allowing them to gain technology skills," Masisak says.

And while MotherCoders helps individual moms, its greater vision of achieving gender equality through economic empowerment is always top of mind. As the world moves into the digital future, MotherCoders envisions a time when moms diversify the marketplace by contributing to the design and development of technology products and services. Simultaneously, they strengthen communities by creating businesses and thriving in jobs with livable wages and advancement opportunities.

"Women reinvest 90 percent of income back into their communities, so when we empower mothers, everyone benefits," Lee says. "I have two little girls, and I do what I do because I want to build a better world for them, for everyone."

AN EYE TO THE FUTURE

Today's NGOs have moved beyond the basic requirement of a website. Nonprofit leadership teams and boards of directors want more: mobile, apps, cloud, and global connectivity. And, soon, when they're grappling to turn their digital transformation ideas into reality, they'll be able to turn to TechSoup's Digital Assessment tool, launching in early 2020.

"We are developing a methodology to help organizations assess their work and understand what they can do with digital technologies, [identify] where they have gaps, and how they can close them by connecting them to new solutions, experts, or training resources," Masisak says. The assessment will provide individual NGOs both valuable insights and recommendations to help them move further along the digital transformation path.

In addition, TechSoup aims to expand its offerings to purpose-built apps paired with expert services. They believe this will help close the gap between what's commercially available and what organizations are trying to achieve with technology.

"It's the promise of doing things in a way that can uplift many organizations at once—without each shouldering the burden of becoming a technical expert in developing applications, but rather using what that organization uniquely knows—which is having an understanding of the social issue," Masisak says. "Digital transformation is an enormous opportunity for all of us."

As part of its own digital transformation roadmap, TechSoup is digging into emerging technologies. "We are actively exploring blockchain for validation services, so we can ensure the data we have on the nonprofit sector is protected, secure, and valid," says Michael Enos, senior director of community and platforms at TechSoup. "And we are looking at leveraging machine learning to better understand what nonprofits would benefit from in terms of courses, resources, information, and solutions," he continues.

TechSoup is committed to improving civil society by using technology as an enabler—to help people, communities, and our collective future.

"There's a lot of amazing social good going on, and almost everything threads to technology. But it's not about the tech by itself," Masisak says. "Technology is not inherently good or inherently bad. But if we help people use it effectively, that makes a difference for them. It's an exciting time." ■

PHOTOS COURTESY OF MOTHERCODERS

Tina Lee presents at the MotherCoders Demo Day at Pivotal in New York City.

"Women reinvest 90 percent of income back into their communities, so when we empower mothers, everyone benefits." **—Tina Lee, founder, MotherCoders**

Both Sides of the Bitcoin

How open banking, cryptocurrencies, and emerging fintech platforms can promote equitable commerce.

BY STEPHANIE WALDEN

When fast-casual salad chain Sweetgreen announced in 2016 that it was transitioning all of its U.S. locations to a card-and-mobile-only payments model, some applauded the act as a future-minded step toward a cashless society.

ILLUSTRATIONS BY JAMES STEINBERG

Others, however, lamented the decision, citing the move as a problematic barrier to entry for those who rely on cash for day-to-day purchases. The policy, they argued, would discriminate against customers lacking access to credit cards or smartphones. In response to the heated backlash, Sweetgreen announced in April 2019 that it would be accepting legal tender in its stores again.

The Sweetgreen debacle is just one example of a fissure within the field of fintech—financial technology—between those who extol its virtues as a potential equalizer of the masses and those who snub it as just another launchpad for the rich to get richer.

Both sides present thought-provoking arguments. Critics of fintech suggest that technologies like cryptocurrencies—which require electronic hardware and internet access to mine, purchase, and use—propagate socioeconomic biases by limiting their accessibility to tech-savvy (and, typically, already affluent) users. A 2018 *New York Times* piece notably cited a stat from howmuch.net that around 95 percent of Bitcoin wealth is in the hands of just four percent of cryptocurrency owners.

On the other hand, proponents of fintech tout its implications for social good. This side argues that blockchain and other emerging platforms can bolster charitable causes. This use case holds water: In 2017, an anonymous donor created an experimental philanthropic project called The Pineapple Fund to funnel $55 million in Bitcoin earnings to more than 60 charities. Nonprofits like GiveWell have also updated their donations-processing systems to be able to accept cryptocurrencies.

While there are more than just two sides of the coin, there are clear implications for fintech as it pertains to social good.

FINTECH FOR SOCIAL GOOD

One concrete way fintech may contribute to social initiatives is by updating antiquated financial infrastructures. The concept of "open banking," for instance, which encourages development and integration of third-party APIs into big banks' products, professes to open doors for previously underserved populations. Many large institutions are working alongside fintechs to better serve customers: JPMorgan Chase & Co., for example, has backed startups such as EverSafe, a tool that uses intelligent data analysis to help seniors avoid scams and, in turn, improve their financial literacy.

Mobile transaction is another trend making waves in the fintech sector. Despite Sweetgreen's failed experiment with going cashless in the U.S., on a global scale, mobile payments are prolific. In developing countries, phone-based banking can be especially impactful, as more than two-thirds of people in these areas lack access to a traditional bank account. In Kenya, up to 96 percent of the population uses the Vodafone-sponsored platform M-Pesa to conduct mobile transactions. In Mexico, a program called CoDi is helping unbanked citizens achieve greater financial autonomy.

> Mobile devices are actually now so densely distributed around the world that the average number per person is greater than one. And that's really all you need to participate in cryptocurrency: a smartphone that's capable of running apps.
>
> —Trevor Filter, co-founder, Flexa

BEYOND BITCOIN

When it comes to the viability of cryptocurrency and blockchain on a mainstream scale, companies like Flexa are making inroads. The startup provides cryptocurrency payment services to retailers and consumers. Flexa's app, SPEDN, allows consumers to spend cryptocurrencies, including Bitcoin, Ether, Bitcoin Cash, and the Gemini dollar, directly from their mobile device at participating merchants across entertainment, apparel, and other major retail avenues.

Flexa co-founder Trevor Filter, who comes from a traditional finance background, points out that smartphone proliferation now outpaces that of credit cards in the U.S. He notes in almost the same breath that credit cards are about 20 years older than the internet. "We believe the existing payments ecosystem is stuck in the Stone Age," he says.

In the U.S., Filter explains, one flaw within the current credit card rewards system is that merchants typically offset the higher fees associated with accepting "premium" credit cards by raising the prices of products.

"If an affluent person goes into a mom-and-pop grocery store with a high-rewards credit card, and a less-privileged person goes in and buys the same thing [with a debit card], both of those people are going to pay the same price, but the cost for the merchant is different," Filter explains. As a result, the debit card user essentially pays more to cover the affluent spender's rewards.

"I don't know if there's a better example of the income gap getting stretched," says Filter.

Cryptocurrency, Filter posits, the first digitally native form of payments, is a more appropriate fit for today's tech-fueled world. "The ecosystems we can build if we start from scratch can be a lot more inclusive," he says. "With Flexa, we can not only make payments more accessible to all kinds of consumers, but also lower the cost for merchants and rebuild rewards around efficient incentives."

Filter acknowledges that cryptocurrency isn't exactly a paragon of accessibility just yet. Users still need some form of a traditional account to purchase from Coinbase—the digital currency exchange currently used for brokering cryptocurrencies like Bitcoin and Ether—assuming users aren't going to mine coins themselves. But he believes it won't be long before crypto is an attractive, accessible, and realistic option.

"Mobile devices are actually now so densely distributed around the world that the average number per person is greater than one," Filter says. "And that's really all you need to participate in cryptocurrency: a smartphone that's capable of running apps."

TACKLING THE "POVERTY PREMIUM"

The concept of the "poverty premium"—or the undue costs the poor pay for essential goods and services—has been around for decades. The phenomenon remains a problem around the globe today.

Incuto, a U.K.-based fintech, is taking an inventive approach to tackling this systemic issue. CEO Andrew Rabbitt explains his impetus for launching the startup: "There's a huge market for payday lenders—short-term, high-cost loans—but these services prey on [disadvantaged] people," he says. Credit unions and community banks can combat this nefarious practice by offering loans to the same people at a much more reasonable rate, he explains.

"The problem is that these organizations are heavily inaccessible; they tend not to have a digital presence," says Rabbitt. "Incuto's primary mission is to provide the credit union sector with all the tools to be able to actually [compete]." Such tools currently include things like automation, a strong mobile presence, and aggregating volume across multiple branches to reduce overall costs.

Though Incuto has spent the past three years playing catch-up—"the application stack right now is sort of bringing people up to [speed] from somewhere in the '70s," says Rabbitt—in the near term, he hopes to begin integrating more advanced technologies into Incuto's suite of offerings.

