

Programming
ethics into
self-driving
cars

Fighting
cyber threats
with machine
learning

The analytics
fueling race
cars and better
health

Is data
monetization
a money
tree?

Realize

WISDOM AT SCALE



We're living in an age of wonder—wonder at the infinite possibilities the digital future holds and wonder at how feats we once thought impossible are unfolding before our eyes in the data era. With tens of billions of connected devices and the speed that 5G promises, data continues to grow at a wondrous pace. At Dell Technologies, we're already seeing how, by applying the power of artificial intelligence, all that data can turn into invaluable insights that transform business, grow industries, and fuel human progress.

When I talk to our customers, I'm in awe of the real transformation I see them working toward every single day—from personalized care to healthier populations, faster race cars to cars that drive themselves, better customer experiences to entirely new revenue streams.

Of course, with data and the powerful technologies that make sense of it also comes important questions and great responsibility. After all, behind the 1s and 0s are human beings. Here, too, we're seeing transformation. New technologies are augmenting our ability to protect data, and new roles are being created to treat its use with care. When I think about the digital future, I'm filled with optimism that, together, we can thoughtfully harness technology and data to create new wonders.

In the following pages, you'll discover stories of those who are creating some of these wonders today, reimagining business, and shaping a digital future in which data turns into wisdom at scale.

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Chief Marketing Officer, Dell Technologies

Realize

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Meet the Data Ethicist

When it comes to trust, transparency, and training algorithms, who makes the call?

BY STEPHANIE WALDEN

In 2016, location-based analytics startup Geofeedia landed in its own position of scrutiny. The company, a social media intelligence platform, had been sharing whereabouts of protesters with local police—a practice the American Civil Liberties Union condemned as reckless and having the potential to facilitate racial profiling.

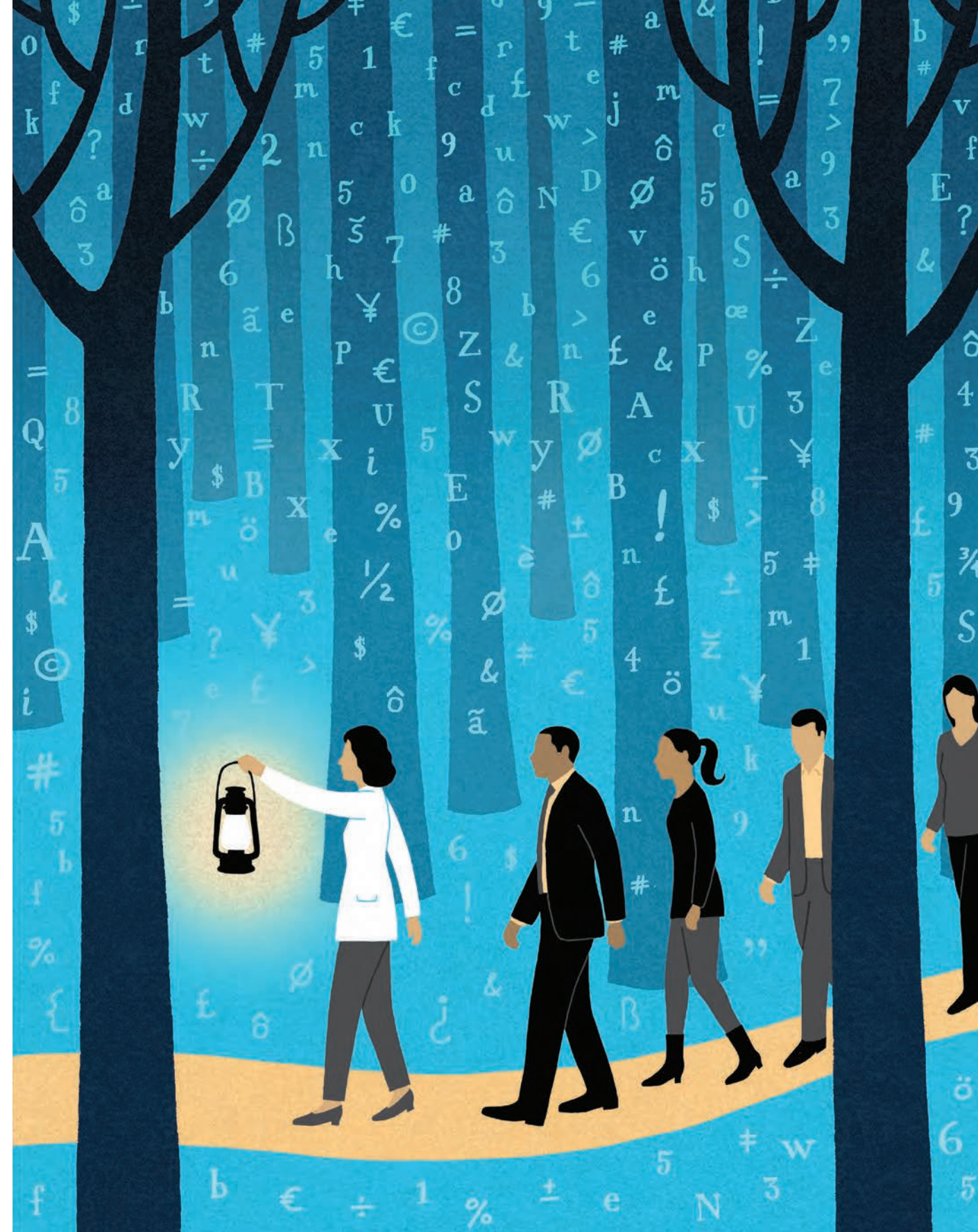
The rebuke was the first in a series of public backlash campaigns against companies for questionable data practices. In 2018, online outrage culminated in thousands of users clamoring to #DeleteFacebook in the wake of the Cambridge Analytica scandal. As a result

of the PR nightmare, Facebook experienced the worst single-day loss in the history of the U.S. stock market.

As the volume of collected data stretches to hundreds of zettabytes in the not-so-distant future, companies are learning—sometimes the hard way—that complex data systems and algorithms require equally intricate ethical considerations.

Today, companies are faced with the question: what is “right” and “wrong” when it comes to collecting, using, analyzing, and sharing data? And, whose job is it to make this call?

ILLUSTRATION BY JAMES STEINBERG



A NEW ZEITGEIST

One emerging job title aims to clarify some of these ambiguities. Much as the term “data scientist” was relatively obscure 15 years ago, “data ethicist” has yet to hit zeitgeist status. But the role, designed to help companies consider the ethical implications of their practices, is slowly gaining traction. In some cases, it’s already taken off.

Reid Blackman, Ph.D., is the founder of Virtue Consultants, a firm of more than 60 ethicists spread across the globe. With expertise in data and AI, the Virtue network advises corporations in areas such as privacy, fairness (including bias), trust, and respect. “I want companies to do better,” Blackman explains, “and now, they have a financial incentive, because consumers and employees are demanding it.”

Virtue’s client services go beyond assessing simple cases of data misuse. For instance, the company is currently in talks with a facial-recognition startup to determine the ethical ramifications of each function of its API, including how data is stored, disclosed, and shared.

One of Virtue’s objectives is to instill confidence in corporate decision makers who are responsible for data missteps. “Companies are intimidated by the topic. They think it’s going to require a whole bunch of technical chops—but making certain kinds of decisions doesn’t require deep technological knowledge,” Blackman says. “Leaders should be educated about what the issues are so that they feel empowered to make decisions in a responsible way.”

As organizations continue to make data central to their operations, experts like Blackman predict that moral crossroads will only continue to crop up. What’s more, efforts to clearly define just who answers such questions often do not keep pace with the rate of innovation.

Lisa Spelman, vice president, Data Center Group, and general manager, Intel Xeon Processors and Data Center Marketing, cautions against assigning ethical oversight solely to the data science team. “A data scientist is a mathematician, a deeply technical resource—not necessarily an ethicist,” says Spelman. “So, if you are putting all of that responsibility on your data science team, it’s too big of a burden, and can slow down the path to success.”

Instead, Blackman suggests that every employee who touches data should have basic knowledge of its ethical implications. A chief privacy officer or chief data officer, for instance, must not only work with a development team to enact privacy policies and best practices, but he or she must also educate other executives to ensure their buy-in.

THE INTERSECTION OF AI AND DATA ETHICS

Moral quandaries associated with AI open a whole new can of worms, ethically speaking, explains Blackman. “There was data well before there was artificial intelligence. But because AI is all about data, data ethics is almost—not quite, but almost—a subset of the discipline,” he notes.

As such, ethics around training AI are becoming increasingly salient. AI algorithms present a twofold challenge: Companies must consider both input (are algorithms biased in any way?) as well as output (where and with whom is the resulting data shared, and is it leading to a valuable outcome?).

Spelman suggests this is where the data ethicist can facilitate honest conversations as they’re building out AI capabilities—from the very earliest stages of algorithm development. “This will give you the capability to

stand back, look at what you’re delivering, and determine whether it’s leading to the right result,” she says.

She also urges companies to consider just how much data they really need to collect to be effective. “You don’t need as much data

“Data in general is a very abstract topic,” she asserts. “People cannot convert technical terms and written words into examples that they can then make judgments on. When disclosing to consumers, companies need to be specific in their examples.” She proposes

“You don’t need as much data as people think you need to be valuable in the AI space. We have a responsibility not to collect as much data as possible, but to collect as little data as possible to drive good results.”

—Lisa Spelman, VP and GM, Intel Xeon Processors and Data Center Marketing

as people think you need to be valuable in the AI space. We have a responsibility not to collect as much data as possible, but to collect as little data as possible to drive good results.”

A TRUST ISSUE

Still, if a primary ethical concern is how businesses use data, another equally important issue is how to disclose data usage to customers beyond pages of legal jargon followed by a consent checkbox.

While a truly ethical lens goes beyond regulatory compliance, initiatives like the EU’s General Data Protection Regulation (GDPR) loom large. Similar, imminent legislation in the United States may provide extra incentive for companies to proactively develop appropriate ethical standards and communications.

Daryl Crockett, CEO of ValidDatum, a data consulting company, points out that although consumer outrage around data misuse has gained traction, many people still have no idea the extent to which companies collect and use their information.

visuals like pictures or animations as a way to ensure company messages sink in.

Blackman concurs that transparency is crucial, pointing out that the proliferation of technologies like location-tracking, biometrics, and chatbots make clear messaging even more paramount. “Companies may say, ‘Oh, we’re just collecting your metadata.’ But number one, you can do some powerful things with metadata, and number two, the average consumer doesn’t have a clue what metadata means,” says Blackman. “It’s hard to consent to something when you don’t even know what it is.”

Ultimately, Blackman believes that his uptick in clients is a sign that more companies are turning introspective, considering the ethics of their products, services, and related data. A primary motivator for these businesses, he notes, is building and maintaining public trust.

“Millennials in particular want to purchase from ethically upright businesses, and they want to work for them as well,” he says. “People of all ages are raising concerns and spreading them in a way that we haven’t seen before.” ■

Sara Adkins, Carnegie Mellon Computer Science and Music Technology graduate, programmed the LEDs in her viola bow using an open-source microcontroller embedded in her costume.

Taking AI to the Humanities

Universities take a multidisciplinary approach to shaping tomorrow's AI leaders.

When MIT's new College of Computing starts this fall, it won't be comprised of just computer science students. Instead, the Stephen A. Schwarzman College of Computing will target what MIT President Leo Rafael Reif calls bilinguals—students who will learn to use artificial intelligence to address challenges in areas like political science, economics, linguistics, anthropology, and urban studies.

The billion-dollar investment is a big deal, but not just because it's one of the largest monetary bets on the application and ethics of computing and AI by an American academic institution. Or, for that matter, because of the initial \$350 million foundational gift from Stephen A. Schwarzman, the chairman, CEO, and

co-founder of Blackstone, a leading private equity firm.

What makes the new college stand out is its ambitious mission: It will reorient MIT to bring the power of computing and AI to all fields of study. In turn, it will shape the future of computing and AI, molded by insights from many disciplines, including the humanities. In Reif's words: "We are reshaping MIT."

MEETING GEN Z NEEDS

The new college, MIT's president shared, is the school's "strategic response to a global phenomenon—the ubiquity of computing and the rise of AI." Yet for Reif, computing is no longer the domain of experts alone.

"It's everywhere, and it needs to be understood and mastered by almost everyone," he

PHOTO COURTESY OF CARNEGIE MELLON UNIVERSITY

BY PRAGATI VERMA

wrote in an October 2018 letter to the MIT community. “For a host of reasons, society is uneasy about technology—and at MIT, that’s a signal we must take very seriously.”

The move to give weight to AI and its applications seems to have reached Gen Z, those born after the mid-1990s, too. A staggering amount—97 percent—of Gen Z students believe technology literacy matters, according to a recent study by Dell Technologies that surveyed 12,000 students between ages 16 and 23 and across 17 countries. What’s more, four out of every five people polled said they aspired to work with cutting-edge technology in their future careers.

More than 50 percent also stated that future jobs will require technology skills because they will be working with robots or some other form of technology. Finally, about a third of those surveyed said that everyone needs technology skills and that people who understand technology will be the future leaders.

If this research is any indication, Gen Z is hungry for AI education in a traditional aca-

ademic setting, as well as in the real world. But MIT is not the only academic institute reshaping itself to meet their demands. Stanford’s Human-Centered AI initiative is a university-wide effort that taps into a wide range of disciplines, from neuroscience to ethics, to catalyze multidisciplinary research and train future AI leaders.

At Carnegie Mellon, the BXA InterCollege degree program targets students interested in fields that meld technology and arts, such as game design, computer animation, computer music, recording technologies, and robotic art. The school’s Music and Technology program also offers a set of courses that span across music, electrical engineering, and computer science.

“Portions of what we call AI are now pervasive and are finding applications everywhere,” says Yiannis Papelis, research professor and director of the Virtual Reality and Robotics Lab at the Virginia Modeling, Analysis and Simulation Center (VMASC). Old Dominion University, where VMASC is based, also offers

“It’s time for academia to change with the world and embrace interdisciplinary fields around new technologies. This new approach means that we will need to break down silos and academic structures that have existed for years.”

—Yiannis Papelis, VMASC at Old Dominion University

an Individualized Integrated Interdisciplinary Studies program.

“It’s time for academia to change with the world and embrace interdisciplinary fields around new technologies,” Papelis says.

This shift towards interdisciplinary education, however, is not without its challenges. The biggest problem, according to Papelis, is that the new courses don’t fit into the traditional academic paradigm.

“This new approach means that we will need to break down silos and academic structures that have existed for years,” he says. While the shift won’t be easy, he reiterates that “problems in life don’t come in neat packages with specific outlines.” Just as students will face multidisciplinary obstacles in the real world, academia must also adopt a multifaceted approach to AI education.

BUILDING A BRIDGE

MIT seems to be doing exactly that kind of innovating with its new College of Computing. Case in point: the way it’s hiring for tenure positions. The school will offer 50 new faculty positions, half of which will be bridge positions—dual appointments between the new

college and academic departments located in any one of MIT’s five schools.

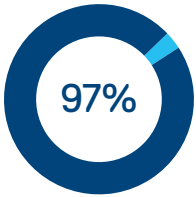
The goal is not to drop the specializations that the university worked so hard to create—it is simply about accepting that everyone needs to study technologies like AI, no matter what their field of study or their future job aspiration. The formula to prepare the next generation for an AI-driven world, he explains, is not to change the entire curriculum but to “fold AI it into existing courses.”

On the whole, for the students who don’t go on to become AI experts in the traditional sense, “they might not build deep learning models to recognize patterns, but they will be aware of what AI is, what it can do, and how to bring AI tools to their field,” Papelis says.

