

Think:Act

navigating complexity

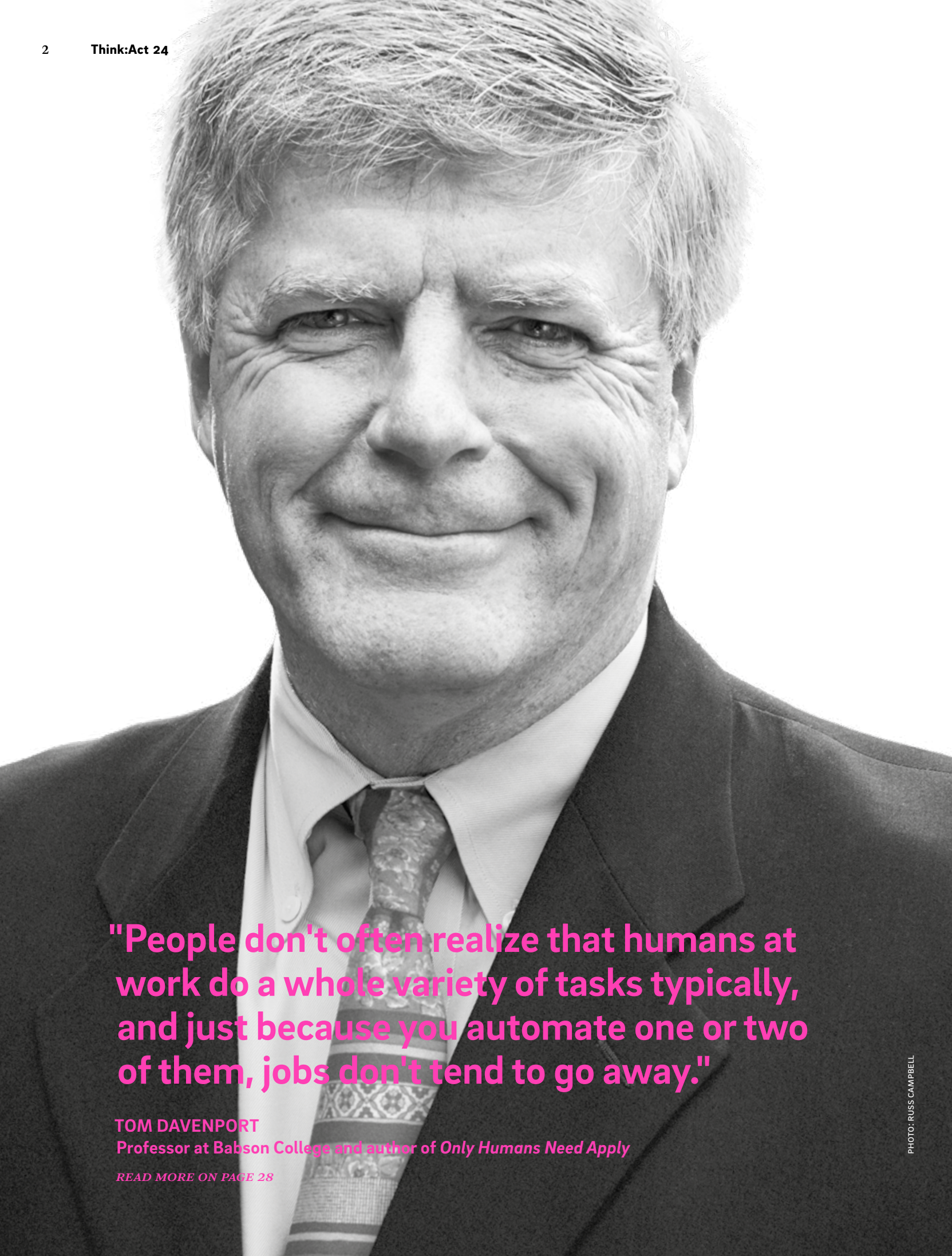
+
bonus
POSTER
Top thinkers
on AI's future
impact

Think:Act #24 02 | 2018 ARTIFICIAL INTELLIGENCE

**AI think,
therefore
AI am**

Are we ready
for the next revolution
in technology?