"When we start to bring in the world of automation [for decision-making] and credit risk assessments and fraud prevention, that's where we get into the exciting stuff around using big data, AI, and looking at the way we can augment the customer journey with more intelligent design," Rabbitt says.

Data-based, custom-tailored financial services are a feature that Rabbitt envisions being part of Incuto's future. Using AI-backed systems, he says, can help customize financial services to individual users or families. "If we can take someone on a user journey who is potentially financially excluded and use all the data points that are available, which may not just be the traditional kind of credit score route ... [we can] build a product almost dynamically around that individual," he says.

Getting to this stage will be a gradual revolution. For one thing, many customers are still uncomfortable with the concept of letting a machine make judgments about their finances—even when those decisions are favorable compared to traditional avenues of financial reporting. "We have a learning journey to go on before [emerging technologies] become really embedded, but we're building the foundation now," says Rabbitt.

Incuto's ultimate objective is to bring the functionality and features of fintech to the people who need it most. "It's not about what we've done—it's about who we're doing it for that we see as being the real shift," Rabbitt says. "For us, the fintech revolution is about how you enable organizations to better serve people. It's really exciting and will change the world at some point—but it has to change the world for someone whose world needs changing." ■

Need a refresher on blockchain? Listen to the "Disruption: Cha-ching!" episode of the Trailblazers with Walter Isaacson podcast. DellTechnologies.com/Trailblazers

> When we start to bring in the world of automation [for decision-making] and credit risk assessments and fraud prevention, that's where we get into the exciting stuff around using big data, AI, and looking at the way we can augment the customer journey with more intelligent design.
>
> —Andrew Rabbitt, CEO, Incuto

PLASTICS:

RETHINKING the CYCLE

CAN EMERGING TECHNOLOGIES HELP SOLVE the PLANET'S PLASTIC PROBLEM?

By STEPHANIE WALDEN

LETTERING AND ILLUSTRATIONS BY JOEL HOLLAND; PHOTO BY DIMITAR DILKOFF/AFP/GETTY IMAGES

For eco-conscious consumers, plastics have become public enemy number one. Images of sea creatures tangled in plastic packaging and waste-clogged waterways have made the rounds online in recent years, eliciting public outrage.

As a result, anti-plastic policies are popping up around the globe. In the U.S., New York and California have already prohibited single-use plastic bags, while Maine recently issued an outright ban of polystyrene (Styrofoam) food containers. Across the Atlantic, the European Union overwhelmingly voted in favor of banning 10 types of disposable products including plastic utensils, plates, and cotton swabs in 2018.

But finding sustainable solutions for the staggering amount of plastic the world produces on an annual basis—estimated to be between 320 to 450 million metric tons—will involve rethinking each stage of its life cycle to encourage more sustainable consumerism.

Technology will be a critical puzzle piece for curbing plastic pollution. Artificial intelligence (AI), the Internet of Things (IoT), blockchain, and other emerging technologies may supplement efforts to redesign packaging, revamp recycling programs, and reimagine the way consumers use—and reuse—everyday products.

THE MANUFACTURER'S DILEMMA

Plastics are appealing to manufacturers because they're cheap, versatile, and virtually indestructible. These same qualities, however, make them an environmental hazard. Composite plastics—like the toothbrush your dentist hands out to dozens of patients every day—can take centuries to decompose. When they do break down, they often end up in the ocean in the form of microplastics, which pose dangers to sea life and can ultimately become an unwelcome and possibly harmful ingredient in human diets.

But the truth is that plastics are prolific in our modern lives. They are integral to products ranging from sterile medical devices to food-grade storage bins. And the material's versatile, hardy nature has helped humanity achieve incredible feats—we could not, for instance, have gone to the moon without it.

But it's the cheap, easily disposable plastics that have generated the most backlash in recent years. According to the United Nations, about half the plastic we produce is only designed to be used once—the single-use culprits like straws or flimsy take-out containers. The U.N. estimates that the global population uses up to five trillion single-use plastic bags each year.

Much of this type of plastic comes in the form of packaging. Today, some consumer packaged

PHOTO BY RICH CAREY/SHUTTERSTOCK

Left The Lush app serves up "digital packaging" when customers scan products on their mobile devices.
Right These Lush bath bombs are packaged in plastic-free, 100% biodegradable cellophane bags.

PHOTO (LEFT) BY PIUS UTOMI EKPEI/AFP/GETTY IMAGES; PHOTOS (ABOVE) COURTESY OF LUSH

goods (CPG) companies are attempting to tackle the problem by eliminating packaging entirely. Cosmetics brand Lush, for example, has become famous for producing "naked," completely unpackaged products, such as signature bath bombs, shampoo bars, and other beauty products.

Lush is also adding AI into the mix: The Lush Lens feature on the brand's app uses machine learning to identify products when customers scan them on a mobile device. The app recognizes the item and displays the product's ingredients and usage instructions, eliminating the need for plastic signage or labels. Lush has even spun off its own technology arm, Lush Digital, to explore 3D-printed bath products, as well as how AI, image recognition, and augmented reality (AR) may contribute to sustainability efforts.

FROM USE TO REUSE

Agilyx is an Oregon-based company taking an opposite but equally inventive approach to using AI to combat plastic pollution. Instead of trying to eradicate plastics, Agilyx uses chemical recycling to create circular pathways for difficult-to-recycle polymers like polystyrene. Using a chemical process, Agilyx breaks the materials back to basic polymers in the form of an oil. The oil is then sold to refineries and turned into a range of products including virgin polymers and plastics, as well as low-carbon fuels like diesel and jet fuel.

Joe Vaillancourt, the company's CEO, has been involved in the waste management industry for more than three decades. He says that Agilyx's products produce about 50 to 70% less carbon than traditionally manufactured items.

The chemistry of it all is highly complex, he explains, and AI is part of the formula. "If you go to 10 recycling facilities and you take a random sample of the plastic waste, you're going to get a statistically different chemical composition. We can manage that complexity using our database to map out more chemical recycling pathways," explains

PHOTO COURTESY OF AGILYX CORPORATION

The Regenyx facility in Tigard, Oregon, uses Agilyx's chemical recycling process to convert used polystyrene products into new ones.

Vaillancourt, who notes that Agilyx has been in the depolymerization business (another term for chemical recycling) for 14 years. "We have robust data and predictive modeling capabilities. We have chemical conversion relationships that we have uncovered over time."

Vaillancourt believes that AI will help Agilyx keep pace with evolving trends. "We're going to continue seeing shifts in design, materials, and construction. So, while we will continue to use AI on the efficiency side, more importantly ... we're going to use AI to advance the recyclability of a changing set of manufacturers' packaging."

Agilyx isn't the only organization envisioning a cyclical path for consumer goods. One initiative recycling company TerraCycle launched in 2019 is resurrecting the "milkman model" for products ranging from deodorant to dish soap. The program, aptly named "Loop," aims to change the consumer shopping experience by redesigning product packaging for multiple uses. Products are delivered via a reusable tote, and when packages are empty, customers can return them to be cleaned, refilled, and redelivered.

Anthony Rossi, VP, global business development at Loop, says the program is less about eliminating plastics altogether and more about changing mindsets.

"What we're really trying to combat is the idea of disposability and single-use," he says, noting that the plastics used in Loop's packaging are akin to the durability of a Nalgene bottle—the famously unbreakable water bottles beloved by adventure-seekers around the world.

Although Rossi says that Loop's back-end processes don't yet integrate AI, he believes such technologies will be important to the program's long-term growth.

"We believe that AI and blockchain technology [are] going to have a huge impact on the platform as it grows," he says. "As we're setting up the back-end infrastructure of Loop, we're working with several partners to make this a smart platform. We know that it can't just be built on sustainability; it needs to be built on convenience. It needs to be a phenomenal shopping experience. That's been a North Star in building this platform: Making sustainability irresistible to the consumer."

THE POWER OF COLLABORATION

Plastic pollution is a multifaceted issue, and addressing it will require collaboration on an unprecedented scale. Manufacturers, politicians, waste and recycling companies, corporations, and, yes, consumers, too, will need to work together.