These multidisciplinary academic structures around AI, Papelis points out, will be key to positioning AI as “an integral part of basic technology literacy, no matter what field of study you choose.” ■



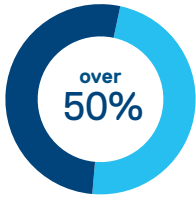
How will AI impact human creativity? Subscribe to the AI: Hype vs. Reality podcast to find out. DellTechnologies.com/HvR



of Gen Z students agree that technology literacy matters.



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believe future jobs will require technology skills for working with robots or other emerging technology.

about
1/3

said that everyone needs technology skills and that people who understand technology will be the future leaders.



Explore the Dell Technologies Gen Z research at DellTechnologies.com/GenZ

Guardians of the Rainforest

The key to fighting illegal logging might be your old phone.

In 2012, Topher White was taking a break from his work as a web engineer by volunteering at an Indonesian gibbon reserve when he had an encounter that would change the trajectory of his life. Hiking out into what seemed like pristine rainforest one morning, White ran straight into a man with a chainsaw, chopping an old teak tree into lumber.

BY KATHRYN NAVE

Topher White, CEO & Founder of Rainforest Connection, prepares to install Guardians in Fairfax, California.

PHOTO BY TYLER ROEMER

TRENDS

The reserve was small; he wasn't far from the ranger station. Still, the three full-time guards were unable to keep a constant eye over a square mile of forest, making small-scale logging a tempting proposition for many living nearby.

An inveterate engineer, White is the kind of person who, even in the rainforest, happened to have some electrical components and an old phone on hand "just for fun." So he hacked together a rudimentary listening station and demonstrated it for the rangers. They liked it enough that White headed back a year later to set up a permanent system.

This proved its value in just 48 hours, when White received a GPS alert for chainsaw sounds on the other side of the reserve and headed out with rangers to investigate. They arrived at the location within minutes to find a small group of men from the local village chop-

ping down trees. This unexpectedly rapid response was enough to send a message, White says: "You can't log here anymore, because if you do, you will get caught."

Since then, White has raised more than \$160,000 on Kickstarter to create conservation non-profit Rainforest Connection. The organization has now launched hundreds of smartphone "Guardians" in remote regions of forests all over the world, expanding monitoring capacities for local conservation groups from the Temb  tribe of the Brazilian Amazon to Peruvian government rangers in the Alto Mayo. Together, the efforts have protected more than 100 square miles of forest.

CREATING THE GUARDIANS

While the operation has scaled, the Guardians are still built on the same smartphone bases. For one thing, it's a small contribution to reducing the impact of the 350,000 or so phones discarded daily in the U.S. alone. For another, "it's actually a great little computer to write software for," White explains. "It has all the sensors that we need, and it can connect to the cellular networks. Building something like that from scratch would be very hard."

Instead, discarded smartphones are repackaged into a box with a powerful microphone, a battery reserve, and a solar panel specially designed to maximize the energy from the sun flecks that make it through the tree canopy. The Guardian contraption is then placed around 150 feet up a tree, accessing cell towers up to 12 miles away and detecting sounds more than a mile away.

Still, the innovative project faces its own set of challenges. "It feels like launching a satellite to me," White says. "The Guardians are in places that are so inaccessible, and they're

Topher White mounts a Guardian—complete with microphone, battery reserve and solar panel—about 150 feet up a redwood tree.

Topher White assembles Guardians using discarded smartphones.

PHOTOS BY BEN VON WONG



HOW DOES RAINFOREST CONNECTION WORK?



trying to do a very energy-intensive thing in this very harsh, wet, and hot environment.”

And then there is the noise. From the calls of howler monkeys to the squawking of the macaws, the rainforest is rarely a quiet place. No matter how sensitive your microphone is, picking out anomalies amid the cacophony can be a difficult task.

Yet rather than running this computationally demanding analysis on the phone itself, the Guardians continuously stream audio to the cloud, where Rainforest Connection’s system analyzes it for suspicious sounds, like chainsaws, trucks, or motorbikes. More recently, they’ve also begun to spot predictive patterns, such as the calling sounds of certain bird species falling unusually quiet when intruders draw near, in order to send warnings before loggers even arrive at a site.

This sensitivity in pattern recognition is crucial now that Rainforest Connection is helping people take on larger black-market operations,

where confrontation could potentially be much more dangerous than it was back in Indonesia.

“A lot of our partners typically wouldn’t show up at a site because if they do, it’s going to be a gunfight,” White reports. “That’s what we’re trying to avoid, and that’s why this real-time or even predictive response is important, because if you stop a truck on the way in, then the stakes are pretty low.”

In the predictive scenario, no crime has been committed yet, but the invaders know they’re going to get caught so, in some cases, they will turn around and just leave. Alternatively, “if you show up once they’re already cutting down trees,” White says, “then the stakes are high, and people can get hurt.”

BIOMONITORING

Successful intervention usually has a longer-term impact than just driving the loggers away one time. Illegal logging relies on being able to operate undercover, and once the organiza-

ILLUSTRATION BY RANDALL MARTIN

tions know that an area is under surveillance, it’s typically enough to keep them away for at least a year, White explains. This yearly estimate is based on the organization’s own observations, as well as reports from partners at the five sites where the systems are installed.

That leaves Rainforest Connection with the question of what to do with the hundreds of hours of undisturbed rainforest recordings that they’re continuously collecting. One solution is to use machine learning to allow ecologists and biologists to build sound profiles for species that interest them. From here, the researchers would be able to—at-will—select relevant recordings from Rainforest Connection’s database.

“Right now, if you’re an ecologist and you want to do research on the rainforest, you’d have to apply for a grant and wait months for it to come through,” White says. “Then you’d fly out and record for maybe two weeks, and then you take this back to your lab and spend years analyzing just a couple of weeks of audio you were able to collect.

With Guardian technology, we can make years’ worth of audio data, from hundreds of locations, available to them instantly.”

Ultimately, White wants people all over the world to be able to listen to the sounds of the forest. Rainforest Connection’s smartphone app now allows anyone to tune into sound streams from locations in Peru, Ecuador, Africa, and others. This is important, he explains, because the survival of the rainforests should matter to more than just the animal species and the humans who inhabit them.

“The destruction of the rainforests is the second largest contributor to climate change,” White says. “The CO2 emissions from deforestation are greater than all other forms of transportation put together.” But 90 percent of this deforestation is illegal, and because it’s already a crime, there’s no additional mandate to stop the ongoing abuse.

With White’s rainforest engineering underway, it seems possible to tackle the crux of the issue. For White, “this could be one of the easiest ways to make a significant impact on preventing climate change.” ■

The New Frontiers of Computing



Bask Iyer, CIO and general manager for Edge Computing/ IoT for Dell Technologies and VMware, shares his perspective on the future of IoT and the Edge.

BY BASK IYER

Victor Hugo said: “There is only one thing stronger than all the armies of the world, and that is an idea whose time has come.”

Sometimes, an idea’s time takes years to come. Consider the lightbulb: Edison started lighting up parts of Manhattan in 1882, yet his idea was not embraced by the majority of U.S. homes for more than four decades. Why did it take so long for lightbulbs to truly shine? Simple, really. While the idea was brilliant, the technology to make it practical—fine tungsten filaments, pervasive electric grids, etc.—had yet to be fully realized.

Like the lightbulb, IoT was ahead of its time. Believe it or not, the first IoT device was a toaster created by John Romkey way back in 1990. Building automation has been around for at least a decade, and smart-home thermostats were introduced eight years ago.

So why is enterprise IoT taking so long? As with the lightbulb, a lot of work had to be done to make the idea truly practical. But I believe the time has come for IoT. The question becomes, should you launch headlong into Edge and IoT, or should you take a “wait-and-see” approach?

There will always be risks to innovation, and people will always resist change. But I have good news: We’ve been hard at work engineering an Edge and IoT architecture that is open, flexible, compatible, and secure, and paves the way for you to move ahead with confidence.

THE CONNECTED EDGE

I love to explain the Edge and its importance by citing NASA’s Mars Rover project. Mars is so far away that during the Curiosity landing, if there was a problem, it would have taken 13 minutes for the radio signals to reach Earth and at least 13 more for the response to make it back. A lot can happen in 30 minutes, namely the whole Curiosity landing!

The delay, of course, is due to the speed of light. To keep the Mars Exploration spacecraft flying safely, NASA made sure the required computing and commands were on board so all the relevant information could be close to the action. That is the Edge—where compute acts on data in real time.

The Connected Edge, or IoT, represents the best of both worlds, where devices and computers can work together unsupervised—such as the Mars Rover—while also being connected to nearly infinite storage and processing in the cloud. And although connections can potentially increase security risk, the benefits of Edge and IoT are too great to ignore.

IoT data is already fueling the engines of AI and other emerging technologies that impact every aspect of life. We’re seeing this impact as customers across many industries successfully use Edge and IoT.

For example, top-selling protective eyewear brand Uvex monitors machines, protective wear, and environmental parameters in real time to maximize worker safety on construction sites and in factories. Siza, a not-for-profit organization that provides medical and technology support to people living with disabilities, uses IoT-based monitoring and alerting capabilities to predict if a patient might need assistance and send help. AeroFarms, too, is transforming agriculture with indoor, IoT-equipped vertical farms to increase yields 390X over traditional farming—with 95 percent less water.

BEST PRACTICES FOR ENTERPRISE IOT

The opportunity for IoT and Edge is significant, but there are challenges. The most pronounced is that, in business, the demands of “right now” can outweigh the demands of tomorrow.

Capturing IoT’s full potential to enable data-driven decision making will require leaders to embrace innovations in technologies, change business models, and invest in new capabilities and talent.

““

I believe IoT will accelerate our ability to generate even more groundbreaking ideas and propel human progress. Its time has come.”

But the danger of de-prioritizing Edge and IoT is that the business will implement the technology without IT's involvement. These shadow projects create serious bumps down the road, including not being able to scale device management, manage large volumes and diverse types of data, or ensure security and compliance.

Despite these challenges, the IoT and Edge train has left the station, as the number of “things” continues to grow exponentially. Capturing IoT's full potential to enable data-driven decision making will require leaders to embrace innovations in technologies, change business models, and invest in new capabilities and talent. To thoughtfully deploy and run your Edge and IoT environment, consider the following best practices:

- ♦ **Join forces.** Build relationships across OT, IT, and business decision makers to gain enterprise-wide expertise.
- ♦ **Simplify device management.** Free up IT and operational personnel by automating device detection, configuration, and management.
- ♦ **Be smart about data.** Lower storage costs, bandwidth requirements, and security risk with comprehensive data orchestration tools.
- ♦ **Speak a common language.** Build your solution on infrastructure that connects and integrates heterogeneous communication protocols.
- ♦ **Integrate security.** Minimize data and network exposure by delivering timely software updates to your Edge devices and applications.
- ♦ **Prepare to grow.** Easily add more and new types of “things” with a flexible, scalable architecture, and vendor-neutral management tools.

THE TIME HAS COME

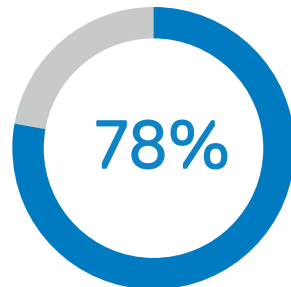
Even at this early stage, IoT has already made a real impact, proving that the digitization of machines, vehicles, and other elements of the physical world is a truly powerful idea. I believe IoT will accelerate our ability to generate even more groundbreaking ideas and propel human progress. Its time has come. ■

Embracing a Digital Future

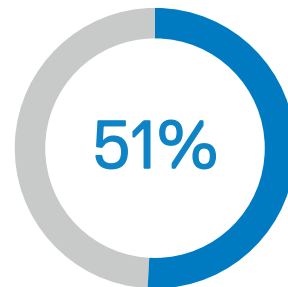
THE STATUS OF DIGITAL TRANSFORMATION AROUND THE WORLD

In today's hyper-digital world, businesses must transform in order to compete—and survive. But how are organizations faring on their path into the digital future? To find out, Dell Technologies, in collaboration with Intel and Vanson Bourne, commissioned a survey of 4,600 business leaders across the globe to score their organizations' transformation efforts and map their progress on the Digital Transformation Index.

The case for digital transformation is known.



of business leaders believe digital transformation should be more widespread across their organizations.



of business leaders believe they'll struggle to meet changing customer demands within 5 years.

Yet, progress is slow.

Only 5%

of businesses are considered digital leaders, with digital technologies ingrained in their DNA.

39%

either have no digital plan or have made very few investments to date.

91%

of organizations face persistent barriers to transformation.

The top three barriers are:

- 1 DATA PRIVACY AND SECURITY CONCERNS**
- 2 LACK OF BUDGET AND RESOURCES**
- 3 LACK OF THE RIGHT IN-HOUSE SKILLS**

There is a confidence crisis.

~1/3 don't trust their organizations to:

- Comply with regulations (like GDPR)
- Protect their employee data
- Safeguard customer data

In response, businesses are formulating digital rescue plans.



58%

are investing heavily in cybersecurity



77%

believe they'll harness emerging technologies to predict customer demand and manage resources



46%

are developing in-house digital skills by teaching employees how to code

Other IT investments within the next three years include:



46%

Internet of things



44%

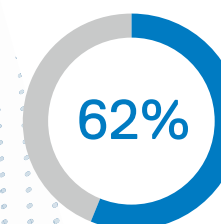
Multi-Cloud



40%

Artificial Intelligence

The time to embrace the digital future is now.



expect significant business gains, including:

- Productivity
- Profitability
- Revenue growth



Explore the full Digital Transformation Index report at [DellTechnologies.com/DTIndex](https://www.delltechnologies.com/DTIndex)

Welcome to the Data Era

John Roese, president and chief technology officer at Dell Technologies, in conversation with *Realize*, shares his outlook on the state of data and the technologies that make sense of it.

What was the path that led to your role as CTO at Dell Technologies?

It's a long one! The punchline is I'm a serial CTO, but I'm a CTO that has crossed many different industries. I've been in telecom, enterprise networking, compute, security, cellular, unified communications, real-time communications, storage, and everything else.

It was 2012 when I got a call from EMC. I wasn't actually looking for a job, but I had a feeling that EMC was going to end up right in the middle of something very disruptive. I didn't know exactly what it was going to be, but it seemed like with VMware, Pivotal, and EMC, we were going to be in the middle of the

action. For me, that's the most exciting thing about the industry. Then when we announced we were going to combine with Dell, it seemed even more like being in the center of the technology universe. I led the overarching technology strategy to integrate Dell and EMC (and build Dell Technologies), then became the CTO.

Funny enough, when heading to college, I flipped a coin between being a lawyer and an electrical engineer. I sometimes say I lost and picked the engineering path, but of course I don't really think that.

What are you most passionate about as CTO?

As a technologist, probably the most important thing in your life is when you see the ideas and technologies that you saw first or that you created actually go into practice and change the human condition in a positive way.

PHOTO BY BOB O'CONNOR



There are a lot of technologies I'm passionate about—AI, Edge, 5G, take your pick. What's most exciting, though, is the platform we have as Dell Technologies. CTOs are all about predicting the future, but also helping to make it happen. It's very hard to make it happen if you don't have a platform.

But if you're Dell Technologies, a roughly \$90 billion company with global reach and trusted customer relationships, what we say matters, our platform matters, and our point of view matters. In this time of massive transformation, we have a huge opportunity to put our fingerprints on the industry and help move it—and the world—forward.

What keeps you up at night?

There are so many things changing so rapidly in the industry that if we don't navigate any one of them properly, it could create a disadvantage for us. So, we need to be agile. We need to move fast to be ahead of the curve. We have a huge capability to do that, but we also have a lot going on. So, what keeps me up at night is making sure that we know not just what to do, but what not to do.

Some technologies are buzz words and will remain buzz words for a long time. Quantum computing is a great example. We should be aware of it, but if we took all of our engineering capability and tried to build a quantum computer, we'd go out of business. I have the responsibility of making sure we pick the right battles and focus our energy

to best position ourselves in the industry. If we get it wrong, that's where problems start to happen.