Roland
Berger 



"People don't often realize that humans at work do a whole variety of tasks typically, and just because you automate one or two of them, jobs don't tend to go away."

TOM DAVENPORT
Professor at Babson College and author of *Only Humans Need Apply*

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PHOTO: RUSS CAMPBELL

"You'll see more and more everyday things becoming more alert to your context, a little bit smarter."

DEMIS HASSABIS
Artificial intelligence researcher and co-founder of DeepMind

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PHOTO: ADRIAN LOURIE/EYEVINE/INTERTOPICS

"A thorough understanding of a company, its employees, its customers and products and its culture is a great help when it comes to shaping the future."

HANS VAN BYLEN
CEO of Henkel

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PHOTO: MAYA CLAUSSEN

"You want to be careful about who you hire. The data suggests that having the right people on your bus isn't as critical as keeping the wrong people off that bus."

ADAM GRANT
Organizational psychologist
and author of *Give and Take*

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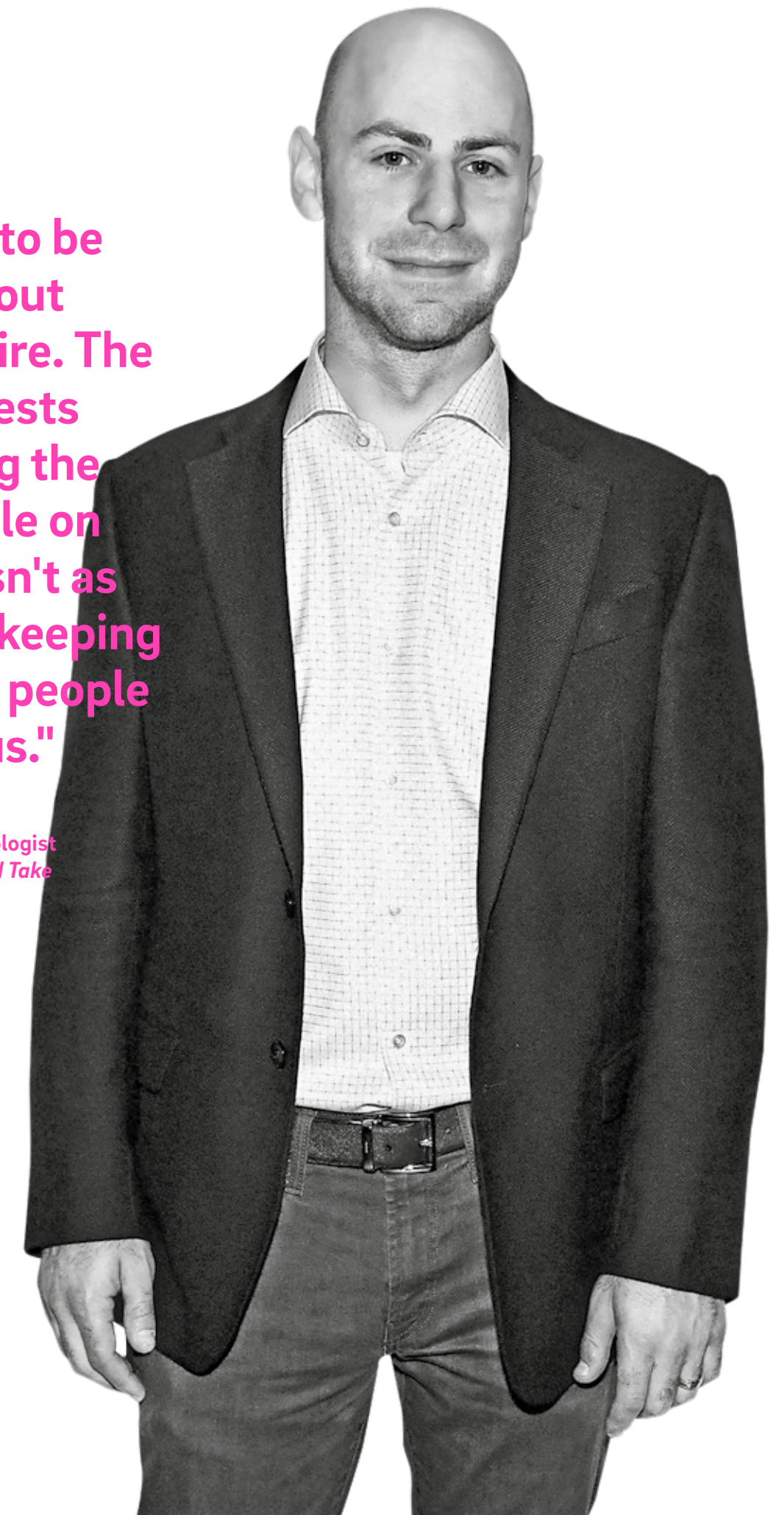