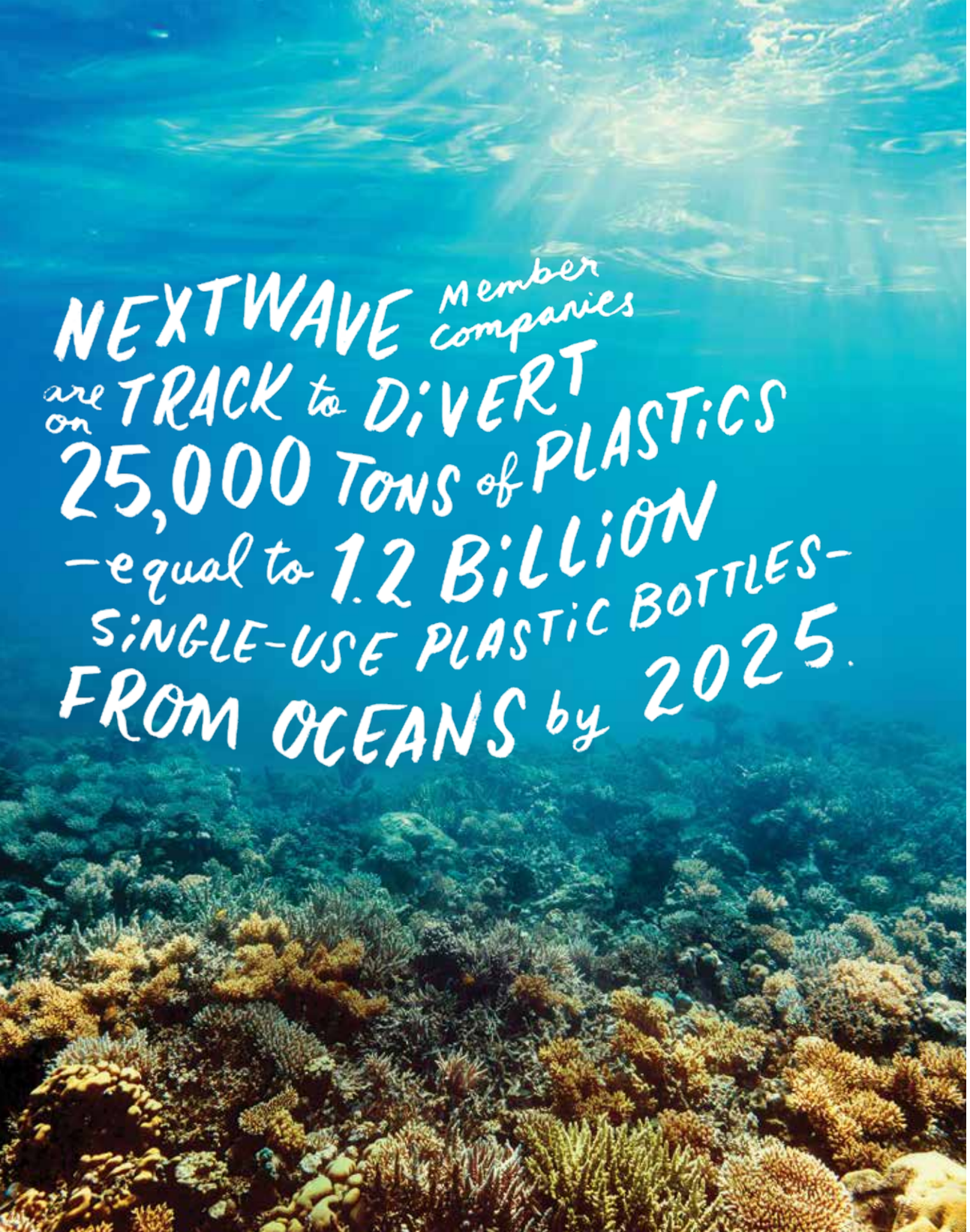


PHOTO BY VOVAN/SHUTTERSTOCK

Loop is just one example of the power of collaboration—the program is operating in partnership with some of the world's most recognizable CPG corporations, including Procter & Gamble, Unilever, and Nestlé. "We're working with over 100 brands globally, and that number continues to grow," says Rossi. "We're also working with retailers like Kroger and Walgreens. Today, Loop exists as a pilot—the retailers are going to allow us to grow our footprint much more quickly and get to more consumers. Those retail partnerships are tremendously important toward making the impact we want to make."

At Agilyx, too, partnerships with third-party companies are crucial. Agilyx is involved with a wide range of corporate partners including Delta Airlines and Monroe Energy. Together, they're working to convert waste mixed plastics into crude oil targeted to be refined for jet fuel.

A number of coalitions have also cropped up to bring private companies, NGOs, and business decision-makers together to mitigate plastic pollution. NextWave, a global consortium, is one such initiative launched in 2017. NextWave builds off Dell Technologies' ocean-bound plastics program, a pioneering effort to use plastics collected off beaches and other coastal areas in some of its products.

As part of the company's broader environmental initiatives, Dell Technologies pledged to the United Nations to increase its annual use of ocean plastics 10 times by 2025, and in 2017, partnered with Lonely Whale to unite companies across a wide range of industries to create the world's first network of ocean-bound plastics supply chains. From this initial working group, the NextWave program was born. NextWave member companies are on track to divert 25,000 tons of plastics—equal to 1.2 billion single-use plastic bottles—from oceans by 2025.

Dune Ives, executive director of Lonely Whale, an incubator for "courageous ideas" to drive market-based change, explains that "radical collaboration" is at the heart of NextWave's mission and vision. The organization's primary goal is to spark innovative ideas that will positively impact the health of the world's oceans.

Ives says that emerging technologies will play a key part in facilitating the type of industry crossover such ambitious endeavors will require. "Technology can play a critical role in tackling plastic pollution throughout the material's life cycle," she says. "Imagine a world where we can track from source through to recycling and reuse a specific type of plastic used in a product." AI, for example, can be used to identify plastic pollution from other materials in marine environments. IoT smart sensors may track plastic packaging throughout its consumer journey. Blockchain can be used to build new supply chains and improve "end of life" processes for the products that people use every day. Even virtual reality (VR) programs might be used to drum up support for plastic waste reduction.

"With VR, we can engage the hearts and minds of individuals no matter where they live, showing both the destruction plastic pollution causes, as well as the solutions and what can be done through application of technology," says Ives.

The stats may be daunting, and the images of plastic-laden seas stark, but there's reason to remain hopeful. With the aid of emerging technologies, we can rethink the role plastic plays in our lives, from how we produce it to how it's consumed and recycled. The life cycle of plastic doesn't have to end in our oceans. ■

Living to 1,000?

Can the use of deep neural networks extend a person's life span by decades, if not centuries?

BY RUSS BANHAM

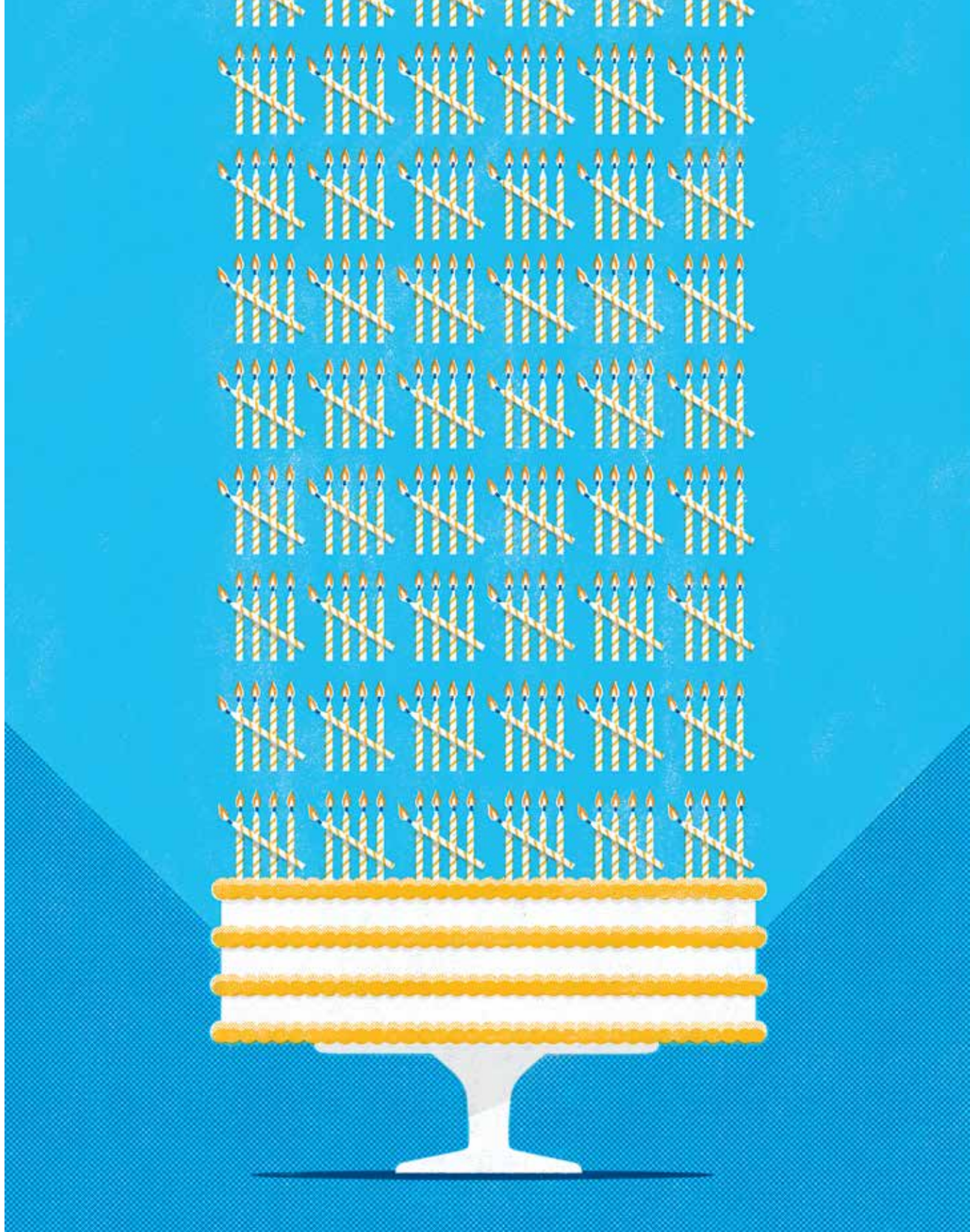
The longest living human on record was Jeanne Calment, a French woman who died in 1997 at the age of 122. That's a pretty sizable leap from today's average life expectancy which, on a worldwide basis, is 70 for males and 74 for females, according to the Population Reference Bureau. But scientists like Alex Zhavoronkov predict people will soon achieve "extreme longevity," an age where those who pass at 100 are mourned for dying too young.