You've been outspoken about the "data era," but data and big data have been around for decades. How is this era different?

For the first time in history, we not only have an abundance of data, but we have also invented new, more economic ways to store and process that data. Then most importantly, the software and algorithms have now reached a point, primarily through artificial intelligence and machine learning, that we can mine this data and turn it into something more interesting.

There's a hierarchy in data. There's data, which is raw. Information is when you organize the data into structures. Knowledge is when you gain insights from the information. And wisdom is when that knowledge becomes useful to predict the future and understand the past. We are entering an era when the compute infrastructure, amount of data, and the algorithms are all coalescing so we can get to knowledge and wisdom at scale, across almost any industry. I think that justifies saying that we're entering a new era—the data era.

IoT devices are creating vast amounts of data at the edge. What is the edge, and why is it important?

First, it's important to recognize the edge isn't a standalone environment. There are four layers that make up the multi-cloud architecture. There are the devices, which connect to the edge, which ultimately connects to private data centers, where you have full

"We are entering an era when the compute infrastructure, amount of data, and the algorithms are all coalescing so we can get to knowledge and wisdom at scale. I think that justifies saying that we're entering a new era—the data era."

control and optimization. Then there are public clouds, which give you aggregation at an industry level.

Edge is the newest layer, and it offers a place where you can push some of your processing and analytics capabilities out to the physical location of the people and devices you interact with in real time. There are two advantages of doing this.

What are those advantages?

First, because the compute and analytics are close to where the users are, the speed-of-light issue that we have when we move data over distance is no longer an issue. You can operate and make decisions in real time. This is incredibly important for things like autonomous vehicles and their ability to react to their environment. But there are several use cases—in factories, healthcare, gaming—where the goal is, first and foremost, to do things quickly and not have the latency of crossing the internet involved in the real-time service.

The other advantage to the edge is—as much as we think the internet has infinite

bandwidth—it takes a lot of time, energy, and money to move huge quantities of data back and forth across the internet. The edge gives you the ability to run the analytics locally so that you don't have an urgency to move all the data into the cloud or into a private data center. You might eventually move the data, but you don't have to move it in a priority manner that costs a lot of money.

There's a lot of hype around AI, both positive and negative. Where do you see AI having the greatest impact?

I'm very bullish on machine intelligence. I believe we can't progress without sharing the burden of thinking tasks with machines, and AI is a set of tools that allows us to do that.

Largely today, we don't use machines to do thinking tasks. We store data. We process data. But the actual empirical decision almost always happens at a human level. As we look at the world today, there are so many things that, quite frankly, are incredibly inefficient and would improve if machines were to take over more of that responsibility.



Where do you see these opportunities for machines to step in?

The first is the user experience. Some simple examples are voice assistants and digital assistants that already make customer care more productive and our homes more efficient. Those experiences are not possible with an army of human beings behind them. You need machine intelligence.

The second is business process improvement. Every business process we have today—financial, industrial, manufacturing, healthcare—involves thinking tasks, and most of them do not have enough human beings with the expertise to do those thinking tasks. Applying machine intelligence to take on just some of the thinking, such as with radiology, achieves a more effective operational outcome, without running out of humans to do the work.

Then the third is the creation of entirely new industries. The autonomous vehicle industry is the best example. Candidly, if you want cars to drive themselves, you can't do it by adding more people.

All of these outcomes have different degrees of complexity, but none of them are possible without shifting most of the task—maybe all of the task—to a machine environment that operates with speed and efficiency. The upside is enormous.

How do you address concerns about job disruption?

All technology, all industrialization changes disrupt jobs, full stop. AI will disrupt jobs. There are jobs that will go away, and there will be jobs created. But there's also a third category,

and that's improvement of the human condition. What happens when machine intelligence achieves its outcome, like making cars autonomous? Or making healthcare more intuitive, or making customer service easier? What happens to the businesses that use them? It's very likely those businesses will grow because some impediment to their growth suddenly disappears, which allows them to reach more customers and provide a better service.

It's much more complex than just a one-dimensional consideration of jobs. New technology will always equal some job disruption—hopefully more job creation—plus a change in the human condition that is a net positive and makes our existence happier and better.

What is the biggest misconception leaders have about their data?

Many leaders are wrestling with the idea that you have to understand your data—what to collect and what to keep—before you can develop a data strategy. That's not true; flip it around. You have to pivot to the idea that it's because you don't understand all of your data that you should gather it and use tools like AI and machine learning to figure out what it's telling you.

If you don't pivot, two things will happen. One, your data strategy will probably never happen because you'll never really understand all your data. Or two, you'll throw away a bunch of data that could've been really valuable in getting better insight.

The other misconception people have is that the data era equals big data. Big data allowed us to use some new, but rudimentary tools to mine lots of data to try to see patterns, then present

it to a human being to do something with it. In the data era, you want to take the data, get insight from it, and make it actionable. To do that, you have to move much faster than human beings can operate. That means moving beyond big data and developing an AI strategy, so that you can get insights quicker than human beings, and then apply the outputs right back into your systems to change their behavior.

Where does Dell Technologies fit into the data era?

We have hundreds of AI projects going across Dell Technologies, so we're not just talking about it—we're doing it, and we know what our customers are facing. We've used it in marketing, services, and engineering, and we're applying AI to our core products to make them faster.

On our client devices, we apply machine intelligence to better manage power consumption. You want your battery life to last a long time? It's not just about bigger batteries; it's about smarter systems. And the best way to do that is with machine intelligence.

Another example is PowerMax, our flagship, high-end storage product. Its 10 million-plus IOPS performance wasn't achieved just by brute force compute, memory, and IO, but by adding sophisticated machine learning technology. Then on the backend, predictive maintenance and predictive failure analysis have dramatically changed the economics of delivering service, while also improving uptime for customers of all sizes.

This is just a small sample of the pervasive activity inside of Dell Technologies to incorporate machine intelligence so we can create smarter products and solutions and a smarter, more efficient and effective company.

Is there an innovation you are most excited about?

I don't have favorites, so I can't pick just one innovation. But we are using these technologies across our product portfolio because the fact is: The future winning product won't be the product that's just biggest, fastest, and cheapest. It will be the product that's smartest. ■

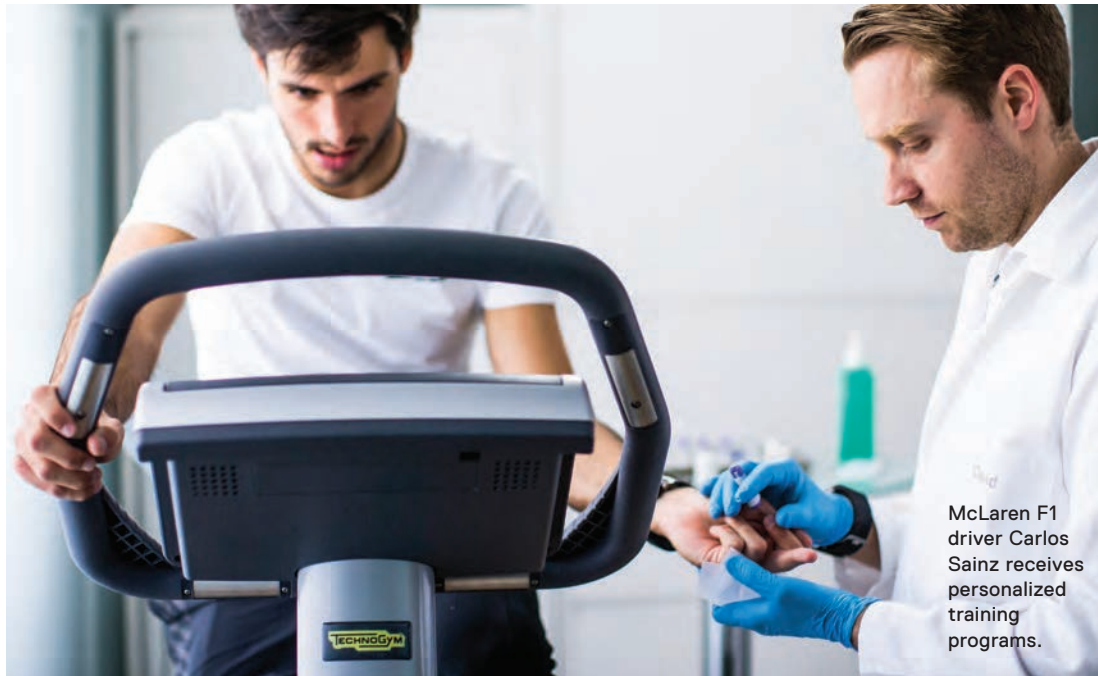
“The future winning product won't be the product that's just biggest, fastest, and cheapest. It will be the product that's smartest.”



Racing Toward Deeper Health

Real-time data insight isn't just fueling race car performance—it's pushing the boundaries of modern medicine.

BY PRAGATI VERMA



“It started off with us saying, ‘Well, if you can continuously develop a Formula 1 car by using real-time data insight and being predictive about the outcome of the race, why wouldn’t you do that for a human...?’”

—Duncan Bradley, health unit business director at McLaren Applied Technologies

Formula 1 typically conjures images of fast cars, checkered flags, and quick tire changes. And today, the same digital technology that optimizes race car performance is buzzing around medical facilities and in consumer wellness, monitoring improvements in patients, and helping us perform at our best.

McLaren Applied Technologies—a company that uses data-driven technologies to power Formula 1 car racing—helped one British pharmaceuticals company monitor recovery in stroke victims and people suffering from severe arthritis, using smart sensors and data analytics. Much like with cars, the key is to find predictive and actionable insight (in this case, from the human body) efficiently from rich, real-time data.

To track the health of stroke patients enrolled in clinical trials, clinicians have typically relied on recording activity levels each time a patient visited the clinic. McLaren Applied Technologies provided patients with sensors to accurately monitor patient

recovery with a greater degree of real-world, evidence-based insight. The sensors correlated wearers’ activity and gait profile with disease progression, helping to provide personalized insight about the patient’s response to drug treatment.

This real-time data about patient activity has allowed clinicians to get a better understanding of patient progress between clinical visits and determine informed interventions. This kind of biotelemetry has also ensured more accurate results and increased confidence in the studies, and long term the hope is that this technology will help to bring new drugs to market sooner, at lower cost.

According to Duncan Bradley, health unit business director at McLaren Applied Technologies, these kinds of health monitoring systems are not all that different than those used to monitor McLaren Formula 1 cars. The McLaren team uses up to 300 sensors on a car at any one time and uses that data to build the best strategy for a race. “It started off with us saying, ‘Well, if you can continuously devel-

op a Formula 1 car by using real-time data insight and being predictive about the outcome of the race, why wouldn’t you do that for a human, swapping the race outcome for a health outcome?” Bradley explains.

And in fact, roughly 10 years ago, McLaren Applied Technologies started applying the same scalable data analytics technology used to understand F1 cars to better understand the human element of the race: McLaren’s Formula 1 drivers. Bradley points out that understanding the makeup of a driver goes well beyond his natural driving skills to include movement, recovery, nutrition, and cognition. “We track, monitor, and predict all the key health and wellness indicators that a driver needs to be able to perform at his best over season and create personalized interventions and programs.”

The data collected from biometric sensors enables McLaren Applied Technologies to understand each driver’s body and personalize training programs over the course of a race season, but these

same insights are directly applicable to the general population. “In the F1 world, it’s all about maximizing race performance, but in healthcare it could be recovering from a surgical procedure, managing a disease or weight loss, or running a marathon,” Bradley says. “Whilst the field of application is quite different, the technology and approach underpinning our digital health and wellness business is quite similar, directly taken from what we have learned over the years of going racing.”

According to Bradley, the healthcare industry is at a pivotal point where it can benefit from adopting such innovative technologies, with a growing requirement for evidence-based, predictive insight to improve our well-being coupled with the availability of more high-quality human data. “Thanks to investment in motorsport, a highly-competitive environment with a cutting-edge technology focus, the racing world saw a digital revolution before many other industries and learned a lot about handling data to drive decision-making,” he says, “but what

The Empatica Embrace smartwatch monitors signs of grand mal seizures.



PHOTO COURTESY OF EMPATICA

we learned about processing real-time data can be very useful in providing services to the healthcare sector, from clinical research to wellness and sports performance.”

In addition to the technology found on the race tracks and McLaren Applied Technologies’ labs, other advanced data analytics from disparate industries is helping healthcare professionals better monitor signals on an individual patient level, creating new care pathways and mapping health trends across populations.

DOCTOR ON YOUR WRIST

In this quest for real-time monitoring, a new generation of wearable devices is burrowing into health like never before. Smartwatches, probably one of the most popular wearables today, don’t just count steps, monitor heart rate, and record burned calories. They are also monitoring biomarkers from heart rate, glucose, and oxygen levels to toxins and other physiological signs in order to detect and predict serious medical episodes.

Empatica, for example, a startup with offices in Milan and Boston, developed Embrace, the first smartwatch to be approved by the U.S. Food and Drug Administration (FDA) for neurology, to monitor one of the most dangerous kinds of seizures, known as grand mal or generalized tonic-clonic seizures. Through a machine-learning process, it gathers biomarker data and sends an alert to summon caregiver help during a seizure.

Empatica’s journey began long before it ventured into medical features. Its core technology traces back to 2007, when a team at MIT Media Lab developed a wearable that measured changes on the surface of the skin that could communicate main components of stress, such as electrodermal activity and temperature.

Professor Rosalind Picard led the research at MIT Media Lab, and today she also works as Empatica’s chief scientist. The team at MIT Media Lab, according to Picard, “worked for years building wearable stress and emotion sensors, and then

accidentally discovered we could pick up changes in the skin elicited by brain activity related to the most dangerous kinds of seizures.”

Today, Embrace works by measuring three kinds of data. First, it detects the electrodermal activity that represents electrical changes on the surface of the skin. For most people, increased neural activity and stress elevate the sweat level on skin. Even if the sweat is too little to be seen or felt on the surface, pores below fill and increase electrical conductance enough to be detected by Embrace’s sensors. Embedded accelerometers and gyro-meters then measure movement to tell the device if the person is likely to have fallen or is making sudden movements. Third, a thermometer picks up longer-term changes in skin temperature.

When the Embrace wristband determines that a seizure is underway, it relays this message to the user’s paired phone and sends an alert to all the individuals listed as caregivers in the Empatica Alert app.

The device is already saving lives. According to Empatica, a 25 year-old patient suffered from an epileptic seizure that left her unresponsive and not breathing. The Embrace watch on her wrist detected the seizure and immediately sent out an alert to her mother, who called the paramedics. “I was in the hospital for a total of four days, with three of those days in ICU,” the patient explained in a blog post. “I believe the Embrace saved my life. It helps give peace of mind to me, as well as my friends and family.”

McLaren Applied Technologies, too, has upped its wearables game in a collaboration with Huami, best known for its branded fitness bands. The company will work with the Chinese biometric device company to develop co-branded intelligent, custom-designed performance optimization solutions and wearable technologies to keep people healthier—without sacrificing personal style.

And while Bradley is excited to be working with Huami, he’s clear that McLaren Applied Technologies’ platform is not restricted to wearable data. “We collect a huge amount of structured data, such as



McLaren Applied Technologies Health Unit Business Director Duncan Bradley and McLaren F1 driver Carlos Sainz at the McLaren Technology Centre in Woking, Surrey, England

activity level, heart rate, joint movement, and glucose information from wearables,” he says. “But we look at a lot of other datasets, such as clinical reports from hospitals and patients’ responses, to characterize someone’s management of their lifestyle.”

SOLVING THE BIGGER PUZZLE

According to Bradley, McLaren Applied Technologies is focused on the application of its analytics platform in specific therapeutic areas and wellness applications—orthopedics, diabetes, and weight loss, to name a few. The core idea, he explains, is to “mechanize and scale our approach to data analytics,” which means monitoring doesn’t stop at the individual level.