PHOTO: SLAVEN VLASIC/GETTY IMAGES



"The coming revolution in portable artificial intelligence will dramatically shift the balance of power between large firms and users."

CHARLES-EDOUARD BOUÉE
CEO of Roland Berger

PHOTO: JAN VOTH

COVER ILLUSTRATION: ERKIN DEMIR | PHOTOS: VCG/IMAGO, SPACEX PR | ILLUSTRATION: ANA KOVA

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Think:Act



Getting Down to Business With AI – The Future of Artificial Intelligence: Beyond the Hype

It seems like suddenly everyone is talking about how AI will change the world. We cut through the hype and find out what it will really mean for business – once you push those fears of killer robots aside, of course.



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Friends or Foes?

Some see a bleak, jobless future ahead. For others, it's the dawn of a new harmony between man and machine.



74

Aiming for the Perfect Moon Shot

The new space race is on. But it's not countries footing the bill this time around – it's companies.



Think in Numbers

\$10bn

THE ESTIMATED VALUE of the opioid drugs industry in the US. The painkiller use epidemic has been called the worst drug crisis to hit the US.

126m

PEOPLE – THE NUMBER of Americans that Facebook now says were reached by Russian-backed posts during and after the 2016 US presidential election.

100

THE LENGTH IN FEET of a large, mysterious and void-like space recently discovered inside the Great Pyramid of Giza by a French team using cosmic rays to gain a view of the ancient structure's hidden secrets.

10%

THE NEW ENERGY vehicle score (linked to the production of zero- or low-emission vehicles) that China has imposed on automakers manufacturing or importing more than 30,000 vehicles annually. Automakers must reach that target by 2019, which will then rise to 12% in 2020.

Food for Thought

Can you shape experiences and capitalize on opportunities to create them?

BY Chip and Dan Heath

PSYCHOLOGISTS KNOW that we don't remember experiences start to finish, like a video that we can play back in our heads. Rather we forget most of what happened and hold on to certain key moments. Specifically, we tend to remember two particular moments: the "peak," which is the best moment in a positive experience; and the ending. Here's what the research is telling us: Some moments matter vastly more than others. And it helps explain what we might call the Disney Paradox: If you were to measure your minute-by-minute happiness at a Disney theme park on a hot, crowded summer day, chances are you would have been happier for most of the day if you were sitting on your couch at home. But, in memory, the Disney visit might be a highlight of your year. And you're not crazy to think that, because at the park you experienced some peak moments – the kinds of moments that never come from sitting

on your couch. For anyone in the business of serving others – patients, customers, employees – this is a critical lesson. Great experiences hinge on peak moments, and peak moments don't build themselves. We must create them.



BROTHERS CHIP AND DAN HEATH are co-authors of the bestselling business books Switch and Made to Stick. Their new publication The Power of Moments: Why Certain Experiences Have Extraordinary Impact is out now. Dan is a professor at Duke University and Chip is a professor at Stanford Graduate School of Business.