"In the not-too-distant future, medical science will possess the technology to slow and even reverse the aging process itself," Zhavoronkov writes in his best-selling book, *The Ageless Generation*.

This impressive prediction is based on the longevity kicker offered by deep neural networks, a subset of artificial intelligence (AI) that employs a multi-layered system of artificial neurons to glean insights from massive amounts of data.

The data, in this context, relates to both a better understanding of the aging process and the ability of different molecules to prevent or halt life-threatening diseases. By training the deep neural networks to predict biological age based on genetic, environmental, and other relevant data, scientists can discern the specific reasons why a person is likely to die by a certain age. Once these reasons are understood, the deep neural networks can be used to identify what Zhavoronkov calls "correctives," such as tailored medicines that overcome these factors and lengthen the person's life span.

ILLUSTRATIONS BY CHRIS GASH



By leveraging deep neural networks, we're able to discover novel molecules targeting specific diseases and develop them into compounds for life-extending drugs.

—Alex Zhavoronkov, CEO, Insilico Medicine

"By leveraging deep neural networks, we're able to discover novel molecules targeting specific diseases and develop them into compounds for life-extending drugs at a vastly faster rate than is achievable in the current clinical trials process," says Zhavoronkov, who is also the founder and CEO of Insilico Medicine, an AI and bioinformatics company focused exclusively on aging and age-related diseases.

Zhavoronkov and other scientists engaged in the use of deep neural networks are confident the tool will lead to a day where living beyond 120 years is common, if not expected. In Zhavoronkov's view, this longevity depends on the ability to discern how long a person is likely to live, well in advance of the thing that kills them. "Ideally, we want to prevent disease before it manifests," he explains.

TICK TOCK

Think of your life span as an "aging clock." By using deep learning to examine a truly gargantuan set of data on biological age—influenced by each person's genes, the environment, and lifestyle behaviors in the data set—scientists gain a better understanding of the aging process, as this data closely correlates with each person's overall health and mortality. The factors governing why one person's aging clock is ticking faster than another person's aging clock become evident. "Once you understand these markers, you have the means to understand longevity on a person-by-person basis," says Zhavoronkov.

Doctors conducting a patient examination can already determine potential life span, as can an MRI machine. Many of us can do the same. "Generally, a human being can guess with relative accuracy the age of other human beings within plus-or-minus five years," Zhavoronkov notes. "But sometimes they're off by many years. Typically, people who look significantly younger than their actual age live longer life spans than other people who look their age."

Deep neural networks are a way to learn why such individuals outlast the rest of us. "By using deep learning to examine massive repositories of 'omics' data, we are able to predict the age of healthy people," he explains. Omics is a suffix referring to the varied technologies exploring the relationships and actions of molecules that make up the cells in an organism, such as in the study of genomics and proteomics.

To get a sense of this massive repository of omics data, the total number of small molecules alone is estimated to be between 10^{60} and 10^{200}. For humans alone to study and test this many molecules as potential drug compounds would take an eternity—the equivalent of looking for a needle in a giant haystack. But AI—in this case, deep learning—is really good at finding the needles.

For example, scientists can rapidly learn in the omics data how specific blood markers have positively or adversely affected the life spans of people. Zhavoronkov and his colleagues recently screened more than one million clinical blood tests to determine patients' biochemistry in what he called a "deep hematological aging clock study." The

analysis yielded a data set of more than 60,000 reasonably healthy people, providing the means to predict longevity based on a person's blood biochemistry.

By adding other predictors like gut bacteria, and stool and tissue samples, to the blood data, the better the opportunity to compare and contrast their interplay in affecting life span. Cumulatively, these biomarkers can predict how much longer each of us has to live. That sounds like bad news if the prediction is grim, but this isn't necessarily the case.

By training the deep neural networks to recognize the underlying signaling pathways leading to a disease like Parkinson's, Alzheimer's, cancer, or diabetes, researchers can quickly identify the relevant biomarkers. From there, they can generate new molecular compounds with the properties that combat the particular disease before its manifestation.

If, for instance, a particular compound is discovered to make certain tissues younger or older, the compound can be provided to people susceptible to lung cancer to slow the rate of organ failure, if not halt it. While several cancers have been cured in animals genetically similar to humans—substantially increasing the life spans of worms, fruit flies, and mice, for instance—often these compounds don't translate well to humans. "By mining the biological data, we hope to progress pretty quickly toward developing a chemical compound that squarely hits the target and prevents a disease from manifesting," Zhavoronkov says. "The pieces are coming together."

YOUNG AT HEART

Although he declined to estimate how long someone born today can expect to live, Zhavoronkov is confident we've not yet reached our biological life span limit. A 2018 study published in *Science* suggests that a fixed limit to the human life span has yet to be ascertained. The study also indicates that people at age 100 have the same 50 percent chance of dying within a year as people between the ages of 105 and 109; they also share the opportunity to live another 1.5 years.

In other words, the risk of death at extreme ages seems to plateau, giving hope that we've yet to reach an expiration date. Some scientists, like Aubrey de Grey, chief science officer at the SENS Research Foundation, project that human life spans will extend into the hundreds and possibly in excess of 1,000 years. The thinking is that by the time someone born today makes it to 100 years, the state of AI and medical science will have advanced to the point where the person can conceivably live to the age of 150. Fifty years later, the same progression occurs, lifting the individual's chances of making it to 200—and so on.

"I don't like to speculate on how long we can hope to live, but I will say that human beings have a way of setting seemingly impossible goals like landing on the moon and then pulling it off," Zhavoronkov says. "In that regard, I would aspire to live young as long as possible."

> By mining the biological data, we hope to progress pretty quickly toward developing a chemical compound that ... prevents a disease from manifesting. The pieces are coming together.
>
> —Alex Zhavoronkov, CEO, Insilico Medicine

WHILE YOU'RE WAITING

Living to a ripe old age, of course, is not without complications. For one thing, the world could become as crowded as a Los Angeles highway at rush hour. Long-term care is another dilemma. In the past, it was common for children to take care of their aging parents. But that was when the children were in their 50s and 60s, and their parents were in their 80s and 90s—not 120-plus.

In these regards, other technologies can be both a lifesaver and life extender. Today, a variety of tools using sensors, smartphone apps, GPS systems, and voice activation have been developed to help older people age in place—enjoying independent lives in their homes.

Lively, for instance, is a smartwatch that can remind older people when it is time to take a particular medication. ElliQ is a social robot that uses AI technology to encourage a more active and engaged lifestyle; marketed by Intuition Robots, the robot may suggest that the user go for a walk, knowing that the weather outside is perfect that very minute for a stroll. Voice technologies allow people to communicate with their smart speakers, like Amazon Echo, and connect to smart devices to help perform household tasks.