As clinicians collect troves of health information, there is an opportunity for such technology to support wider health management initiatives. “These are big societal issues, and data comes from various places,” Bradley states. “We are developing technologies to drive scalability and apply insights from this huge amount of data to big patient groups and populations.”

For starters, McLaren Applied Technologies is working with Born in Bradford (BiB), a long-term NHS project tracking health and well-being of over 13,500 children born in the Bradford area of West Yorkshire UK, from birth into adult life.

The study generates a vast amount of data

across a number of therapeutic areas, and McLaren Applied Technologies’ expertise in healthcare and data analytics will be deployed to help predict health risks and provide early insights.

The first phase of the collaboration will concentrate on childhood asthma and the risk factors, such as environment and pollution, that affect the symptoms and diagnosis of the disease. It will look at the point at which patients are picked up by the healthcare system and how they interact with local services.

What McLaren Applied Technologies is attempting to do is to look at clinical pathways across specific patient cohorts and assess how to use

this information to predict outcomes and impact interventions.

Whether it is an individual or a population group, Bradley says, it’s not hard to monitor people and gather a lot of data about their health. But what matters most, he says, is how you deliver consistent and meaningful insights to patients and health systems. “The future of healthcare is to use innovative technologies to save lives and drive better outcomes.” ■



Watch how McLaren analyzes real-time data from Formula One car sensors to maximize race performance. DellTechnologies.com/McLaren

AI

on the Frontline of Cyber Threats

In the annals of cyber warfare, the ability to use machine learning to detect and thwart threat actors will go down as a watershed event.

BY RUSS BANHAM

With a huge magnitude of data flowing across the network and an equal magnitude of threats to scour for, security experts shoulder the burden of hunting for anomalies that could indicate the presence of an outsider.

But not everything that looks suspicious actually is suspicious. Compounding security experts' already daunting challenge of monitoring thousands of malware variants and malicious URLs is that traditional intrusion detection systems often aim the searchlights at too many potential suspects. (For example, the employee who is on the network to print birthday invitations late at night.)

"Just because a behavior is anomalous doesn't mean it's malicious, but at least a security analyst can gain more evidence to this effect," explains Jon Ramsey, chief technology officer at Secureworks, an information security services provider that protects customer networks, computers, and information assets. In other words, machine learning narrows the field to the most likely threats. "Now a more in-depth investigation can begin."

ILLUSTRATIONS BY KEITH NEGLEY



“

We humans are imperfect and mathematically inconsistent; sometimes we're right, sometimes we're wrong. Machine learning can be a great training tool to increase the odds of being right.”

—Jon Ramsey, chief technology officer at Secureworks

While this form of AI to analyze true data correlations that fall outside of normal parameters is still in its nascent stages, its high success rate is stirring hopes that a critical new weapon is at hand.

ANOTHER ARROW IN THE QUIVER

For security experts, machine learning is not a replacement for current threat assessment practices. Rather, it's a valuable adjunct that confronts the very real problem of too many false alarms.

“Most intrusion detection systems are rules-based—if a specific condition occurs, you respond according to what the rules state,” explains Samir Hans, a partner in Deloitte's risk and financial advisory practice who focuses on vigilant cyber threat management solutions. “But that's a challenge all data security specialists have to contend with, since not every alert is an actual threat. There's so much noise, making it difficult to confirm what is and isn't a threat.”

Given this high decibel level, most companies cannot hire enough information security analysts to listen in on every possible intrusion. “The threats just keep adding up,” says Hans. “It begins to feel like a losing battle, even with accuracy improvements in rules-based systems.” For years, he explains, really smart researchers have been asking what else they can do to detect real fraud.

That's where machine learning has come into the picture. For Hans and his team at Deloitte, machine learning algorithms achieve two very clear goals—first, they sample unique data behaviors so security staff can improve their discernment of a threat, and second, they help experts learn from the experience. “We're not throwing away the rules,” he says, “we're just layering more advanced

techniques like machine learning to enhance the speed and precision of our threat detection capabilities.”

This is important given the serious shortage of skilled cyber security employees, as Ramsey describes it. “Consequently, we want our security resources focused on the threats that machines can't determine are malicious or have low confidence that they are malicious.” He says organizations can think of this as “tri-state logic: ‘no, it's legitimate; yes, it's malicious; or I don't know.’ In the cases the machines don't know, you get a human involved.” For example, if three people look at a threat suggested by the algorithmic calculations and agree it looks like the real thing, that's considered an efficient use of resources. Otherwise, he says, “everyone is looking at every possible threat.”

Despite the need for machine assistance to supplement the shortage, Ramsey emphasizes that machine learning is not a replacement for people—it's just another tool for security specialists to sharpen their analyses. “We humans are imperfect and mathematically inconsistent; sometimes we're right, sometimes we're wrong,” Ramsey says. “Machine learning can be a great training tool to increase the odds of being right.”

GROUND TRUTHS

To underscore the value of machine learning technology to identify large-scale cyber threats, Ramsey highlights a scenario of three separate attacks against companies in three different industries—oil and gas, copper and gold mining, and agricultural. “Since the three companies have little to do with each other, the attack against one company would appear to have no relationship to the attacks against the other two,” he explains.

By using an algorithm to simultaneously study all three attacks, however, the technology can detect data correlations that otherwise would not be apparent to an unassisted human being. “The algorithm may suggest that the attacker in all three scenarios was interested in profiting from natural resources, indicating that a single attacker was possibly at play—what we call a ‘ground truth,’” Ramsey says. “By drawing this connection, we’re able to infer that the same threat actor might go after a similar entity engaged in natural resources.”

Machine learning can be a way to ferret out similarities and anomalies in different types of malicious behaviors such as these. And while, in theory, security specialists could undergo a similar analysis, algorithms have the capacity to draw these inferences much sooner and with greater accuracy.

It’s these same benefits of anomaly detection—and speed—that have compelled a global financial technology institution to use AI to help protect its customers against fraud. The financial services giant is familiar with biometric authentication tools, such as fingerprint and facial recognition software, yet machine learning presents a new opportunity to protect and provide value to customers.

“We’ve started to use an algorithm to examine how customers interact with their mobile devices,” explains Nick Curcuro, data analytics and cyber security expert. “Their interactions with the device’s keyboard, for instance, create a unique signature of typical behaviors, giving us the ability to paint a more refined profile of that person for verification purposes.”

Machine learning algorithms analyze these customer behaviors, or what Curcuro calls “passive biometrics,” to detect unusual patterns. If the algorithm suggests an atypical

behavior that does not align with the customer’s profile, the information may indicate attempted fraud by a threat actor.

Curcuro points out that this potential fraud detection has to happen within a matter of nanoseconds so a “go or no-go” decision regarding the customer’s transaction can be made instantly. “This is all about the customer. This is all about the experience to make things seamless. Make things frictionless.”

ILLUMINATING THE THIEF

The security experts anticipate refined improvements in AI’s capabilities to fight cyber threats in the next three to five years. “I believe we will see tremendous progress in the sophistication of the algorithms,” Hans predicts. “We have plans to build ever more robust threat models, possibly on an industry sector basis.”

Meanwhile, Secureworks plans to apply machine learning to other cyber security aims. “The more we know about ground truths, the better we can apply that to other needs, such as whether or not a threat actor has stolen data,” he explains. “Right now, there’s typically no factual evidence to be sure that data has actually been stolen. AI can at least help narrow these odds.”

And, Ramsey adds, if information security providers can reach a consensus to work together on giving machine learning greater visibility, their collective clout will mount an impressive offense against the enemy.

“We and other security firms using machine learning models have improved the accuracy of our threat detection,” he says. “Assuming we can collectively share our data insights, a significant shift in cyber risk management will be at hand. This is a potential game-changer that will go down as a pivotal moment in cyber security.” ■



A full-page background image showing a firefighter in silhouette, wearing a helmet and carrying a large fire hose, standing in a field at night. A massive fire is burning in the background, illuminating the scene with a bright orange and yellow glow. The firefighter is positioned in the lower-left foreground, facing away from the camera towards the fire. The fire is intense, with many sparks or embers visible in the air, creating a dense, glowing pattern. The overall atmosphere is dramatic and urgent.

Fighting Fire's Fury with Data

Accurate satellite images and predictive power help firefighters get ahead of the fire and its long-term devastation.

BY MARTY GRAHAM



CALFIRE Captain Scott McLean, who fought fires for more than 25 years before he became a spokesman, was heading home from his assigned station when his wife called and told him he should go back to work. “She said, ‘Turn around and look,’ and I saw an enormous cloud of smoke from Paradise,” he says.

What he saw at the Camp Fire was of an intensity like nothing he’d ever seen before. “The Camp Fire was not normal, it wasn’t just a fire front,” he says. “Embers scattered much farther than usual. The strong wind was pushing it right to dry fuel.”

McLean encountered his first evacuee on his way in to the burning town. A woman in a wheelchair with a puppy on her lap came rolling through the thick smoke in front of him. He took her to safety. “The first day, all we did was evacuate,” he says. Though it’s hard to grasp that there was little point in trying to stop or contain the fire, there are times that happens. “Our world is rugged and unforgiving.”

After touring the devastation, California governor Gavin Newsom came away understanding the new realities of fighting wildfires: that they spread faster, burn hotter, and are more difficult to fight than ever before. That’s why, on January 8, 2019,

his first official day in office, Newsom committed \$105 million to reduce the danger of wildfires that have devastated California communities in the past two years. The money—in addition to buying helicopters—will advance a new way to fight wildfires: with data.

California has long had wildfires that swept through its national forests and neighborhoods built at the edge of cities and in the back country. And as more frequent bouts of dangerously dry weather, combined with drought that dries out new brush quickly, wildfires have become savage. The need for a faster and more focused response, better warning systems, and the ability to get ahead of fires has never been more pronounced.

More experts from around the world are turning to data to predict, prepare for, and manage the disasters that follow fire, including dense smoke, landslides, and the spread of toxins from ash and

other materials transformed by fire. In this pivotal moment in wildfire history, California’s investment is speeding up research and leading the charge to fight fire through transformative technology.

‘FEELS LIKE MAGIC’

The Los Angeles Fire Department (LAFD) began using WIFIRE, an integrated system for wildfire analysis, in 2014. Use of this smart technology will now expand with access to some of Newsom’s funds.

The WIFIRE platform, which handles the enormous task of making sense of massive data from many sources in real time, is a game changer for the people behind the scenes. Assistant Chief Carlos Calvillo at LAFD calls it one of the most useful tools he’s seen in his career. Getting information in real time, he notes, feels like magic.

“It gives us information that’s more detailed and precise in that initial phase of the fire, when things are fluid and moving very quickly and there isn’t a management team set up,” Calvillo says. “This is a very useful tool—fast and easy to use—that can assure or reassure an incident commander that they’re making the right decisions when placing resources or asking communities to evacuate their homes.”

Also a public platform, WIFIRE has millions of hits from viewers watching while cities from Santa Rosa to Malibu burn. More versatile still, the firefighters’ version lets users run scenarios and, most importantly, predict what will happen in the next minutes. Los Angeles County, Ventura County, and Orange County fire departments have committed to signing on this year.

Recent developments build on a legacy of innovation. Ilkay Altintas, chief data scientist at San Diego Supercomputer Center, and her team first launched the WIFIRE project in 2013 with seed money from the National Science Foundation. Focused on volume and efficiency, the team built a comprehensive data management structure that

could handle workflows of enormous amounts of data—topography, weather conditions, historic fire behavior, for starters—and provided critical information that was less than 15 minutes old.

Yet in the last year, WIFIRE has become far more precise because the platform’s power has been ramped up to include fresh, current data that’s being crunched quickly with machine learning. It has also been beefed up with data and processes that help predict what firefighters call the “PIG” (the probability of ignition) created by wind-scattered, fire-spreading embers. In addition, the platform now includes census data to identify where people are. Finally, fire study is also increasingly turning to social media to gather information, as well as share it.

“The predictions are coming out faster and bigger,” Calvillo says. “The accuracy and timeliness of the program are great, and we’re getting information that helps us do more and do it sooner.”

THE VIEW FROM (WAY) UP HIGH

While L.A. was an early adopter of this technology, Calvillo says his department wasn’t always so sure of its value—the team’s data mapping expert, who now embraces the platform, was at first a skeptic.

In addition to initial hesitation among some leadership arms, one of WIFIRE’s biggest challenges, according to Altintas, was getting accurate and timely information about brush. Until recently, the best data they could find was no less than a year old, and a lot can change in a year.

Fortunately, emerging technologies that transform satellites are delivering data far more frequently and with more detail, according to Kim Slater, space innovations lead with Draper, a not-for-profit research and development organization that focuses on advancing new technologies and ideas to solve global challenges.

Today, Draper is developing technologies for small satellites—as small as 4-inch cubes that capture and transmit imagery from orbit more than

PHOTO (BOTTOM) BY ILKAY ALTINTAS, SDSC



Aerial view of a burned mobile home park in Paradise, California.



Los Angeles Fire Department personnel use the WIFIRE platform to analyze wildfire data in real time.



Toxins from burned metals and household items such as those shown in the images above can make their way into streams and the local farming water supply.

200 miles from Earth. Hundreds of those satellites are already in space, and Draper can build more.

“What used to cost hundreds of millions of dollars to fly a satellite the size of a school bus now costs tens of thousands of dollars, and they’re the size of a toaster or lunchbox,” Slater says. “We’re now approaching being able to capture images of every place on Earth every day. In a year or two, we’ll get images from almost every place on Earth at least every 10 minutes and in some places, every minute.”

What to do with this monstrous amount of raw data—whether to transmit or sort it—then becomes an important question. Draper is working on technologies for optical systems to get the data back to Earth better and faster, but the company is also focused on microprocessors that can sort it in space, relying on machine learning to discern



meaning. “We do things like teach a computer to look at imagery and start seeing the patterns,” Slater says. “It’s detecting change, that’s the most important part of this,” which brings her back to the fires. The images Draper satellites capture can also be used to help fend off post-fire disasters.

CAPTURING TOXINS AFTER THE FIRE

When the fire is finally put out, its fallout is just beginning. Not only is the denuded, ash-covered landscape incredibly vulnerable to landslides, the burned material can be full of toxic chemicals and metals that can get into water sources with devastating consequences, explains Jack Webster, an engineer and assistant professor at California State University Chico, who studies and measures water quality.



Environmental engineer Jack Webster collects water samples from a stream in Paradise, California.

Fires like the Paradise fire are particularly troublesome because the fire was barely out before the rainy season arrived and began sweeping a harrowing array of metals like lead, mercury, and nickel into creeks, streams, and the local farming water supply.

“There are so many possible contaminants in these structures, in these cars, and in these buildings; the consumer electronics that burned, the solvents and hydrocarbons that were in people’s garages, in auto shops,” he says. “There’s rubber, there’s adhesives. There’s vinyl siding and patio furniture. There’s plastics.”

For example, the fire was so hot, it melted aluminum and left it scattered in pools. Aluminum is incredibly toxic to fish, and fish die-off affects the entire ecosystem. Cadmium from batteries is another extremely toxic metal for humans. These

chemicals, if swept up and dumped onto farm land, will render the land barren. It’s a long list of things you don’t want mixed into growing human food, Webster says.

That’s where the space data comes back into the picture. Imagery from the tiny satellites has the potential to help keep these chemicals and metals out of the water supply because people looking at detailed, high-resolution images will often, over time, be able to identify how the harmful materials are moving after a single day or multiple days of rain.

And if environmental engineers and scientists can see the change—a lot of Earth science moves slowly—then they can get out to the right place to test and to block and catch the water, or at least filter it before it goes into the streams, rivers, and lakes. It’s the difference between sampling scien-

tists with up-to-date information who know where to look for toxins and the scientist who comes to test a spot in a lake once a week, who may not notice that the water is higher, or that there's an algae bloom or die-off somewhere else in the lake. With the satellite technology, images taken hours and days apart can show those changes: a flat spot one day that is part of a moving hillside over the next few days, for example.