PHOTOS: TRAVELINK / GETTY IMAGES; HENRY MEDINA

Think:

AT A GLANCE

Thoughts to Live By

"Someone is sitting in the shade today, because someone planted a tree a long time ago."

— Warren Buffett Investor and philanthropist

Re-Thinking Buzzwords

Get to grips with new industry lingo in a flash with our stripped-down explanations of the latest jargon.

"Kill chain"

If someone on your team asks "what's our kill chain here?" you should know that what they mean is the step-by-step analysis. It sounds aggressive because it comes from the military's four Fs: Find, Fix, Fight, Finish.



Borrowing a phrase that was apparently coined at Lockheed Martin for a cyber-defence system, however, might be a little jarring. Also, it's been used for years by gamers, so it might not be a good look. And since the word "strategy" will do, why not just use that?

Act



The Redacted Read

Fully Connected: Surviving and Thriving in an Age of Overload by Julia Hobsbawm. 256 pages. Bloomsbury Business. \$28.

Everything connects

Too busy to read the strategy books? We have it covered for you. Here's Julia Hobsbawm's new book cut down to its essentials, in the style of the original.

TODAY WE HAVE MORE opportunities to be connected than at any time in human history. Mobile, social media and the internet make up the background hum in every corner of the planet. But how healthy or desirable is this? There is an edge of madness creeping into all of this and it's called "overload."

Humanity is beginning to choke on the fumes of excess connection. We suffer from information obesity, time starvation, techno-spread (when technology expands around us like a ballooning waistline), network tangle, organizational bloat and life gridlock.

We need to start looking after our "social health," balancing our face-to-face and electronic connections in a way that manages flows of knowledge, networks and time. People with social health know how to use technology and where to find the off switch.

To reach that state, you need to follow the Hexagon of Social Health. The top three factors are: knowledge, networks and time (the KNOT), the key constraints in this age of overload. Three coping mechanisms can help untie the KNOT. These are management, communication

and a sixth sense, and together they form the balancing half of the hexagon:

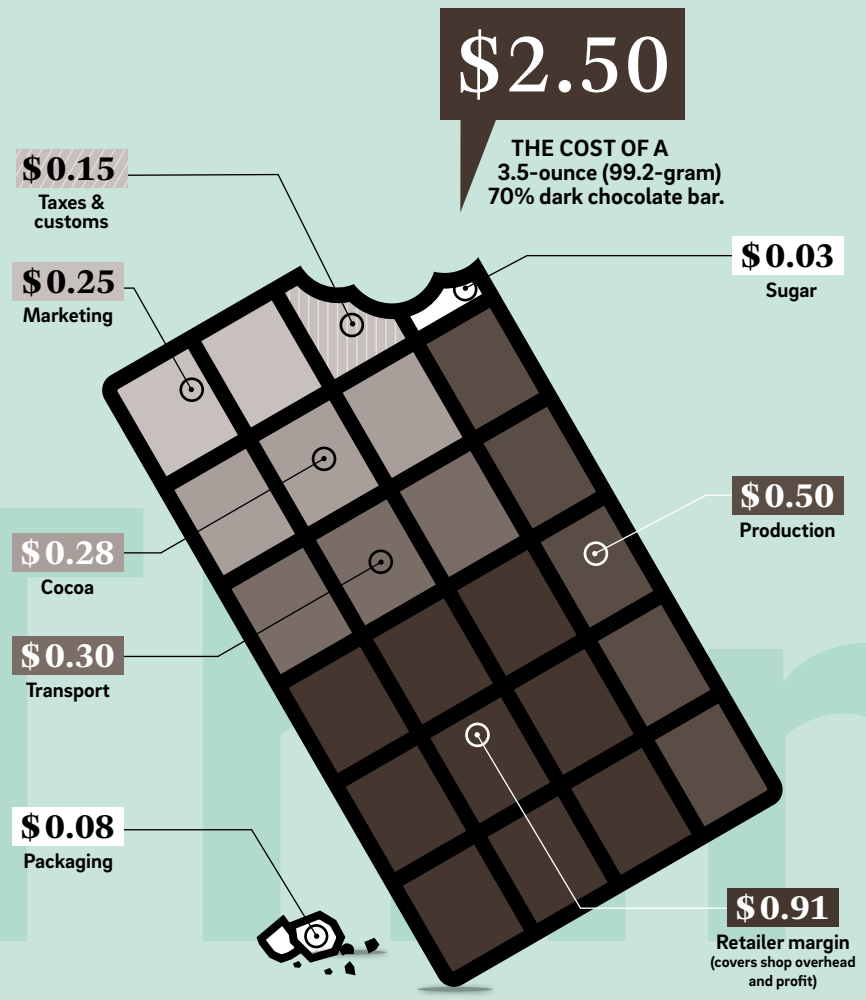
MANAGEMENT: It's important to manage the pace, process and performance of your work.