Other technologies are a step up from traditional personal emergency response systems worn on the wrist or around the neck in case of a fall or other predicament. Unfortunately, only 14 percent of older people wear the devices continuously, and approximately 83 percent of seniors fail to activate the alert button after being on the floor for more than five minutes, according to the National Center for Biotechnology Information (NCBI).

Addressing this issue is technology like TruSense, a smart health-monitoring and tracking device that combines GPS with a range of monitoring sensors in the home. TruSense detects periods of human inactivity that may indicate a possible health crisis.

"If someone gets up at a certain time of the day and then moves through a series of rooms over a period of time—and does not do this one morning—a designated family member is contacted immediately," says Rob Deubell, senior vice president of TruSense.

The internet-enabled sensors measure motion, temperature, water leaks, the presence of visitors, and voice sounds. Algorithms then analyze the data to discern when normal human behaviors, habits, and patterns are out of alignment. While surveillance cameras can achieve similar aims, Deubell says that nobody likes the Big Brother-ish feeling they're being watched in their own home. "We wanted a solution that was noninvasive to maintain the dignity of seniors," he explains.

Undoubtedly, these technologies can improve the lives of baby boomers looking to age in place. As for today's newborns, deep neural networks may just catapult them well into the 22nd century and possibly beyond, their aging clocks ticking away, slowly, tick … tock. ■

How are emerging technologies advancing healthcare now and in years to come? Find more stories at DellTechnologies.com/Perspectives.

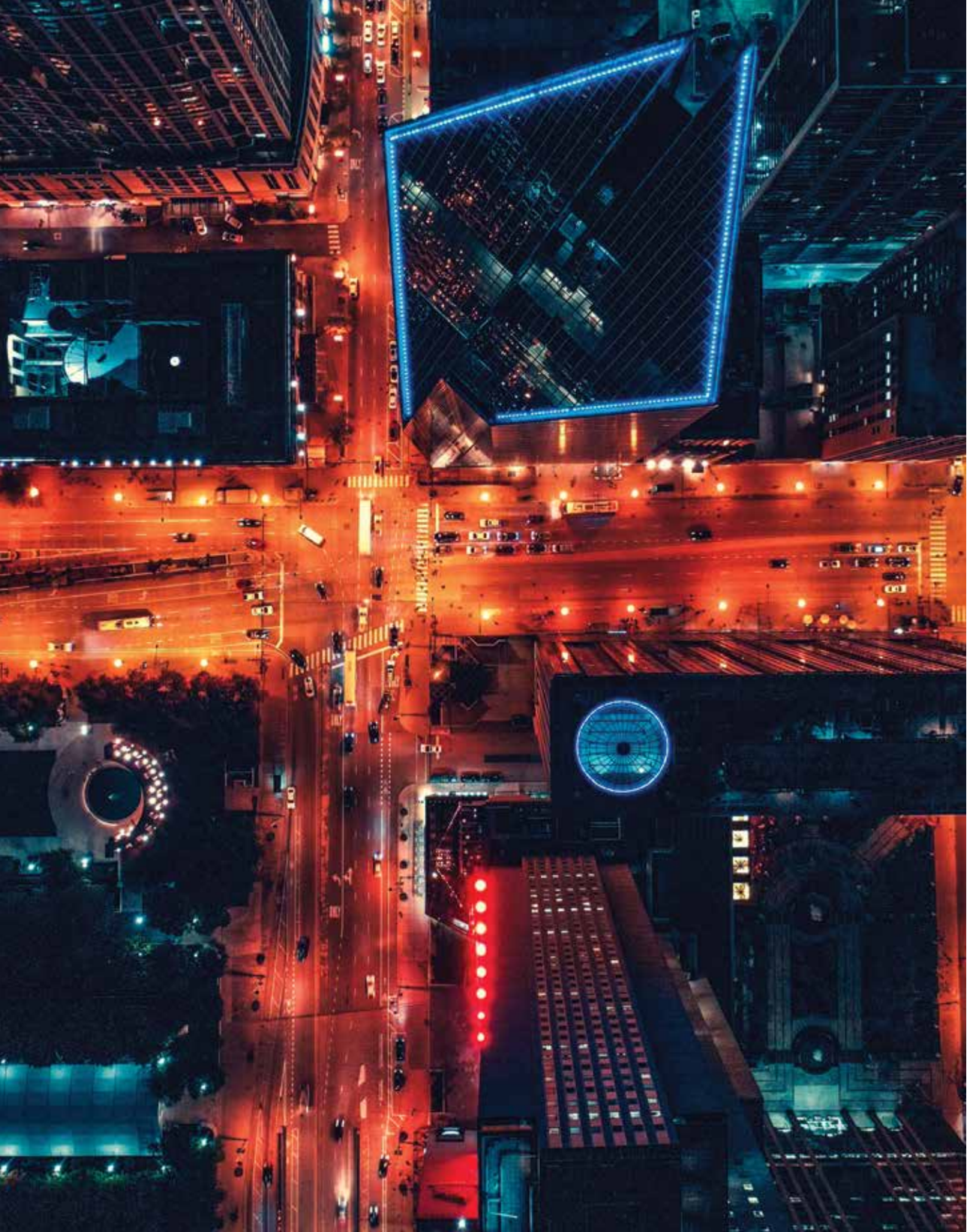


PHOTO BY MAIN FOCUS MEDIA/SHUTTERSTOCK

Building a Digital City for All

BY MARTY GRAHAM

As Chicago moves toward a tech-driven future, officials want to make sure no resident is left behind.

When Chicago committed to becoming a smart city, officials worried that the digital divide between residents would deepen. No city can thrive when a wide swath of people are left behind, and individuals whose access to data innovations is limited—by factors like physical disabilities, aging, cognitive challenges, and language barriers—are particularly at risk.

Because people who face these challenges often aren't using—much less giving feedback on—smart city technology development, tech officials aren't always aware that residents are struggling to be heard, helped, and included, explains Karen Tamley, Chicago's commissioner of the Mayor's Office for People with Disabilities.

"People with limited access face problems that cut across all of what a city does," continues Tamley, who oversees a staff of 28 and reports directly to the mayor. "When we think of city hall now, it's virtual city hall, where residents can [use their phones and computers to] find information they need, track when the next bus [arrives], pay a water bill or a speeding ticket, apply for a permit, or arrange to attend a city event."

But what about Chicagoans who don't have a seat at the digital table?

"It's a challenge to ensure technology is accessible," says Tamley, noting that, while people with disabilities have federal protections thanks to the Americans with Disabilities Act, the challenges they face resemble those of many other people who can't or don't go online.

Aging, for instance, can lead to fixed income, social isolation, and mobility issues—all common barriers to tech adoption. Meanwhile, learning

disabilities like dyslexia, as well as mental illness and brain injury, can similarly complicate use and access. Language barriers—think logging on to public computers that use an English alphabet keyboard when a user's native alphabet is Cyrillic, Arabic, or Chinese—and poverty are also well-documented barriers to digital equality.

In a citywide effort to ensure all residents were included in the tech leap forward, the Windy City announced its partnership with Microsoft and two nonprofits, G3ict and World Enabled, in October 2018.

"No one ever set out to create an inaccessible city, business, or website," says James Thurston, vice president of global strategy and development at G3ict. "They just weren't aware that they were leaving anyone out. Everyone benefits from inclusivity. It's a matter of creating awareness."

SMART BEGINNINGS

Chicago dove into smart city initiatives in 2016 with the launch of Array of Things, a citywide sensor deployment effort. The city installed data-gathering boxes on light poles, with the goal of setting up 500 boxes in the 227-square-mile city and the first 200 by the end of 2019. The boxes include cameras and sensors to detect hyperlocal data—such as unhealthy airborne gases, temperature, and traffic conditions via vibrations—that's then transmitted to the Department of Innovation and Technology (DoIT) in real time.

Much of this information can be viewed on the city's open data portal, which was first launched in 2011 under then-mayor Rahm Emanuel. Officials are using the city's data sets, ranging from street-sweeping schedules and planning department applications, to make data-informed decisions on everything from preventing traffic jams to helping people avoid pollution-induced asthma.

While increased efficiencies and cost cutting are immediate and achievable goals, city officials have been concerned that marginalized communities don't always reap the benefits. This has pushed the city's techies to democratize internet usage at home and in public spaces.

The DoIT and Chicago's 81 public libraries have made more than 3,000 computers available to the public; they've improved Wi-Fi access at city facilities and let residents borrow portable mobile hotspots. The city's departments have teamed up to organize more than 100,000 one-on-one mentoring sessions on internet navigation, and continue to work to close broadband gaps. Meanwhile, Tamley's staffers seek out residents whose lack of computer and internet skills are a barrier to participating in Chicago's vibrant culture and economy, and look to identify other challenges—including disabilities, reading difficulties, language barriers, and poverty—that are at play.