"We're working with researchers to develop ways to track this," Slater says. "The magic in the new imagery and in the artificial intelligence applications is that you can look at those changes over time."

FIRE-SPOTTING

Enormous improvements in underlying data are also helping with novel research on some of the least predictable challenges firefighters face, such as how the fire can generate its own weather—winds, heat, and embers that create sudden, unpredictable, and dangerous conditions.

Tarek Zohdi, a professor of mechanical and micro-mechanical engineering at University of California, Berkeley, launched the Fire Project in November just days after Newsom committed funding. By then, Zohdi was deep into looking for patterns in the piece of WIFIRE he developed. Today, he studies how nightmarish fire-spreading embers and the terrible smoke from fires behave, so firefighters can send people out to the right places and arrive with the right tools.

"Data is going to tell us where smoke will end up, although the data is relatively coarse now," he says. "Embers, on the other hand, flow stochastically. The models aren't very complicated, but they are a very different physical effect than fire."

When Zohdi talks about fire-spotting, he means the seemingly random spread of embers and their behavior. Some cool off and become harmless while they're flung around; others remain dangerous, in the form of random patterns. Both smoke

and embers behave erratically in the face of a number of different forces, Zohdi explains. So, he studies the forces as well as the flaming bits.

"When something is burning, there's a giant updraft of hot air. When the updraft encounters cooler air moving laterally, the air masses tangle and twirl, creating a turbulent fire," he says. Yet, with enough data, experts will be able to predict how embers will travel and how dangerous they'll be when they land.

Still, that kind of turbulence can turn into what McLean calls a fire tornado—like the ones that hit Redding, California, during the Summer 2018 Carr Fire. The fire seemed to be 40-percent contained until the winds shifted and an unpleasant wildfire turned into a 100-foot wall of fire, spewing embers and starting more fire in every direction.

According to McLean, the fire tornado generated winds up to 143 mph, tearing off roofs that then ripped trees—still on fire—out of the ground. In addition to being a dramatic scene, the fire tornado—seen in both the Carr and Paradise fires—spread the disaster much faster and farther than people had seen in their lifetimes. "That's unusual fire behavior, but not unheard of until this year, when we saw it twice," he says.

Experts such as Slater and Zohdi believe in the power of data to mitigate some of this fury. However, Zohdi cautions, "There's no one silver bullet here."

And while the combination of strategies might not add up to one all-powerful bullet, Zohdi is nonetheless certain of one thing: What looks unpredictable, he explains, can be better understood with data crunching, more precise imaging, and communication. ■



Watch how Draper satellite technology can help scientists pinpoint fire-devastated areas to test for toxins.
DellTechnologies.com/Draper



Charred trees line a reservoir on the outskirts of Paradise.



Reexamining the Data Money Tree

Seeing dollar signs in data?
Here's how companies may need
to redefine data monetization.

BY RUSS BANHAM

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While success stories around transforming data into dollars get a lot of media attention, the truth is that not every business can make money by selling its data. For one thing, though precious internally, their data may have little value to others. For another, rushing forward with an initiative that lacks a clear strategy, much less the requisite people, processes, and capital to manage the new business is foolhardy at best.

“Data monetization is an exciting idea, but profitable results are hard to come by,” explains Chris Brahm, leader of management consultancy in Bain & Company’s advanced analytics group.

Regrettably, many companies are convinced that monetizing their data in a separate data-as-a-service business is a guaranteed pathway to riches. They get so caught up in the anticipated financial killing, they neglect the vastly more important value of leveraging their internal data to improve operations, productivity, and customer experience.

“It’s like they get these dollar signs in their eyes, thinking they’ll make a bunch of free money from this unmonetized asset,” Brahm says. “When things don’t pan out as they expected, they’re genuinely surprised.”

SEARCHING FOR GOLD

When done right, data monetization can be an untapped source of third-party revenue, seeing that it provides value to customers or partners. Yet Matt Maccaux, global data analytics practice lead at Dell Technologies Consulting Services, encourages organizations to expand their definition of monetization.

“The definition of data monetization as using data to improve the top line or bottom line can be too narrow,” Maccaux says. “A better definition would be extracting value from data to drive better outcomes.”

That more encompassing definition, he says, allows organizations to include use cases in which the stated goal is not an immediate monetary benefit, but could eventually lead to one, such as improving customer experience. Brahm and other advanced analytics practitioners like Henna Karna, chief data officer at

the large global insurance company AXA XL, agree. They advise companies to focus on the internal value of their data before thinking in terms of how to sell it.

“Our data team’s focus is to capture and analyze internal and external data for reuse and scalability across the insurance value chain,” explains Karna. “By doing that, we can derive optimal insights in risk mitigation, portfolio balancing, claims analysis, product development, and distribution.”

In effect, these insights are “monetizable,” as they reduce costs and result in better products and services that can contribute to more revenue. Yet much of the hoopla surrounding data monetization involves developing a separate business unit to sell this new set of information.

There have been notable successes across industries. Payroll provider ADP provides predictive HR workforce analytics through its ADP DataCloud product. The cloud software packages data from more than 30 million employees across 95,000 ADP clients to give companies a better understanding of how their human capital management metrics measure up.

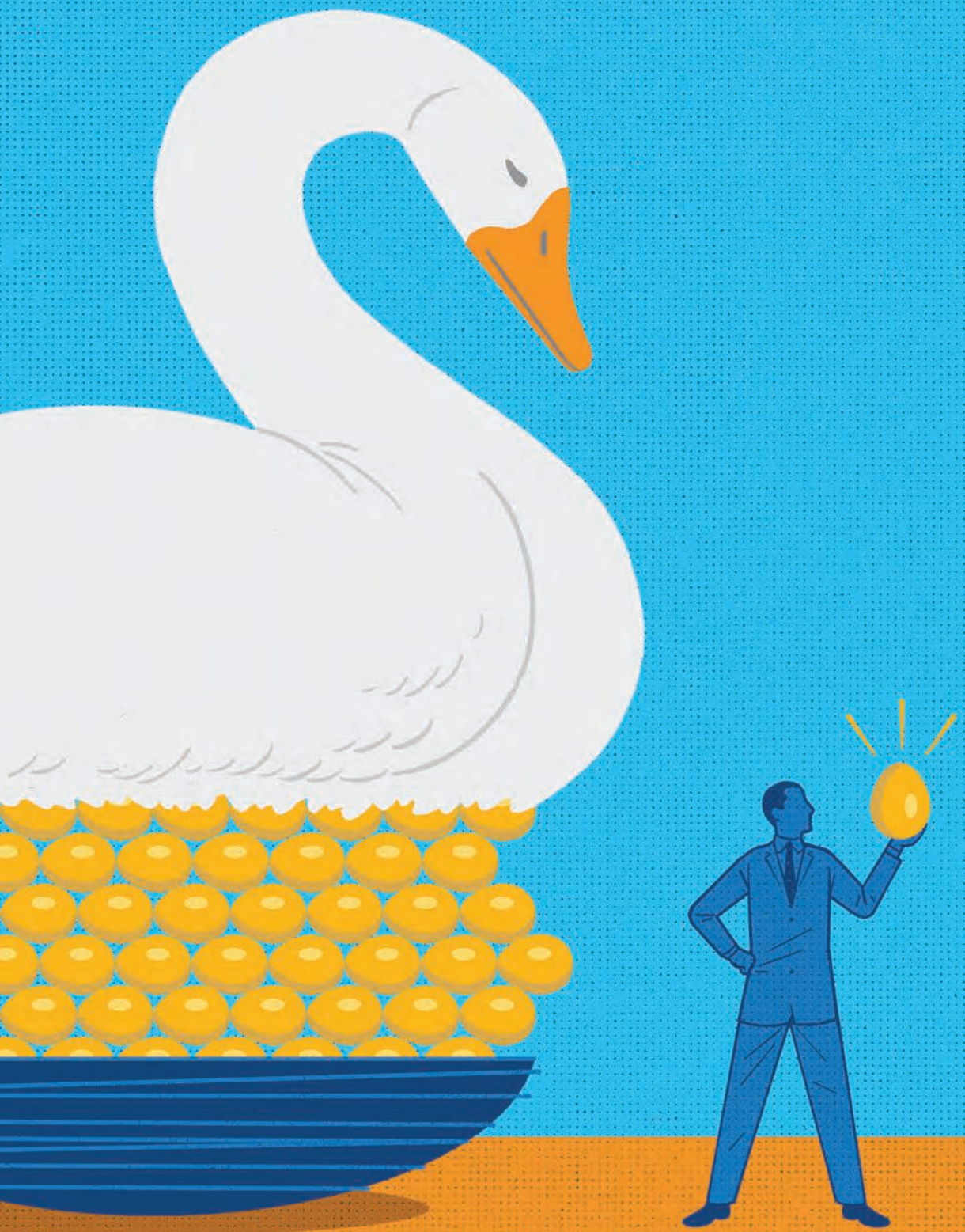
Retailer Tesco has, since 1996, collected insights on customer behavior by analyzing shopper Clubcards. Its subsidiary, dunnhumby, collects and assesses this data from more than 16 million active Clubcard members, along with other retailers, to produce predictive analytics and personalize the shopping experience through various digital marketing campaigns.

The possibilities to make money are limited only by the imagination, the business media trumpets, and the message is compelling. Such

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The definition of data monetization as using data to improve the top line or bottom line can be too narrow. A better definition would be extracting value from data to drive better outcomes.”

—Matt Maccaux, Dell Technologies Consulting Services



sentiment convinces many company leaders that if they fail to monetize their data, they are squandering the opportunity to generate a viable revenue stream. The reality of this endeavor, for most, eventually sets in.

“Compared to a few years ago, there is a greater sense of realism,” Brahm says. “Selling data to third parties is work—it’s no different than any other big business decision.” What’s more, he chimes, “it’s not the golden goose it’s made out to be.”

THREE’S A PARTY

Before companies jump headfirst into third-party data monetization, they need to have a considered strategy in place, Karna says. In some cases, it may make more sense to pool data with another company’s than to go at it alone.

Stock analysts, for example, might be interested in buying aggregate data on credit- or debit-card transactions, which may suggest a slowdown or uptick in consumer spending. They also may be interested in buying data on the volume of commercial trucks that pass through a privately owned tollbooth over a period of time, which may suggest a region’s economic vitality or sluggishness. While these separate data elements have value to the same buyer, their aggregate analysis—through an algorithm—may provide sharper insights.

Consequently, it may be prudent for a credit card company and a private tollbooth owner to create a joint venture for this purpose. “By locking in all their data, companies may relinquish the opportunity to drive even greater value by partnering with another business in a data ecosystem,” Brahm says.

A smart data monetization strategy also must take into account the likely buyers for

the data, not to mention how to provide this information to these companies and what to charge for the data-as-a-service.

“The first step is to determine which data can add value to another organization’s business process,” Brahm states. “Once you have figured this out, you need to contemplate how to capture this data and apply the right mathematical calculations to it to be of value. Then, you have to create an actual business unit to sell the data.”

FOX IN THE FOREST

Many organizations jump feet first without considering true, realized value for their partners. “We once worked with a company in the accounting technology space that had access to customer information that would, in theory, be valuable to a bank’s loan decisions,” Brahm recalls.

Yet when Brahm and his team reached out to a bank that was interested, its leaders came back and asked what percentage of the tech firm’s customers they could get data on. The answer? Five percent. While the bank felt his data would be interesting, it was too small of a percentage to base important loan decisions on. “While the data was valuable to a bank in theory, in practice its use was limited,” he explains.

Another challenge companies face is the possibility that the government or another third party could surface data that is more valuable and, in extreme cases, more affordable or free.

To avoid challenges like these, Maccaux recommends organizations focus on their internal processes to ensure they are targeting high-impact use cases. “As organizations gain maturity in data science and analytics, there will be no shortage of ideas,” he says. “It’s

imperative that organizations follow a process upfront to identify and prioritize business use cases that will have the most benefit with the lowest barrier to implement.”

Maccaux also stresses the importance of building a cross-functional team. “Data monetization relies on the people performing the analytics and building the systems that operationalize them,” he says. These teams need to consist of data scientists, data analysts, operational roles, and last, but not least, data stewards to keep watch over the ethical considerations of the data at hand.

Brahm urges companies to take seriously the growing number of laws surrounding consumer data privacy. “In the consumer data space, the European Commission’s General Data Protection Regulation [GDPR] rule severely reduces the ability to make money out of the concept,” says Brahm. “And it augments the possibility of losing a lot of money.”

He’s referring, of course, to the GDPR’s sharp teeth—and hefty fines. As regulations that govern businesses that deal with personal data increasingly move to become a global standard, companies “must tread very carefully,” Brahm warns.

And while building a cross-functional team that analyzes and operationalizes data is critical, Brahm takes it a step further. If companies are serious about launching a separate monetization arm, he recommends they also establish a separate organization with individuals entrusted to handle sales and marketing, payables and receivables, and other traditional business processes. “This is not something you want your employees doing in their spare time,” Brahm says.

Lastly, another impediment to data monetization is legacy data storage systems that

hinder sharing, integration, and analysis. Maccaux recommends companies put together a roadmap with well-defined milestones to ensure modern technology is in place. The ultimate goal, he says, is to consolidate data as much as possible and make it available through self-service.

“That’s the technology roadmap,” Maccaux says. “If you can get to a point where your users can self-serve with data, then that’s the best outcome.”

ONLY THE BEGINNING

In the meantime, companies can still yield significant monetary value from their data, leveraging it for internal purposes to power a competitive advantage. This is the strategic objective in place at AXA XL, which has no plans at present to sell its data to third parties. “We’re effectively ‘monetizing’ our data by reducing the marginal costs on our data, and enhancing our profits by creating more customized risk management solutions for our customers and partners,” Karna said.

In other words, the insurer’s data is a seedbed of insights into ways to reduce cost, improve products, and provide greater value to customers. Brahm advises companies to consider this intelligent use of data first, before considering its external sale. “For businesses that really give this the time it deserves, data-as-a-service can be profitable,” he says.

With a clear strategic roadmap for how to turn data into internal and external value, the really hard work of launching a business can begin. ■



Read more stories of how to build a successful data strategy.
DellTechnologies.com/Perspectives

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Compared to a few years ago, there is a greater sense of realism. Selling data to third parties is work—it’s no different than any other big business decision... it’s not the golden goose it’s made out to be.”