COMMUNICATION: Think before you write. In the general swirl of overload, the risk of miscommunication is high.

SIXTH SENSE: Pay attention if something doesn't smell right. When all are at sea in a tsunami of overload, such factors may just be the cure.

Actual Cost

THAT CHOCOLATE BAR may have tasted nice, but as you indulge yourself a little, maybe think beyond the price tag: There are the social and environmental costs of subsistence cocoa farming in West Africa and South America to consider. Fair trade and small-batch chocolates, as well as growing demand from Asia, are also having an impact on prices. Here we have broken down the cost of a good quality \$2.50 US chocolate bar, chunk by chunk.



Best Practice

Time is of the essence if you are doing business in India

YOU ENTER A CONFERENCE ROOM in India expecting the meeting to start when you were told. But often, it does not. Fret not, for this is a matter Indians self-deprecatingly refer to as Indian Standard Time (IST). It might be inconvenient, but it isn't meant to be rude. These benign delays are so routine that you'll find few Indians notice them anymore.

Senior business executives, who are used to working with international guests, will be on time, and so will flights and most trains. But the rest of India might still waylay you. Your cab may arrive 10 minutes late or lunch might be served slowly, setting in motion a daylong domino effect of delays. To save time and spare yourself the anxiety, do what punctual Indians do: Work the uncertainty into your plans. Set your watch to reflect a 10-minute, even a 15-minute, delay. Call a cab driver earlier than you need. The only way to truly beat IST is to give in to its predictability.



Economic Impact

Brexit field study

BRITISH FARMERS ARE STARTING to feel the pinch of Brexit, according to some sources. Reports say that fruit and vegetables are being left to rot in the fields due to a shortage of migrant labor from EU countries. The UK has become less attractive to seasonal workers – many of whom come from Romania and Bulgaria – because of the fall in value of sterling against the euro, one of the consequences of the referendum vote in 2016 to leave the European Union. The National Farmers' Union is calling on the UK government to implement a seasonal agriculture workers' scheme to help alleviate the problem.



Act
AT A GLANCE

SOURCES: OXFAM, WAGENINGEN UNIVERSITY, TEJAS CHOCOLATE, HARDMAN & CO.

PHOTOS: WESTEND61/GETTY IMAGES; IMAGES/IMAGO

Getting Down to Business With AI

The Future of Artificial Intelligence: Beyond the Hype



ARTIFICIAL INTELLIGENCE

ARTIFICIAL INTELLIGENCE



Everyone from Elon Musk to Vladimir Putin suddenly seems to be talking about artificial intelligence (AI) and how it will change the world – for better or worse. But what does AI really mean once you set aside the hype and fears of *Terminator*-style killer robots? What will it mean for business? How quickly will it arrive? Where can it be applied? And how should companies be responding to it?

BY **Tom Standage**

ILLUSTRATIONS BY **Ana Kova**

What exactly do people mean when they talk about AI in 2018?