The significant effort and commitment by officials like Tamley made Chicago a good partner for G3ict, Thurston says.

"[Through this process, we're realizing] the broad range of services that are critical to residents," says Thurston. "Emergency response, education, and health and human services programs are increasingly using technology for things [Chicagoans] rely on every day. But if those functions are only available online on a platform that wasn't designed with users facing [certain] challenges in mind—it isolates people from services they need and expect."

PHOTO COURTESY OF KAREN TAMLEY

"People with limited access face problems that cut across all of what a city does."

—Karen Tamley, commissioner of the Mayor's Office for People with Disabilities, Chicago

The Mayor's Office for People with Disabilities is working with the City of Chicago to add 100 audible crosswalk signals over the next two years.

PHOTO BY RICHARD LEVINE/ALAMY STOCK PHOTO

One in four adults has a disability that affects important life activities, according to the Centers for Disease Control and Prevention (CDC), a figure that increases in seniors, affecting 40 percent of adults over 65. Furthermore, the CDC notes, mobility-related disabilities are the most common, with one in seven adults affected. The employment rate for disabled people is less than half that of other adults, and their incomes average about a third less than people who do not have disabilities, according to the Bureau of Labor Statistics.

To tackle these statistics, Chicago officials partnered with Thurston's organization and became the first city in the world to use G3ict's newest tool: the Smart City Digital Inclusion Maturity Model.

MEASURING INCLUSIVITY

As cities across the world recognize the urgent need to include residents of all abilities and demographics in their tech revolutions, Thurston's work at G3ict to develop inclusive tech has taken him to Sao Paolo, Mexico City, and Guadalajara this past year alone.

In a 2016 study, G3ict found that 60 percent of respondents believed smart cities were leaving millions of people behind; that about 25 percent of disabled people do not access the internet, compared to eight percent of the general population; and that few cities, if any, have built inclusion into their smart city plans.

Part of the problem is that people with disabilities are often left out of the data underlying smart city advances, Thurston says. Cities often aren't aware of that underrepresentation, how likely and common it is, and how the lack of data skews outcomes from using the data they do have.

Attendees at the 2019 M-Enabling Summit, a joint initiative of G3ict and E.J. Krause & Associates, explore new forms of accessible technologies for users of all abilities.

PHOTO COURTESY OF M-ENABLING SUMMIT

"Whenever you look at cities that are deploying technology for transformation, what you see is that it often doesn't work well for people with disabilities, people with cognitive challenges, and older persons. But it can work well," he says. "But it can work well."

The Smart City Digital Inclusion Maturity Model rates how a city or institution is performing after intensive interviews, site visits, and analysis, in addition to examining whether the data and technology being used are unintentionally creating barriers. While the report is confidential, the assessment team helps the city with a defined roadmap forward.

> "Whenever you look at cities that are deploying technology for transformation, what you see is that it often doesn't work well for people with disabilities, people with cognitive challenges, and older persons. But it can work well."
>
> —James Thurston, VP of global strategy and development, G3ict

PHOTO COURTESY OF COLORADO TECHNOLOGY ASSOCIATION

> "The pursuit of innovation can leave people behind because the process itself really does not give a lot of thought to inclusion, so we are providing tools and training developers to make sure there's more diversity—including giving our innovators mentors with disabilities."
>
> —James Thurston, VP of global strategy and development, G3ict

Sometimes what they find is a system beyond tweaking.

"There are citizen engagement tools—like the 311 system—that push information out to people, but also [get] information from people—for example, [residents] reporting a broken streetlight or that their trash wasn't picked up," he says. Without naming names, he continues, "one city had developed a pretty leading-edge system, but gave absolutely no thought to whether or not someone with [cognitive challenges] could use it. They discovered later that they'd excluded a whole segment of the city."

And as Tamley aptly notes, it's important to remember that people who aren't facing limitations now very well may be in the future—permanently or temporarily. Aging, mental and physical illness, injury, or poverty can happen to anyone.

EQUALIZING INNOVATION

"Chicago took some really great steps to include the community, to test their plans so they engaged users. They are tracking usability issues and have proactive processes in place to make sure their data and technology work in different communities," Thurston says.

Tamley sees part of her office's mission as getting as many people online as possible—with smartphones that talk to blind people, for instance. But it's also important to make sure that every city website—every piece of technology that brings the city to its residents—works for all residents.

For example, the city has about two dozen self-serve payment kiosks in police stations, city buildings, and a library.

Not only did the kiosks not work very well for low-vision individuals, but they also helped identify another minority group facing a barrier to online access: those without bank accounts. The city estimates that about seven percent of residents don't use online money services.

"Sometimes you can retrofit and re-engineer, like adding audio to the kiosks," Tamley says. "[Other times], you have to start over."

Tamley and her staff spend a lot of time looking for people with challenges, as they realize that the biggest problem individuals face is not knowing what's available to them and how to get it. People with limitations that could be mitigated—whether language, financial, or physical—tend not to demand help, and innovators tend not to think about them.

"The pursuit of innovation can leave people behind because the process itself really does not give a lot of thought to inclusion, so we are providing tools and training developers to make sure there's more diversity—including giving our innovators mentors with disabilities," Thurston says.

Once an organization recognizes and embraces the importance of including everyone in advances, change comes with surprising ease and openness, Thurston believes.

"The biggest challenge to date remains awareness," he continues. "They are not setting up to exclude people; it's that they don't realize that, [by applying strategic thinking,] they can design and deploy technologies that really are accessible to everyone." ■

Learn how Dell Technologies enables city planners to prepare for the future.
DellTechnologies.com/DigitalCities

What Will We Print Next?

In this Trailblazers podcast excerpt, host Walter Isaacson tells the story of the printing revolution.

From the moment Johannes Gutenberg used movable type to produce a copy of the Bible in the 1450s, printing technology has radically altered the way we spread ideas. But it wasn't until the advent of the home computer in the late 20th century that the printing revolution truly became available to almost anyone. Now, a new revolution is underway: 3D printing.

None of this would've been possible, however, if it weren't for a penniless law student with a bold idea.

XEROGRAPHY

In the late 1930s, Chester Carlson was working at a patent office by day and studying law at night. Too poor to afford textbooks, he spent his evenings at the New York Public Library copying them by hand. There in the library stacks, Carlson conjured up the idea for a machine that would change how we work and pave the way for personal computing. His big idea? The photocopier.

On October 22, 1938, in Astoria, Queens, with the help of a hired physicist, Carlson walked through the messy process he'd developed involving a light bulb, electrically charged plate, and buckets of sulfur powder. When finished, they removed the apparatus to reveal a sheet of paper with the words "10-22-38 Astoria." It was the world's first photo copy.

Carlson's innovation took advantage of the property known as photoconductivity—using light to charge particles almost as if they were magnetic. He called his process xerography; everybody else called it incredible.

Yet convincing people to buy his xerography machine was a challenge. Finally, in 1947, a photo supply company called Haloid took an interest as a means of distinguishing themselves from their competitor, Kodak. In 1959, the company shipped its first photocopier. It bore the name the company had adopted the year before as a sign of confidence in their xerography technology: Xerox.

The Xerox 914 photocopier became so popular it was produced for 17 years, and "Xerox" so ubiquitous it entered our vernacular as a verb.

SCREEN TO PAGE

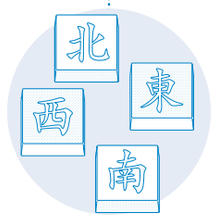
In the early 1960s, the typewriter dominated offices, but the computer revolution was just around the corner. And that posed a problem: How do you get a document you create on a computer screen onto paper? The first solution

868

A Chinese translation of *The Diamond Sutra* is the earliest dated printed book.

1041

Chinese alchemist Bi Sheng invents movable type made of a baked mixture of clay and glue.



1440-1450

Johannes Gutenberg invents the metal movable type printing press.

1455

Gutenberg's Bible is completed, ushering in the Renaissance.

1796

Bavarian playwright Alois Senefelder invents lithography as a means to duplicate scripts.

1829

Louis Braille invents embossed printing.

INFOGRAPHIC BY CYNTHIA PARK; PHOTO (LEFT) COURTESY OF THE BRITISH LIBRARY

PHOTOS (LEFT TO RIGHT) COURTESY OF RANSOM CENTER, UNIVERSITY OF TEXAS AT AUSTIN; ROOK76/SHUTTERSTOCK.COM

was simple: Connect the computer directly to the typewriter. But these devices were slow and cumbersome, and they couldn't produce graphics. Enter Robert Howard.