—Chris Brahm, Bain & Company

Diversity is

How Tech Can Help Foster Greater Inclusivity in the Workplace

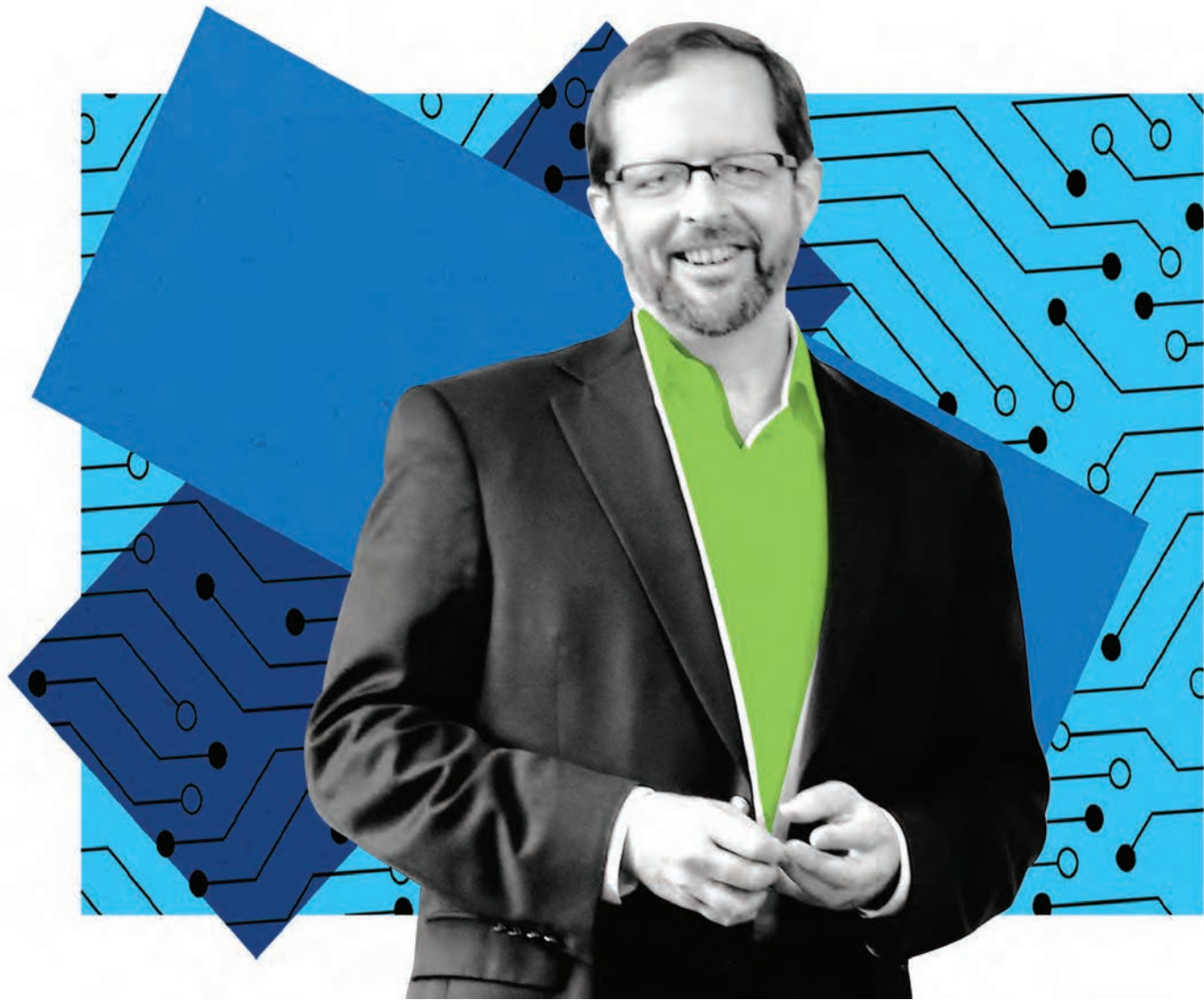
Half the Story

BY STEPHANIE WALDEN

Statistics about diversity—a 50-50 male/female split, X percentage employees of color, LGBTQ-friendly policies—often serve as points of pride on boardroom presentations about company culture. There's a reason these stats have become crucial benchmarks for so many companies: Studies suggest that diversity is important not only for employee morale, but also for profitability.

PHOTO ILLUSTRATIONS BY KELLY CAMINERO; SOURCE IMAGES VIA SHUTTERSTOCK





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If you don't get inclusivity right, you're going to be a training academy for your competitors who are getting it right. In other words, if employees don't feel heard, valued, included, and seen, they either check out or they leave.” —Tom Morgan, head of Morgan Intercultural

PHOTO BY JULIET JARMOSCO, COURTESY OF MORGAN INTERCULTURAL

A strictly numbers-boosting approach to diversity, however, ignores a fundamental fact about modern workplace dynamics: Just because an organization hires a range of ethnicities, cultures, sexual orientations, abilities, genders, and generations doesn't mean that members of those groups feel valued—or that they'll stick around.

Failing to factor inclusivity into the equation, says Tom Morgan, head of Morgan Intercultural, a consulting firm that conducts inclusivity training for Fortune 1000 companies across 70 countries, is a business risk with direct ties to the bottom line. “If you don't get inclusivity right, you're going to be a training academy for your competitors who are getting it right,” he says. “In other words, if employees don't feel heard, valued, included, and seen, they either check out or they leave.”

Today, organizations have the opportunity to use technology in creating a workplace that encourages constructive discourse and empowers underrepresented employees. Here are three buckets of technology that HR and IT teams can tap to turn inclusivity goals into realities.

TECH THAT FOSTERS EMPATHY

Morgan says that much of the corporate world has adopted a habit of “minimization”—a mentality that tiptoes around cultural differences and takes the approach of treating everybody alike. “That might be equal, but it's not equitable, because people need different things,” he asserts. “To get inclusivity right, you have to actually call out those differences.” And doing this effectively requires a blend of data collection, analysis, face-to-face training, and technology platforms.

On the data side of the equation, Morgan's company uses a series of online, interactive assessment tools like the Intercultural Development Inventory (IDI), which helps companies measure and record their “cultural profiles.” The data collected by these tools includes dimensions of culture like communication styles (direct versus indirect, instrumental versus expressive) and leadership or team structure preferences (hierarchical versus flat, task-oriented versus relationship-oriented). This intel informs future programming.

“When you're talking about diversity and inclusivity—or D&I—in companies, we can measure it,” says Morgan. “What this topic really boils down to is a mindset and developmental stages. When employees take this test, one score tells us where they think they are, and the other tells us where they actually are.” Nearly everyone, Morgan adds, thinks they'll score higher than they actually do when it comes to measuring inclusive thinking, behaviors, and policies.

Virtual reality is also beginning to play a role in inclusivity training. In the workplace, the implications for VR empathy training have countless use cases, from managers experiencing one-on-one sessions from their employees' points of view and role-playing solutions for individuals experiencing workplace conflict to social learning initiatives that include immersive, perspective-shifting exercises.

Such VR programming can help employees take virtual walks in their colleagues' shoes. Vantage Point, for instance, a VR software startup, recently released a program that allows trainees to follow "Rachel," a fictional employee at a Silicon Valley startup, as she experiences sexual harassment at work.

The training consists of four modules: one encourages users to identify instances of sexual harassment; the next features bystander intervention; a third focuses on individual-response training; and the final discusses stigma and bias. Throughout the experience, trainees gain insightful perspective as to how certain actions and phrases may be perceived by others—and employers are fed real-time metrics about associates' completion and engagement rates.

TECH THAT IMPROVES COMMUNICATION

Communication—both verbal and nonverbal—is one of the underlying tenets of an inclusive workplace. Assessment tools like the ones employed by Morgan Intercultural can help teams become aware of nonverbal communication cues like micro-inequities (small, subtle behaviors that indicate unequal power dynamics) and culture-specific gestures. Understanding these elements can help companies create an environment where employees feel understood by their peers and superiors.

Although machine learning or facial recognition technology that automatically identifies—and suggests corrections for—problematic communication behavior isn't yet fully realized, there are promising advancements in the field, particularly when it comes to the written word. For instance, augmented writing platform Textio identifies potentially disparaging language in corporate communications. It can help businesses craft inclusive text for everything from recruiting efforts to company-wide mission statements.

There are also a variety of digital apps that facilitate open and honest conversation in the workplace. Bravely is one such platform that serves as a third-party mediator. An intelligent algorithm connects underrepresented employees with professionals who provide guidance on how to have challenging conversations with colleagues. In one recent case, a woman of color who was ready to leave her job after being passed over for a promotion used Bravely to gain skills to appeal to her employer—and, ultimately, secured the salary increase she'd been seeking for months.

"We're cultivating a proactive, constructive, healthy dialogue that is the heart of conversations making underrepresented voices heard and building trusting relationships among teams," explains Toby Hervey, co-founder and CEO of Bravely and board president of the non-profit organization Out in Tech.

TECH THAT ENCOURAGES INCLUSIVE COLLABORATION

Employee resource groups (ERGs) and affinity groups—voluntary, employee-led communities, both online and in-person—are emerging as valuable resources in promoting inclusivity. Although ERGs themselves aren't a new concept, they're becoming increasingly digitized, with members around the globe uniting via platforms like Slack.



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—Toby Hervey, co-founder & CEO of Bravely & board president of the non-profit Out in Tech



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Any technology tool has to come with training and proper change management. The process needs to be more than just an add-on. Teams and managers should be prepared to gather feedback and willing to iterate and improve as they go.” —Mikaela Kiner, founder and CEO of Reverb

PHOTO BY MICHAEL B. MAINE, COURTESY OF REVERB

When it comes to encouraging ERGs, Mikaela Kiner, founder and CEO of Reverb, a human resources consulting group for fast-growing companies, says that organizations should do “everything in their power” to be supportive.

“Companies need to say more than, ‘We welcome employee resource groups,’” states Kiner. “They need to make sure that people have time to participate in them. Some companies may also consider providing these groups with a meeting space, whether digital or in the office.”

Third-party online communities also help give voice to underrepresented groups. Rita Kakati Shah, founder and CEO of Uma, a company that assists women reentering the workforce after pausing their careers to raise kids, says that while internal chat platforms and ERGs can enable productive communication among colleagues, niche digital communities can galvanize groups across geographical and organizational boundaries. Her company uses digital resources like social media to provide members and affiliate companies with a roadmap for successfully implementing inclusivity measures.

THE ULTIMATE ROLE OF TECH AND PEOPLE

While technology advancements give organizations tools to better promote diversity and inclusion, experts all agree on one thing when it comes to inclusivity in the workplace: Inclusion should start with—and filter down from—the people at the top.

“The structure at the top helps shape the entire vision for the company,” says Kakati Shah. “If you set the precedent at the top to have an equal number of men or women in leadership, or people from varying ethnic and socioeconomic backgrounds, it becomes easier to train management on how to maintain those standards and create an inclusive environment.”

Kiner adds that inclusivity training—and the tech platforms that companies use to support it—should be implemented in a holistic way that makes sense for all parties. “Any technology tool has to come with training and proper change management,” she clarifies. “The process needs to be more than just an add-on. Teams and managers should be prepared to gather feedback and willing to iterate and improve as they go.”

Hervey echoes the sentiment that diversity and inclusion should be a joint effort between people teams and tech platforms. He concedes that tools like Bravely are just “one part” of a comprehensive solution, noting that tech can help HR professionals automate the rote parts of their role in order to focus on what matters most: Proactively developing people.

“We don’t think you’ll ever be able to remove the ‘human’ from human resources,” he said. “Tech is going to give HR superpowers, allowing them to serve people in ways they haven’t been able to historically.” ■



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Morality Behind the Wheel

The uncomfortable questions behind programming
the moral compass of self-driving cars.

BY PRAGATI VERMA

Imagine you're in a self-driving car, on the way to a meeting, and a gaggle of teenagers mindlessly crosses the road in front of you. Should the car swerve to save the five pedestrians, even if it means sacrificing the passenger—in this case, you? What if an animal ran into the road, or the pedestrians in question were an elderly woman and her granddaughter?

In 2016, MIT Media Lab researchers developed a platform to ask people, worldwide, philosophical questions about who a driverless car should kill in the case of an unavoidable accident.

Called Moral Machine, the data-gathering tool has caught public attention, generating conversation around autonomous driving. The website went viral, gathering people's decisions on 14 million scenarios, according to Jean-François Bonnefon, research director at French Centre National de la Recherche Scientifique and co-creator of Moral Machine.

The platform—which is still active—draws accident scenarios and lets people pick their preferences, then compares viewpoints and allows people to debate the issues online. Bonnefon says it's the "largest global AI ethics study ever conducted."

And while we can expect detailed results by the end of 2019, preliminary, unpublished research based on the responses of people from nearly 200 countries shows a few clear preferences. For one, people around the world overwhelmingly favored protecting children over adults. The answers, however, were not always cut and dry. "Opinions get more divided as we dive into more complex scenarios," such as when people had to choose between minimizing the loss of life and saving the car's occupants, according to Bonnefon.

The team at MIT Media Lab also noticed regional trends when it came to developing a moral algorithm. Respondents from Western countries placed a relatively higher emphasis on minimizing the number of overall casualties compared to respondents from Eastern countries, who seemed to show a preference for saving passengers regardless of the total numbers of lives lost.

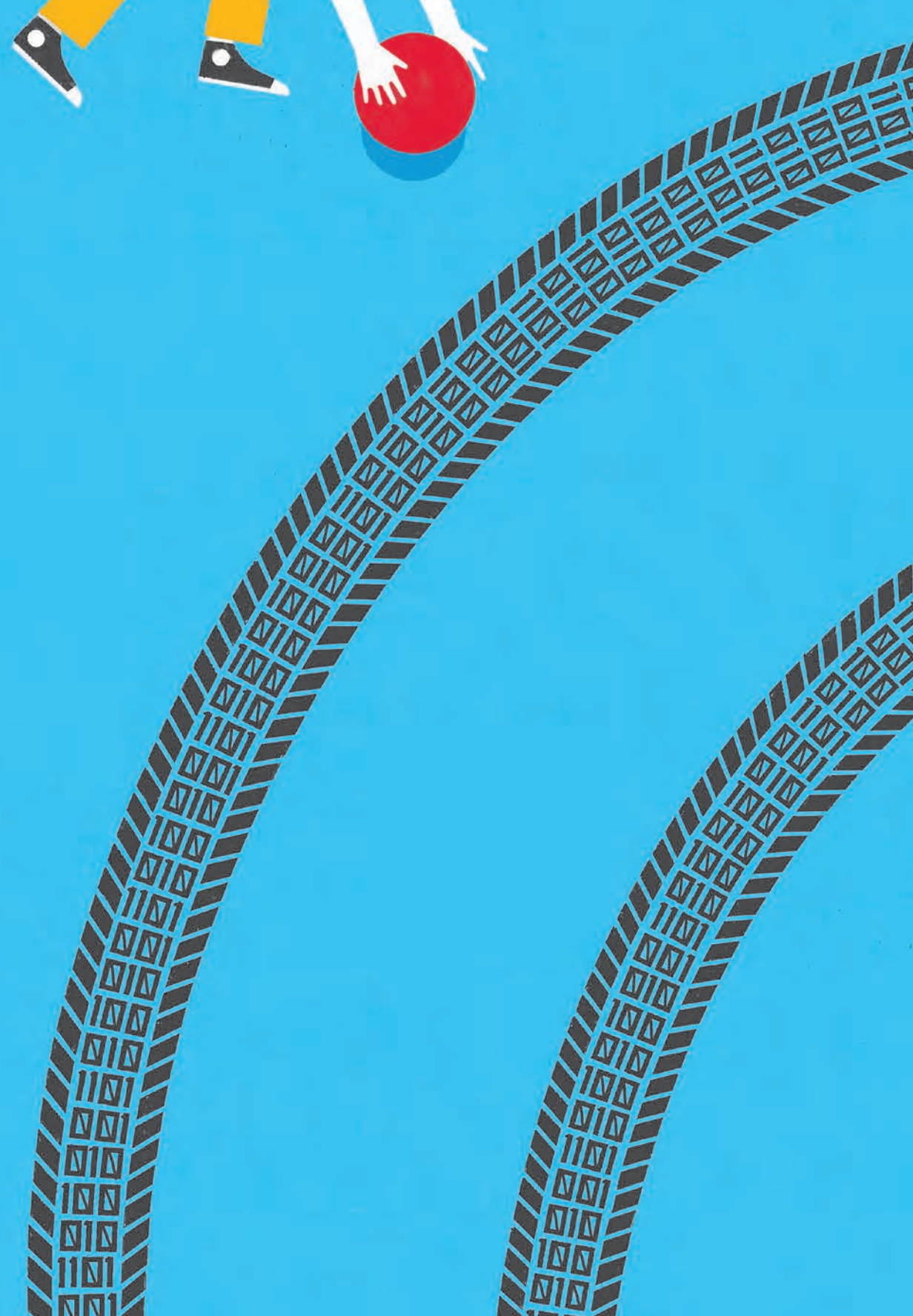
"Our algorithm was not aware of the geography of countries, but we [the researchers] saw broad differences between the preferences of people in the Eastern, Western, and Southern parts of the world," he explains. It's these discrepancies that make it tough to code ethics into a single global algorithm.