ARTIFICIAL INTELLIGENCE IS A VERY BROAD TERM that dates back to 1956 and describes efforts to get computers to do things that could previously only be done by humans. It occurs frequently in science fiction, yet today's excitement is focused on one particular subfield of AI known as "machine learning," which involves teaching machines to do things by example – as opposed to, say, "expert systems," which rely on rules and knowledge distilled from human experts. The excitement, in fact, is mostly centered on a specific machine learning technique known as "deep learning," in which software simulations of simple models of the human brain are trained to do things by showing them large numbers of examples. "Neural networks," as these simulations are called, have been around for a while, but "deep" networks, which are more sophisticated and can be trained to recognize more subtle differences, have become far more capable in recent years.

In other words, deep learning is just one very specific example of a subfield of AI, but the excitement around this particular subfield stems from its ability to handle a very wide range of problems, from image recognition to language translation to transcribing speech. "Machine learning is now superhuman in its ability to do certain classes of very specific tasks," says John Giannandrea, head of Google's machine learning team. But he stresses that deep learning's success does not mean AI is a solved problem. "The idea that one corner of computer science is good for speech recognition, image detection and self-driving cars has got people really excited – perhaps overly excited." The more fundamental questions regarding the nature of consciousness and intelligence remain as impenetrable as ever.

Why has AI suddenly taken off in the past couple of years?

THE RECENT RISE OF AI is the result of rapid progress in machine learning, and deep learning in particular. There are three reasons behind this. First, the internet – and, more broadly, digitization – has provided an enormous volume of data that can be used for training. Second, researchers figured out more efficient training algorithms for use with larger – "deeper" – neural networks. And third, they figured out how to get graphical processing units – the specialist chips found in video game consoles – to run deep learning software instead. This provided a hundredfold boost in performance when it was first done in 2009, and chipmakers have since devised new chips optimized for deep learning; the share price of Nvidia, the leading maker of GPUs, has risen **more than tenfold** in the past four years as a result. Deep learning's power was first apparent in 2012 at the annual ImageNet competition, which pits image recognition systems against each other. That year a deep learning system demonstrated an unprecedented improvement in accuracy, easily winning the competition. That prompted widespread adoption. "The applications are so broad. There are so many ways to use it," says Nvidia CEO Jensen Huang from his self-driving car, which contains two of his company's chips, as it drives him to work in Silicon Valley.

10+

The factor by which Nvidia's stock price has risen in four years. It closed at \$12.72 on Jan. 2, 2013; \$102.01 on Jan. 3, 2017. By October 2017, the price per share was approaching \$200.

There's been excitement about AI before. Is this time really different?

YES. BUILDING SOFTWARE SYSTEMS that learn from data, rather than following explicit rules hand-coded by human programmers, is not new. Previous bursts of enthusiasm around AI always ran out of steam as the technology proved difficult to scale up or deploy, however, resulting in fallow periods known as "AI winters." This time around, deep learning systems are powerful enough that they have been deployed on a large scale by internet companies, and are now used on a daily basis by billions of people, most of whom are entirely unaware of it. Deep learning systems underpin Google's search engine and translation services, suggest replies to emails and recognize speech for its smartphone assistant. Facebook uses deep learning to recognize and help tag people in uploaded photographs, and to figure out which posts and advertisements to show to users. Deep learning powers Apple's Siri and Amazon's Alexa. Chinese internet giants Baidu, Alibaba and Tencent are all using it too. In short, and in contrast to previous AI technologies, it has proven to be applicable to a wide range of tasks and is reliable enough to be embedded in systems that people use every day. "You're using it when you talk to your phone, when you search for something on the internet. You're using it already in so many ways," says Richard Socher, an AI researcher who is now chief scientist at Salesforce. Even if the technology failed to advance any further, says Yoshua Bengio, a pioneer in the field of deep learning, there are still lots of areas where it can be usefully applied. Another deep "AI winter" seems unlikely.

SUITING HER NEEDS
Amanda walks to work and tasks her AI assistant to order her a suit, which is later delivered to the office by a driverless drone.