In the mid '60s, Howard was working with casinos on a way to give their chips individually identifying signatures to prevent fraud. With his system, a needle could poke an ink ribbon as a chip passed before it, giving it a unique printed code. Literally connecting the dots, Howard realized his technology was good for more than poker chips, and the dot matrix printer was born. Capable of printing different fonts and graphics, the dot matrix was an important milestone for home computing. But they were also slow, noisy, and the print quality was decidedly low resolution.

Around the time Howard was developing his dot matrix printer, the next stage in the printing revolution was already underway, and the path led directly back to Chester Carlson.

Back at the Xerox Corporation in New York, engineer Gary Starkweather was toying with the idea of how to use the principles of photoconductivity that Xerox had harnessed so profitably to print original documents from scratch. In 1971, Starkweather moved out to Xerox's Palo Alto Research Center to bring his idea to life. Just nine months later, he'd built the first working laser printer. But despite wild success with its commercial laser printers, Xerox failed to see the potential of bringing laser printing into homes. As a result, multiple personal computer companies beat them to market.

Like Chester Carlson's photocopier, the laser printers we use today are remarkably similar to Gary Starkweather's inventions. Both innovations have stood the test of time, but they share one obvious limitation: They only print in two dimensions.

ANOTHER DIMENSION

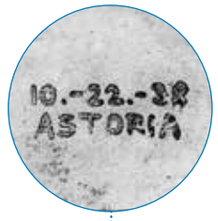
In the 1980s, engineer Chuck Hull set out to design a better way of creating prototypes than the costly process that took weeks or months. He devised a method, called stereolithography, that uses an ultraviolet light to produce thin layers of a specialized plastic. These layers stack on top of each other to create a three-dimensional object. In March 1983, Hull produced the world's first 3D-printed object: a small plastic cup. What once took months could now be done in a day.

For the first few decades, 3D printing was largely used for industrial applications, but the greatest impact of 3D printing in the near future might be closer to home. As consumer-friendly 3D printers become more widely available and less expensive, they are contributing to the rise of the maker movement, in which anyone can create their own wares.

Moreover, the medical applications of 3D printing seem limitless. Surgical teams use 3D-printed models to plan complicated surgeries, such as separating conjoined twins. 3D printing is drastically reducing the cost of prosthetic limbs. And, incredibly, a team at Harvard University is working on printing a human kidney using specially made inks containing human cells.

The first printing pioneers gave us the power to realize our ideas on the page. Today's 3D printers allow us to turn them into physical reality. What will we print next? ■

Hear the full story in the "Printers: What Will We Print Next?" episode of the Trailblazers podcast.
DellTechnologies.com/Trailblazers



1938

Chester Carlson invents xerography, or photocopying, in Queens, New York.

Siemens patents first commercial inkjet printer for use in medical records coding.

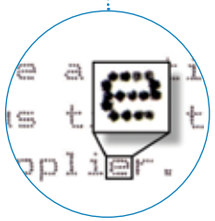
1951

1959

Haloid Xerox introduces the first photocopier, the Xerox 914.

Robert Howard invents the dot matrix printer.

1968



1971

Gary Starkweather develops the first working laser printer.

Chuck Hull creates the first 3D-printed part, inventing stereolithography.

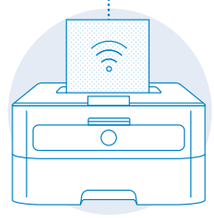
1983

1984-1988

Both desktop laser and inkjet printers are introduced in consumer market.

Andrew Clams invents the wireless printer.

1993



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PHOTOS (LEFT TO RIGHT) COURTESY OF 3D SYSTEMS; BESTPHOTOPLUS/SHUTTERSTOCK.COM

Digital Transformation: Challenge or Possibility

Greg Bowen, senior VP, Digital Acceleration and CTO, Dell Digital, shares how the power of optimism can accelerate transformation.

BY GREG BOWEN

Research shows optimism can help you live longer, perform better, and boost your energy. In my experience, it could have a similar effect on your organization's digital transformation.

You can change your processes and modernize your technology, but if you aren't able to change how people think and behave, your transformation will fall short. People are, without a doubt, the most important piece of the digital transformation puzzle. Unfortunately, people and culture can be the toughest things to change in an organization.

Why? Because we are hardwired to maintain a state of equilibrium. Our primitive brains cling to habit and heuristics, originally for survival, but now to deal with the countless decisions we must make on any given day. Change is interpreted as a threat and triggers our primal fear; our fight or flight instincts. That's why so many people, when presented with a new initiative or idea—even a good one—will resist it.

Like many things in life, how you view your organization's digital transformation can make a difference. You can view transformation as an imperative: Adapt or die. Or, if you focus on the bright side, transformation can be about possibility.

At Dell Technologies, we see digital transformation as the ultimate possibility. As the company nears $100 billion in revenue, our IT organization is making people, process, and technology changes to support a company of this scale and keep up with the pace of change. The result is the Dell Digital Way, a cultural shift in how team members partner with the business using a direct, simplified, and streamlined approach to quickly design, develop, iterate, and deliver new products and capabilities for our customers.

Leading with optimism has helped our teams overcome their natural resistance to change. Here are just a few ways we've looked beyond the challenge to see the possibilities in digital transformation:

"You can view transformation as an imperative: Adapt or die. Or, if you focus on the bright side, transformation can be about possibility."

DOING MORE WITH LESS: CHALLENGE OR POSSIBILITY?

- **Challenge:** You must deliver new capabilities at an increasingly fast pace and continuously innovate to become more efficient—while absorbing budget challenges—to meet the demands of the business and needs of customers. When viewed this way, digital transformation feels like a mandate and is unlikely to be met with enthusiasm by anyone—especially your IT teams.

- **Possibility:** This same challenge, positioned as the ability to reimagine the developer experience with improved technology and streamlined processes, could mean more time for innovation and less time on mundane, repetitive tasks—which tops the career wish list of just about every engineer I know.

  I've seen firsthand how happier team members produce better results. In our old model, IT would receive requirements from the business and then deliver capabilities months—maybe even years—later that often didn't meet the evolved needs of the business. In our new continuous

> In our new continuous delivery model, we're also delivering more value to the business. And, our teams have a greater sense of ownership and are proud of how quickly they can drive results.

delivery model, teams interact directly with the business and iteratively improve products through daily software releases. We've not only shortened delivery times, we're also delivering more value to the business. And, our teams have a greater sense of ownership and are proud of how quickly they can drive results.

LACK OF TECHNICAL SKILLS: CHALLENGE OR POSSIBILITY?

- Challenge: Given the speed of today's technology evolution, it's difficult to find skilled technical talent. So, when the business questions the readiness of your workforce, you turn to outsourcing—driving development costs up, quality down, and putting the brakes on your transformation.
- Possibility: Upskilling your current workforce will not only help them meet the demands of the future but will also increase employee engagement and retention. Consider this: By 2020, Gen Z could represent 20 percent of the workforce. These digital natives place high value on the ability to learn new technologies and have new experiences in their jobs.

When we identified the need to make our IT workforce more technical, we created a coding boot camp that taught full stack development skills to nontechnical employees. All 60 of the initial team members graduated, with several going on to work on product development teams. After an extensive internal and external talent search, two of the graduates landed in our AI Accelerator, where they will be able to advance how we use emerging technologies.

THE HUMAN ELEMENT

Building a digital culture in a traditional organization—with established ways of working and decades of technical debt—is a massive undertaking. A positive vision of the future will help you win hearts and minds, but this alone will not advance your digital transformation. It's only natural for your teams to struggle with fear and resist change. You'll need to have grit, empathy, and optimism to overcome their fears. So, the next time you're sitting across the table from your leaders and asking them to invest differently or asking development leaders to completely change how they've been doing something for 10 years, take a moment to understand where they are coming from and help them see the bright side of digital transformation. ■

Hope and Healing on the High Seas

Mercy Ships brings free life-changing surgeries and care to the "forgotten poor" of the world.

BY JOHN GORMAN

Born with clubfoot and twisted hands, Kadiatou, a young girl from Guinea, always struggled to keep up with her brothers and sisters—simply walking resulted in scrapes and cuts. But last year, at the age of five, Kadiatou and her mother traveled to a ship in the port of Conakry, where, on board, Kadiatou received treatment to correct the conditions that held her back. Now, she's playing hide-and-seek with her siblings and friends, and her mother rejoices in the fact that her daughter will get an education.

Kadiatou's story of hope and healing is just one example of the more than 2.7 million lives Mercy Ships has touched—and, in many cases, saved—since the nonprofit organization was founded in 1978. Through the use of hospital ships, Mercy Ships brings free surgeries

After receiving treatment for clubfoot, Kadiatou walks proudly down the *Africa Mercy* gangway.