UNCOMFORTABLE REALITIES

Some researchers argue the variability and complexity of the moral decisions is why majority opinion alone shouldn't determine a unified ethical standard. A team of researchers from the University of Bologna, Italy, for instance, proposed outfitting self-driving cars with an "ethical knob" that lets riders control how selfishly the vehicle will behave during an accident. In the U.S., Nicholas Evans, philosophy professor at the University of Massachusetts, says the first question people should ask themselves is: How do we value and how should we value lives? Studying ways to make driverless vehicles capable of making ethical decisions, he says, forces us to confront uncomfortable realities about subjective versus objective ethics. In other words, what happens when you are the person in the car? "You could program a car to minimize the number of deaths or life-years lost in any situation, but then something counterintuitive happens. When there's a choice between a two-person car and you alone in your self-driving car, the result would be to run you off the road," Evans explains on the University of Massachusetts website. "People are much less likely to buy self-driving vehicles if they think theirs might kill them on purpose and be programmed to do so." Bonnefon concedes that people don't always do what they say they will in surveys. His previous research found that although most people approve of self-driving cars to sacrifice their occupants to save others, they don't want to ride in such cars themselves. And that is the reason, he says, why they asked people what a car should do rather than what they would do.

ROOM FOR DEBATE

Crowdsourcing platforms like Moral Machine are not perfect, but they are more relevant than ever. As self-driving cars hit the road and start getting into accidents, the ethical exercises begin to take



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We are not trying to find out what is ethical and what is not. We are providing a tool for people to appreciate the complexity of algorithmic decision-making for governments and regulatory agencies to understand what people in their country expect from machines.”

—Jean-François Bonnefon, co-creator of Moral Machine

on a dose of reality. Uber’s self-driving program, for instance, is under close scrutiny ever since an autonomous Uber struck and killed a 49-year old pedestrian.

Yet most of the debates following such accidents seem to turn into a blame-game. Whenever we hear of an accident by a machine, Bonnefon says, people tend to look for a human to blame, as we are better equipped to detect mistakes in humans. While this may be logical, he acknowledges this “hurts our trust in self-driving cars too.”

As it turns out, who is responsible—the driver, the car, or the pedestrian—is not the only question facing the future of autonomous cars. It’s not easy to determine the level of safety that self-driving cars should demonstrate before being allowed on the road.

Research by McKinsey suggests that autonomous vehicles could reduce the number of overall accidents, and therefore fatalities on our roads, by 90 percent. For Bonnefon, “it would be significant progress if self-driving cars could eliminate [even] 10 percent of the accidents.”

According to the most up-to-date figures from the National Safety Council, there were 40,000 automotive fatalities in the U.S. in 2017—the second consecutive year with record numbers of automotive deaths. While any technology that helps reduce that number sounds good in theory, this safety comes with a huge trade-off.

“We will have to wait for a very long time, if we want to reach that level,” Bonnefon points out. “It would mean getting used to accidents by self-driving cars every week.”

As people grapple with these life-and-death decisions, one thing is clear: Researchers are not likely to provide clear-cut moral or ethical guidelines—and that’s by design.

“We are not trying to find out what is ethical and what is not,” Bonnefon explains. “We are providing a tool for people to appreciate the complexity of algorithmic decision-making for governments and regulatory agencies to under-

stand what people in their country expect from machines.” As far as regulation goes, well, that’s a regulator’s job.

THE REGULATION GAME

Despite the intrigue around public opinion when it comes to self-driving cars, policy decisions will not be made based on public opinion alone. Take the ethical guidelines for self-driving cars issued by Germany. Despite overall public opinion to save children over adults, the German government mandated that algorithms should not discriminate based on age, gender, race, disability, or any other distinguishing factor.

“It’s a slippery slope once you begin discriminating between human lives,” Bonnefon expresses. “Many people think it’s okay to save children over adults, but where do you stop this? What about men versus women or rich versus poor? Even if regulators don’t go by what the majority wants, it is important to foster a debate—to weigh in on public opinion before making a decision and then explain the logic behind it when you go against those expectations.”

The current transportation and traffic system works because we are used to it and have come to trust it, according to Bonnefon. On the other hand, self-driving car algorithms are new—pushing the boundaries through technological innovation.

While not perfect, the dialogue Moral Machine is creating around self-driving ethics is a strong starting point for stakeholders to better understand the dilemmas at hand. In order for developers and their issuing governments to build trust in the new autonomous world, Bonnefon explains, people “need to understand what the public expects and what they are likely to find offensive in algorithmic morality.” ■



Just how close are we to self-driving cars taking over our roads? Subscribe to the AI: Hype vs. Reality podcast to find out. DellTechnologies.com/HvR

A Brief History of Artificial Intelligence

AI's roots predict the promise of its future.

BY JOHN GORMAN

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When we talk of self-driving cars, robot vacuums, and voice assistants, we're probably not thinking much about French philosophy. And yet, AI's current automated task-mastering was first posited by the French philosopher René Descartes almost 400 years ago. Descartes, who famously coined, "I think,

therefore I am," pondered about the ability of machines to reason. His theory? While machines may be able to "do some things as well, or better, than humans, they would inevitably fail in others," whereas human reason can universally adapt to any task. Though Descartes' idea of machines differs from today's reality, some say he threw down the gauntlet for what we now

refer to as general AI—or machines that can think like humans.

It would be another 300 years before Alan Turing also explored the question, "Can machines think?" His test, or "imitation game," challenged a human evaluator to pose questions to two contestants—a computer and a human—and distinguish between them based on their responses. If the evaluator could not choose the human subject 50 percent or more of the time, then the machine passed the test that bears Turing's name.

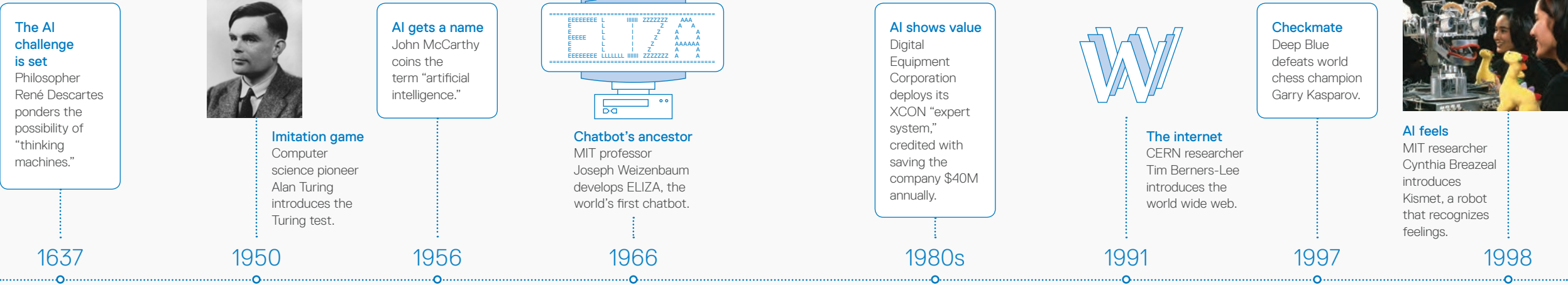
To bring this scenario up to date: If you're having a conversation with a chatbot and are unaware that you're not actually speaking to a human—congratulations, that chatbot has theoretically passed the Turing Test. In 2014, one such chatbot did exactly that: Chatbot Eugene Goostman convinced 33 percent of the judges at an AI competition at the Royal Society in London that it was a 13-year-old Ukrainian boy. While both this win and the

merits of Turing's test are hotly debated, Turing is nonetheless credited as paving the way for AI, though he does not get the credit for naming it.

"Artificial intelligence" didn't come along until the summer of 1956, when John McCarthy coined the term at a Dartmouth conference of top researchers in the field. Finally, the loose and not yet tangible vision of computers thinking like humans had a snappy name that attached itself to continued efforts in the space.

There were significant hopes—and significant government funding—coming out of McCarthy's conference. And the following years did bring some early successes, including ELIZA—the world's first chatbot and early implementation of natural language processing. MIT professor Joseph Weizenbaum designed ELIZA to imitate a therapist who could ask open-ended questions and respond with follow-ups via text.

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But despite the high expectations and proclamations (in 1970, Marvin Minsky told *Life* magazine that “we will have a machine with the general intelligence of an average human being” in 3-8 years), the lack of computational power to bring AI to life ultimately led to the first AI winter. Progress would ensue in the 1980s and stall again in the 90s. But in 1997, when supercomputer Deep Blue called checkmate against world champion Chess master Garry Kasparov, the moment marked a seismic shift in the way the public perceives the intelligence of machines.

Deep Blue’s sheer volume and computing force—processing some millions of positions per second—captivated an audience around

the globe that saw potential in its thinking power. This position would be furthered in 2011 as IBM’s Watson defeated champions of the game show *Jeopardy!*, winning a \$1 million grand prize. And in 2016, Google Deep Mind’s AlphaGo AI beat the top-ranked player of the board game Go in front of more than 200 million viewers worldwide. But we’ve already seen the potential of machine intelligence well beyond fun and games.

The AI trailblazers of this century have celebrated several milestones in the development and application of the still-emerging technology. In 1998, MIT researcher Cynthia Breazeal went beyond thinking machines to feeling machines when she brought forward

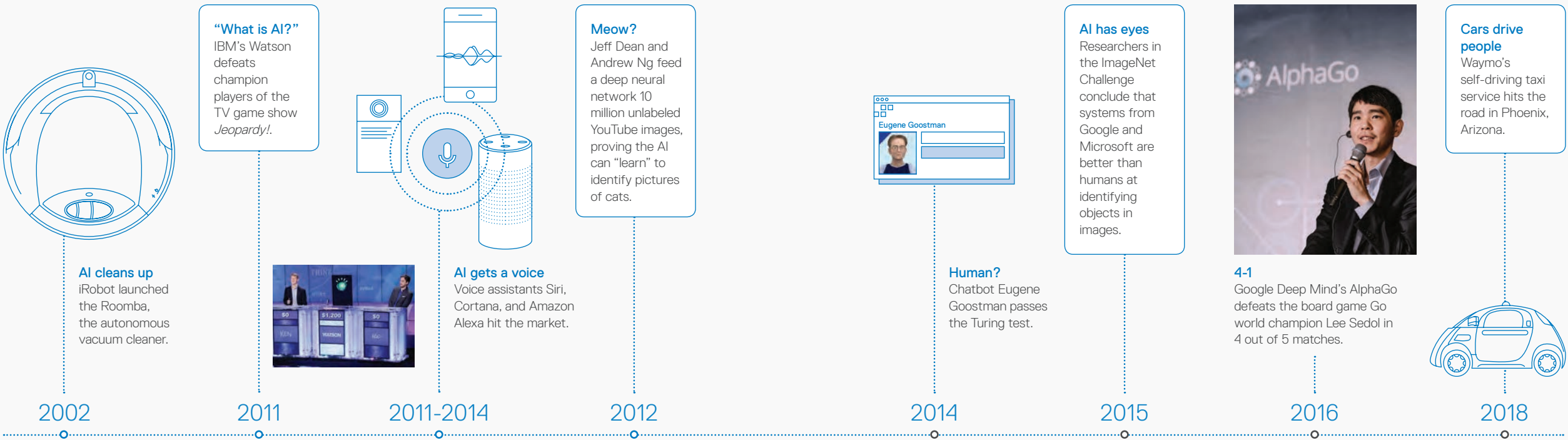
Kismet, a robot that, according to Breazeal’s dissertation, could recognize and simulate emotion. And while they may not feel, the current generation of voice assistants—including Siri, Google, Cortana, and Alexa—have become part of the family in dwellings around the world, and since 2011 have exponentially increased in power, agility, and ubiquity. With rapid progress in machine learning, deep learning, and neural networks, we see algorithms helping to spot disease, detect fraud, thwart animal poachers, optimize supply chains, improve customer experience, predict buying patterns, generate music, and the list goes on.

The road ahead for AI will, in all likelihood, involve travel down actual roads. Autonomous

cars have long been the stuff of fantasy and hype. Yet, advancements in edge computing and 5G are pushing them closer to reality. Volvo has deployed self-driving trucks to take over dangerous mining tasks in Norway, and Alphabet subsidiary Waymo put autonomous taxis on Phoenix-area streets in 2018.

“I think, therefore I am.” We’re long past the Turing Test. Where we go from here in the age of human-machine partnerships will be fascinating to witness. ■

 Hear the history of AI. Subscribe to Trailblazers with Walter Isaacson on your favorite podcast directory or at DellTechnologies.com/Trailblazers



GDPR, A Year In



Margaret Franco, senior vice president EMEA Marketing, Dell Technologies, reflects on the challenges—and opportunity—organizations face a year into the EU's General Data Protection Regulation.

BY MARGARET FRANCO

During the month of May 2018, the term “GDPR” was searched more often on Google than American celebrities Beyoncé and Kim Kardashian. Needless to say, the European Union’s (EU) General Data Protection Regulation has been a hot topic among business leaders and marketers the world over.

That’s because the new regulations, which came into force on May 25th of last year, have big impact (and big consequences) for any business dealing with individuals within the EU—regardless of where it’s headquartered. Under GDPR, these organizations must have permission to collect, manage, and store personal data, and importantly, if asked, must be able to retrieve and remove all information held about an individual. In addition, organizations are required to report the exposure of personal data to both regulators and the affected individuals within 72 hours after they become aware of any such breach.

So, how are organizations faring under these new rules? As of January 2019, EU organizations have reported around 41,000 breaches since GDPR came into force, according to the European Data Protection Board. Law firm DLA Piper reports that, also as of January, fewer than 100 fines—91 in fact—have been issued as regulators perhaps use other penalties, such as warnings, reprimands, or temporary or permanent bans on data processing. 2019, however, is predicted to be a year where the regulators get tougher. We’re already seeing this prediction come true.

On January 21st of this year, French regulator CNIL fined Google \$57 million when it found the company had a lack of transparency for how their users’ data is processed, and a lack of valid lawful basis for targeted advertising. This is a phenomenal sum, but well below the upper limit for GDPR breaches: four percent of annual global turnover. For a company the size of Google, which has reported annual sales of more than \$100 billion, the penalty could have been much harsher. Even still, the fine has sparked a lot of discussion globally that if a company as large as Google can get it wrong, then what about the rest of today’s companies?

BURDEN OR OPPORTUNITY? A MARKETER’S PERSPECTIVE

GDPR’s ripple effect is reaching far beyond business in the EU. In addition to new privacy laws in the U.S., including the California Consumer Privacy Law and proposed Washington Privacy Law, lawmakers in Australia, Brazil, Canada, India, and Japan, among others, are all revisiting their countries’ privacy laws to mirror GDPR.

The burden GDPR and privacy laws place on businesses to make significant and often costly changes to the methods they use to acquire, store, analyze, and use personal data has been well debated and documented. Halfway into the first year of GDPR, a Deloitte report found that 70 percent of the organizations from 11 countries surveyed had increased headcount in roles focused on GDPR compliance, and more than 70 percent said that they were using internal or external tools, such as technical discovery tooling, redaction tooling, and AI, to support GDPR compliance activities.

Further complicating compliance is the fact that the situation around data privacy is not static, but rather constantly evolving, emphasizing the need for marketers and leadership teams to remain vigilant and responsive. For example, one area to watch is public blockchain and its impact on privacy. Calls for the EU to relax GDPR compliance in order not to stifle innovation in this new technology are unlikely to succeed, and blockchain currently has no way of meeting the regulation’s requirement of an individual’s right to be forgotten.