DATA-BASED DIAGNOSIS
Amanda's doctor is assisted by genomic pattern recognition. Tagged data is fed into the database.

DIGITAL PA
Amanda orders a driverless taxi to get to an early doctor's appointment. Her AI assistant set up the appointment based on her work patterns.

What kinds of tasks can AI actually do? How does it approach those tasks?

NEARLY EVERYTHING THAT DEEP LEARNING IS CURRENTLY BEING USED FOR, from image recognition to language translation to speech transcription, is actually a variation of the same underlying task, from a technical perspective at least. In each case a neural network is trained by exposing it to millions of examples (inputs) for which the correct answer (output) is already known. For image recognition, that means training a network with millions of labeled images (this is a dog, that is a cat); for speech recognition, millions of sound clips are used, each tagged with the correct transcription. Once the network has absorbed enough examples, it can correctly predict the right output for a previously unseen input. This configuration of deep learning, called "supervised learning," is the most widely used in business. "Most of the value of machine learning today is supervised learning," says Andrew Ng, a deep learning pioneer who has worked as head of AI at Google and Baidu. Spam filtering, credit scoring, handwriting recognition, analyzing medical scans or teaching a self-driving car to read road signs can all be implemented using supervised learning. More generally, any sufficiently large labeled data set (where the correct output for millions of inputs is known) can be used to train a deep learning system. So now ask yourself: What labeled data sets does your company have?

ARTIFICIAL INTELLIGENCE

Where do I start if I want to embrace AI in my business?

DEEP LEARNING'S DEPENDENCE ON VAST AMOUNTS OF TRAINING DATA explains why internet giants were its earliest and most enthusiastic adopters. They have access to enormous amounts of data that can be used to train systems. For companies that are used to processing a lot of data – for example, those in retail, telecommunications or financial services – moving from "big data" analysis to the adoption of machine learning is an obvious step. For other firms, the adoption of AI techniques depends on first being able to gather, process and analyze internal data effectively; companies with poor analytics capabilities or flaky data management will struggle. But the opportunity is clear. "Today every company has processes that can be managed, optimized or augmented by AI," says **Antoine Blondeau**, co-founder of Sentient Technologies, an AI startup that has attracted more than \$140 million in funding. Elevator companies have data about the reliability of elevators; carmakers have data on the behavior of cars. "I think you're going to see deep learning approaches being adopted in literally every single industry, from engineering to marketing, from sales to manufacturing," says Jensen Huang. But you need lots of data first.

"Today every company has processes that can be managed, optimized or augmented by AI."

Antoine Blondeau, Co-founder of Sentient Technologies

Do big companies with lots of data have an insuperable advantage?

BECAUSE DATA IS NECESSARY IN ORDER TO TRAIN MACHINE LEARNING SYSTEMS, access to lots of data can give companies a big advantage. Google is the most popular search engine, which means it has the largest volume of search queries to analyze and the most raw material to feed into machine learning systems that make its search engine even better. The same dynamic may play out in other industries: The more data you have, the better you can make your product, attracting more users and thus generating more data. This is known as a "data network effect," and it may mean that first movers in some fields end up with a huge head start over their rivals that will continue to grow. But there is a counterargument: For many tasks, abundant training data can be found online. "The internet is full of data. There's enough data to build AI out there," says Yoshua Bengio. Open-source data sets that can be used for training exist in several fields.

Data can also be gathered from the real world or generated in a virtual environment: Self-driving cars are being trained using video from dashboard cameras or images of imaginary streetscapes generated by video game engines. DeepMind's AlphaGo system, which defeated the world's best players of Go, a board game popular in Asia, began its training by analyzing past games and then improved by playing against versions of itself. Future machine learning techniques may someday allow systems to learn from fewer examples. But for now, the more data you have, the better – and access to training data that nobody else has can give you an advantage, though not necessarily an insuperable one.

38%

of companies are still "observers" that have yet to adopt AI, according to an IBM survey of corporate executives.

Will every company end up using AI eventually?