PHOTOS BY SEAN BREITHAUPT

Above Kadiatou receives treatment for her twisted hands. **Below** A rotating staff of 400 volunteers from over 50 countries works on board the *Africa Mercy*.

and state-of-the-art medical care to the most impoverished areas in the world.

More than 18 million people die every year due to lack of timely surgical care, according to the *Lancet* Commission on Global Surgery. A great number of these people live in sub-Saharan Africa, where 93 percent of people cannot obtain basic surgical care, according to the College of Surgeons of East, Central and Southern Africa. It's to these areas of critical need where Mercy Ships' current floating hospital makes its rounds.

The *Africa Mercy* is the largest nongovernmental hospital ship in the world and has been serving the people of Africa's impoverished nations since 2007. After serving 10 months in Guinea, the *Africa Mercy* set sail in August 2019 for Senegal—where it'll spend 10 months providing access to aid not usually afforded to, or affordable to, the poorest of the country's 16.3 million citizens.

The *Africa Mercy*'s specialty surgery unit concentrates mostly on head and neck procedures, such as tumor removals, cleft lips and palates, fistulas, orthopedics, eye treatments, and hernias, as well as dental services.

"These are preventable conditions that we don't think twice about in North America, Western Europe, or most of the world," says Mercy Ships CEO Tom Stogner.

Stogner notes that people are often shocked by the images they see of some of *Africa Mercy*'s patients. "When they see these photos of big tumors, they ask, 'How does this happen?'" he says. "The reality is it is the sign of poverty. There's no access to safe, timely surgery, and even if they can access it, they can't afford it."

> "We know the poor are there. But they're often hidden because they're outcasts of society, their superstition, and they don't know what to do. They're just locked up because people won't come near them."
>
> —Tom Stogner, Mercy Ships CEO

HIDDEN IN PLAIN SIGHT

Stogner and Mercy Ships refer to the people who suffer from these treatable conditions as "the forgotten poor." He explains: "We know the poor are there. But they're often hidden because they're outcasts of society, their superstition, and they don't know what to do. They're just locked up because people won't come near them."

It's for this reason that Stogner says the challenge is not so much that these individuals are forgotten, but rather they need to be found.

To solve the logistics of finding the hidden, Mercy Ships turns to technology, particularly social media and text. "We use the power of social media tools, such as Facebook, Twitter, or Snapchat," Stogner says. "These connectivity tools help us find patients and get them to the ship."

The *Africa Mercy* is truly a small city on board, with a rotating staff of 400 volunteers from more than 50 countries in medicine,

hospitality, marine, information systems, communications crew, food preparation, and other professions. In fact, the *Africa Mercy* even has an accredited school to serve the 30 to 40 families who are living on board at any given time. It's a unique environment that features a diversity and depth of support that goes beyond your typical large ship or major hospital. And so does its reach.

LASTING HOPE

The Mercy Ships mission extends far beyond the ship's surgical center. The organization aims to contribute to governments in building or augmenting their national surgical development plans to further enhance each nation's ability to care for its people.

"One of the things that we ask the first time we meet with a government is, 'Do you have a national surgical development plan?' If they say yes, we see how we can contribute to its development and ongoing fulfillment," Stogner says. "And if they say no, the organization begins the work to establish one."

Much of the lasting impact comes by way of training surgeons, anesthesiologists, nurses, biomedical technicians, administrators—essentially everyone—to become more successful and pass that knowledge around to others.

> "If we are not working ourselves out of a job, we're not doing development work."
>
> —Tom Stogner, Mercy Ships CEO

"It has a multiplying effect," Stogner says. "If we are not working ourselves out of a job, we're not doing development work."

Stogner cites one example of a partnership between the Mercy Ships Medical Capacity Building program and the Guinean Ministry of Health and Public Hygiene to offer mentoring and training courses to faculty and students at Gamal Abdel Nasser University—Guinea's only dental school.

"Our hope and aspiration is that the dental training clinic will do more dentistry and train more people than we've ever been able to do, even through several repeated ship visits," Stogner says. "The goal is to create a long-lasting activity that will not only impact Guinea, but potentially be a regional center of excellence where they could impact the countries around them."

In addition to the lasting impact of training and improvement to national healthcare, there is the lasting impact to the patients themselves—and those surrounding them. Stogner recounts stories of people aspiring to become doctors or nurses after seeing the difference a surgery has made for an individual in their village. "If we can, for example, give the provider of a home a life-changing surgery," he says, "it not only affects his or her ability to provide for his children, to keep them out of poverty, and also contribute to society, it changes the world view of everybody involved."

TECHNOLOGY AT THE HELM

Floating hospitals are among the most complex technological environments in the world. "It's unusual to find out here the IT infrastructure that really requires a higher level of skill set than you'd normally find in a larger city,"

Above Ameloblastoma tumors like this one on an *Africa Mercy*'s patient's jaw can eventually make it impossible to breathe or eat. **Below** Doctors perform a hernia surgery on board the *Africa Mercy*.

says Chris Gregg, CIO of Mercy Ships. "The largest challenge we have, from an IT perspective, is maintaining simplicity amongst all of that complexity."

Simplicity is even more critical as Mercy Ships works to double its operations with a second ship. The new ship is set to begin service within the next two years and will more than double the medical capacity of Mercy Ships. This period of high growth requires the ability to ramp up operations quickly without having to bring on extra IT staff, while still ensuring the organization is set up to do the most good, for the most people, in the most locations.

"We've been looking at how to simplify our infrastructure so we can focus on the growth of the organization, be ready to operate two ships, and run our departments so that we can effectively serve the organization as we scale up," Gregg says. "Having a modern infrastructure approach is really important."

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—Chris Gregg, Mercy Ships CIO

Gregg's vision includes continuing the evolution of Mercy Ships from a traditional data center architecture toward a hybrid cloud model and consolidating support operations, without having to build additional data centers or further stretch existing resources.

"With operating data centers on the ship, we need to keep on-premise, but as we look at the strategy for our support operations, we don't want to continue building data centers and maintaining data centers here in our International Support Center in Texas," Gregg says. "We want to take a hybrid cloud approach, and our goal is to be able to manage our environment seamlessly across the on-premise data centers on ship, along with the cloud environment."

After four decades on the water, Mercy Ships has served citizens of 56 countries and recently surpassed their 100,000th surgical procedure. When their newest, largest ship launches, the organization looks forward to quickly completing their next 100,000 surgeries in far less time.

Stogner says the ship is being built with a 50-year horizon, keeping an eye on how technology and its exponential evolution in health and medicine will allow them to do things they can't even imagine today.

"At the end of the day, a very universal thing to all of us is living well and having access to healthcare," Stogner concludes. "It's something we all identify with, no matter where you come from or what you believe." ■

Watch how Mercy Ships uses hospital ships to transform lives.
DellTechnologies.com/MercyShips

3 Winning Culture Imperatives

Steve Price, chief human resources officer at Dell Technologies, shares his insights on defining the culture of the future workforce.

BY STEVE PRICE

The world of work is changing. Emerging technologies like artificial intelligence, machine learning, and robotic process automation are transforming how and where work gets done, and shaping the expectations of the future workforce. When used thoughtfully, these technologies create a workplace where team members are inspired to do their best work anytime, any place, from any device.

At Dell Technologies, we are committed to building solutions that enable this workforce transformation. We, too, are leveraging new technology platforms to provide more personalized experiences, strengthen conversations, and empower our team members to be in the "driver's seat" of their careers, recognition, performance, and continuous learning and growth.

Creating a workplace that makes people better—that helps them grow both as professionals and as people—is crucial to remaining relevant and competitive in today's rapidly changing world. Here are three key culture imperatives:

1. Define your culture code.

Creating an environment that inspires people requires clearly defining what it means for them to be their best and do their best work. At Dell Technologies, we developed our Culture Code through extensive research and feedback from more than 75,000 employees. It unites us and defines expectations for how we work and lead.

2. Invest in leadership.

Leaders create sustainable value, accelerate execution of your business strategy, foster the culture you need to win, and inspire your people. Our internal research has validated how important inspirational leadership is to the success of our culture, team members, customers, and company. We found employees who rate their leader as "inspiring" have a +42 employee Net Promoter Score (eNPS). In sharp contrast, those who have "uninspiring" leaders have an eNPS of -49.

3. Focus on agility.

To thrive in this new era of digital transformation, your workforce must be able to react quickly and successfully to rapid advancements in technology and shifts in market conditions. Our evolution as a business never ceases. But our philosophy about our talent and culture—about what it means to work here—is unchanging. ■

DELL Technologies