But GDPR is not only about how we extract the data itself or what we must do to avoid penalties. Rather, it’s about how we communicate with our

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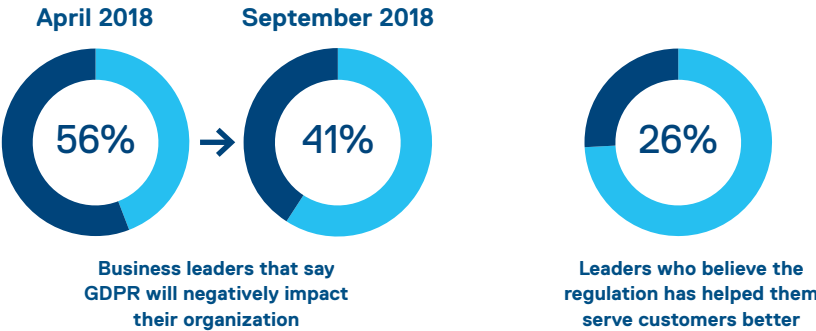
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GDPR is not only about how we extract the data itself or what we must do to avoid penalties. Rather, it’s about how we communicate with our customers to earn their trust. As a marketer, I see this communication as an opportunity to connect with customers on a personal level. After all, privacy is personal.”


customers to earn their trust. As a marketer, I see this communication as an opportunity to connect with customers on a personal level. After all, privacy is personal. Today, our customers have more choice than ever before on how they share their personal data with us. When we are transparent and respectful, we have the opportunity to serve them better.

I’m not alone in this more positive outlook. A survey of UK businesses conducted by the Direct Marketing Association (DMA) revealed that marketers increasingly believe their businesses will experience long-term benefits from GDPR. The percentage of respondents who stated the regulations will negatively impact their organization fell considerably from 56 percent in April 2018, to 41 percent since the regulation came into force. Moreover, an increasing number (26 percent) of organizations believe the regulation has actually helped them serve customers better by enabling them to build sustainable relationships through transparency and honesty.

This positivity around GDPR is not intended to downplay the complexity of meeting the regulations and the robust processes and checks a company must introduce to ensure compliance by all its teams that deal in personal data. Yet, GDPR could be a driver for positive differentiation and signal a move away from generalized communication strategies, such as mass-mailing, to ones that are more personalized or offer an opportunity to engage directly via social platforms. This means more of a two-way exchange with customers, which may deliver valuable insights and feedback. In this way, GDPR turns from regulatory nightmare into stellar opportunity for customer engagement. ■



Source: “Data privacy – An industry perspective” report, DMA, dma.org.uk



In July 1969, Apollo 11 marked the first manned lunar landing mission. Today, rock samples collected from the moon continue to be studied by the science community.

Preserving History on Earth... and Beyond

In this Luminaries podcast excerpt, hosts Mark Schaefer and Douglas Karr journey to space with Tom Stein, operations manager at NASA's Planetary Data System at Washington University.

MARK SCHAEFER: We have liftoff! Our guest today is Tom Stein. Tom, your title is a lengthy one: NASA Planetary Data System Geosciences Node Operations Manager for Washington University. Welcome, tell us a little bit about yourself.

TOM STEIN: Don't let the long title fool you. Nobody really knows what I do, sometimes including myself.

DOUGLAS KARR: That is the best job. You work for NASA, and nobody knows what you do. Sign me up!

TS: Exactly. What we're charged to do at the Planetary Data System is to work with planetary missions and space science data providers to define the data products and then archive them for the long term for the science community.

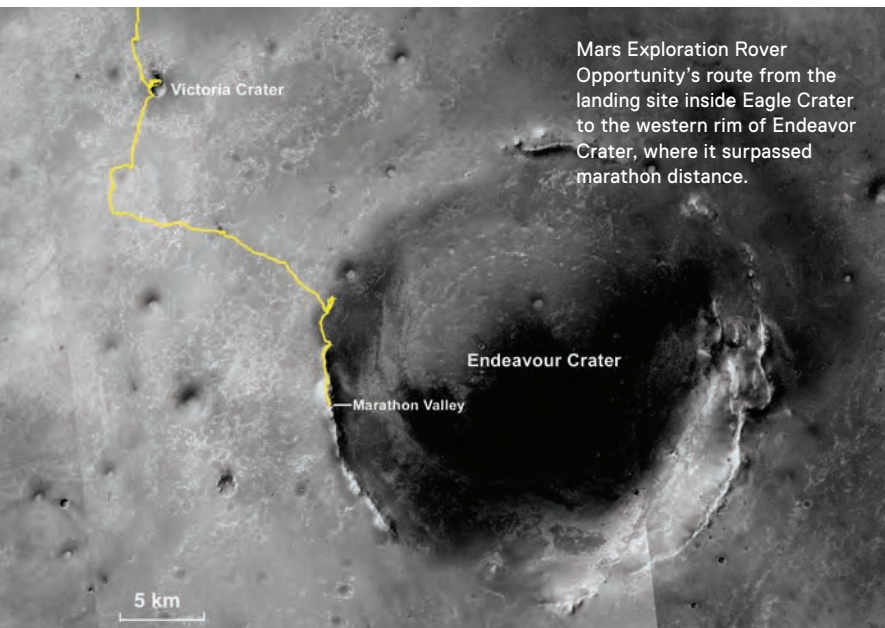
MS: It sounds like you're kind of NASA's library. Am I describing that right?

TS: That's a fair description, in one sense. We are tasked with preserving science data and giving access to the data. But really our task is more than acting as librarians. We start working with data providers years before a mission launches because we want to make sure the science data are well-defined and well-structured, for archiving purposes, but also for daily use by researchers.

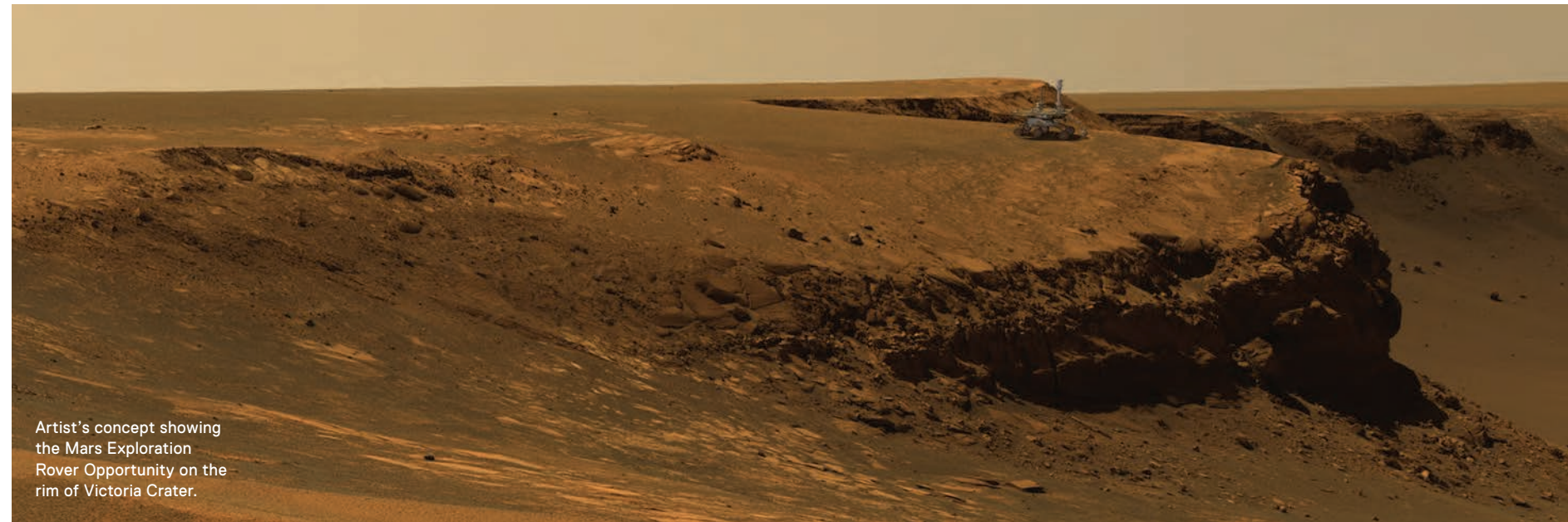
DK: And it's a ton of data. You guys are connecting one-to-two terabytes a month?

TS: That's what's been archived. NASA gives about six or seven months to data providers, science teams, instrument teams, to work through the data they acquire, validate it, and make sure that it's in shape. Then, we release it

THE STORY



Mars Exploration Rover Opportunity's route from the landing site inside Eagle Crater to the western rim of Endeavour Crater, where it surpassed marathon distance.



Artist's concept showing the Mars Exploration Rover Opportunity on the rim of Victoria Crater.

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on a regular schedule. Every month, we release data from some mission or other. Those releases can end up being about three terabytes, depending on the mission set. That volume is growing a little at a time—we've largely followed Moore's law over the years.

DK: This data is priceless, obviously. What extra steps do you take to make sure it's never lost?

TS: It would keep me up at night if I felt like we weren't doing it right. We have our primary data store, which is tiered—things like our database servers and so forth sit up on all-flash. But even our entire archives... the rest of it's sitting on spinning disk, that we mirror over to another spinning disk set in another location every day. Then we've got a tape backup. Our final fallback is a fourth copy at Greenbelt, Maryland, where NASA has a large center for putting stuff on the shelf in the event something really bad happens. We don't take

lightly that responsibility of keeping the data. We get a lot of requests from people saying, 'Hey, try our cloud' or 'Try this system.' But we've got to be really careful, so that's why we maintain that entire ecosystem.

MS: Back in the Apollo days, what did they do before they had you? Where is that data?

TS: The data are still around on rolls of film, negatives, prints, and so forth. But in the early '80s NASA started thinking, 'Gee, we're so focused on the accomplishments during the mission. We need to make sure that we have a plan in place before launch to save the data so that when the mission is over, people can return to it year after year.'

When this whole project started about two years before I came aboard, we didn't have a hard drive. The first hard drive we bought was \$10,000 and one gigabyte, if you can believe that.

PHOTO (LEFT) COURTESY OF NASA/JPL-CALTECH/MSSS/NMNHHS

PHOTO (ABOVE) NASA/JPL-SOLAR SYSTEM VISUALIZATION TEAM

MS: Has a lot of the data been digitized from missions like Apollo and Mercury?

TS: It has been. And what is striking to me is a lot of those data are in constant use. Even 40 years later, a lot of the rock samples continue to be studied by the science community. You can imagine it's not a simple process to send another mission up to Venus, or to the Moon, or wherever. So once you have those data, you want to get the most out of them.

MS: Do you get to sit in on the NASA meetings or go to Houston or Cape Canaveral?

TS: I've had some of those opportunities. It's been pretty fantastic. Some unexpected results can come out of those meetings, too. Almost 20 years ago now, there was a Rover test out in the Mojave Desert. A couple engineers took the test Rover out in the field, and scientists were in a trailer trying to

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pretend that they were actually doing a Mars mission. After a couple of days, they started to realize, 'We're all taking our own notes. But we kind of lost track of what our decisions were along the way. Why did we decide to drive left and not right?'

So as the Opportunity and Spirit Mars rovers were preparing for launch, we started thinking about how we could make a robust system that captured not just the data but the intent behind it, put it in context. We put that system together, not thinking that one of those 90-day Rovers would run for 14 years.

DK: Why did NASA select Washington University for this work?

TS: This might sound a little self-serving, but I think it's one of the smartest things NASA ever did. I don't mean just choosing Washington University, but locating where science research was being



View of Earth taken during Apollo 17 mission. Inset: Geologic traverses from Apollo 17 landing site.



PHOTO (LEFT) COURTESY OF NASA; PHOTO (INSET) NASA/PDS/ASU/WUSTL

done. Washington University has a rich history in planetary science. My boss has been involved with every Mars mission since the 1970s, for example. So, instead of going to an IT location where people are really good at developing IT solutions, but maybe don't fit the research needs, NASA saw an opportunity to take IT abilities and that knowledge domain on the science side and merge them.

MS: Who is your customer? Is it NASA or the people who are accessing the data?

TS: Technically, NASA is our customer because we're in a subcontract role. But really, it's the planetary science community and the general public... The data are 100 percent available for free to anybody. We have people from all over the world downloading data.

MS: Is that students, academics, or just people who are doing it for fun?

TS: We've got all kinds of people coming in. At first, we thought our target audience was going to be senior research scientists at universities or at NASA centers, and graduate students in the field. However, we're finding undergraduates are using it. Once, a teacher came up to me and said, 'My high school students are using your interface and pulling down your data to support their senior research projects.'

We even have mission teams from space agencies outside the U.S. who are preparing for missions to the moon or Mars, saying, 'We're looking at your system to figure out how we can capture the information presented when we go up.'

MS: So do other countries exchange their data too, or is this unique?

TS: One of the groups that we're involved with is called the International Planetary Data Alliance. It sounds kind of like a Star Trek thing, but one of our goals has been to work on internationalizing the planetary science standards and setting up interoperability between agencies. And that's worked really well.

Our six-month release policy from NASA is a big change from the way NASA used to do things decades ago, where scientists would just sit on their data for years. That policy has been adopted by a majority of these other space agencies, who now also release their data, not only in a timely fashion, but for free. That's pretty exciting. We have representatives from about 18, 19 countries that are involved in this process. It's kind of a hands-across-the-sea sort of endeavor.

MS: Have there been any applications that have been particularly interesting to you?

TS: Well, certainly we're learning a lot about traveling in space, developing not only a place for humans to land on the Moon, but how to support long-term activities, to develop opportunities to actually build materials there and make it more habitable. Now, when I say 'we,' I mean the community at large.

But really, for all those discoveries that we're finding now, the data-driven aspect of looking through all of these returned data is going to bring a lot more discoveries that I think, ten, 20 years from now, we are going to look at and say, 'Wow, that is incredible what was found out of that mission.' ■



Hear the full interview with Tom Stein in the "Preserving History... About Earth and Beyond" episode of Luminaries—Talking to the Brightest Minds in Tech. DellTechnologies.com/Luminaries

Four Big Promises of 5G



Liam Quinn, senior vice president and senior fellow at Dell Technologies, shares his perspective on the future with 5G.

BY LIAM QUINN

For as long as I can remember, I've been a tinkerer. Much to my parents' dismay, I ruined quite a few wireless radios by taking them apart so I could see how they worked. I've been fortunate to make a lifelong career in engineering design, building technology innovations that bring as much joy and wonder to people as those portable radios brought to me.

So, it's no surprise that I'm thrilled about the innovation that 5G will bring as a key enabler in the convergence of cloud, enterprise, consumer, and IoT technologies. The implications—and applications—are staggering. Here are the four promises of 5G that excite me most.

1. Bandwidth This is the benefit making the most noise—5G promises to be fast! But bandwidth is more than just download speeds. It's about getting work done, whether you're a student, employee, or simply at leisure. Being able to download and upload multiple workstreams like videos, audio, documents, or other types of information is vital for how we live and work.

2. Lower latency In online gaming, the saying goes "latency kills." While lower latency is huge for gamers, it extends beyond that corner of the market and allows for unique use cases, such

as telemedicine extending the reach of healthcare providers out of the office and into the home.

3. Network slicing More than just segregating a radio network, network slicing allows the provider to flexibly allocate resources and accommodate different ways customers may engage with services. For example, a municipal service like fire-fighting or ambulatory services could, in the case of a disaster, be prioritized on the radio network to allow for quicker response time.

4. Connected devices While a cell phone is a primary use case for 5G, the realm of IoT, including connected devices, cars, and infrastructure, will also see tremendous growth. For instance, a connected car needs to be able to send its telemetry data—oftentimes tens of gigabytes at a time—back to a local collection point. With 5G, this data can be processed expediently and returned to the vehicle, improving safety and driver assurance.

5G has impressive potential to change the fabric of social interaction, technology intersection, and business growth. I'm eager to work on driving innovation in the use of 5G technology, working with our customers and partners to deliver differentiated solutions, services, and applications. ■





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