YES. JUST AS ALL COMPANIES NOW USE ELECTRICITY AND THE INTERNET, they will all end up using AI too. But as with those previous technologies, there are many levels of adoption: Only the biggest companies generate their own electricity. Similarly, for companies that have data processing at the heart of their business, machine learning expertise will become a core competence, requiring teams of specialists. Other firms will adopt the technology at arm's length as AI features are added to devices, software and services they already use, from smartphones to email systems to e-commerce engines. "A lot of what you'll see in the next five years is incremental, and imperceptible to most people, but things will work slightly better," says Demis Hassabis, co-founder of DeepMind. "You'll see more and more everyday things becoming more alert to your context, a little bit smarter." The rapid rollout of AI technology by internet giants is not representative, in short. Most companies do not have vast troves of data, thousands of engineers and billions of users. A recent survey of corporate executives by IBM found that 38% of companies are still "observers" that have yet to adopt AI; only 11% of companies have made significant investment in the technology. As with electricity and the internet, adoption will take time.

ARTIFICIAL INTELLIGENCE

BOT ORDERING
Amanda calls an airline chatbot, which tells her about seat availability and books her ticket.

TAILORED DATA
The retail company sending Amanda's suit assesses data from her and other customers to shape its future offers.

28 others are viewing this ticket. Shall I book it for you?



What does all this mean for my employees, for hiring and training?

MANY OBSERVERS ARE GLOOMY ABOUT THE LONG-TERM IMPACT OF AI ON JOBS. "Seventy percent of jobs will be destroyed, because they can be performed cheaper or better by robots and AI," predicts Bruno Maisonnier, a robotics entrepreneur best known as the creator of the humanoid "Pepper" robot. Others disagree, saying that technology has always created more jobs than it destroys. Either way, mass unemployment is not in the cards just yet. The more prosaic reality is that AI technology cannot yet replace entire jobs: It automates or accelerates some tasks, instead. Most jobs consist of a mix of tasks, and that mix is likely to change more rapidly in the future. That in turn will require workers to acquire new skills and companies to take a more organized approach to regular retraining as skills become more "perishable." The spread of computers into the workplace since the 1980s already requires people to learn new skills and new tools every so often, and AI will simply accelerate the process. Automating some parts of jobs but not others will also emphasize the importance of soft skills such as empathy and social interaction – the things machines cannot do (not yet, at least) – and which employers will increasingly value. Rather than AI directly displacing humans, it seems more likely that jobs that involve using AI will displace jobs that do not. A report from investment bank UBS summarized the situation as follows: "Don't fear the robots, but be prepared to change jobs."

70%

of today's jobs could be eliminated by AI, according to some predictions. Others believe the technology will create more jobs than it destroys.

ARTIFICIAL INTELLIGENCE

AI FOR ID Amanda attends a high-level meeting and accesses the host's building with verified face recognition security.

Where is AI going next, and what will the impact likely be?

ALL KINDS OF NEW MACHINE LEARNING ARCHITECTURES are being developed that go beyond what existing systems can do. "Unsupervised learning" can find data patterns even when you don't know what you're looking for. "Reinforcement learning" is an AI technique that allows machines to develop strategies to solve difficult problems, like driving vehicles, controlling robots or playing complex games. "Generative adversarial networks" can take examples of music, paintings or photographs and then generate a convincing imitation, or recreate one in the style of another. AI techniques will also provide increasingly rich new ways to interact with tools and data, through speech and conversational interfaces and augmented reality, where data is overlaid on the real world. But many researchers are already looking beyond deep learning. "Neural networks are not the ultimate AI – there will be other solutions, other approaches," says Antoine Blondeau. Some researchers are devising systems that can learn from just a handful of examples, just like humans can. That would make machine learning more widely applicable than today's deep learning systems, which require large amounts of training data. Others are pursuing entirely different AI techniques. "The field of AI is dominated right now by a particular approach to machine learning," says Gary Marcus, former head of AI at Uber. He thinks long-term progress in AI will require more input from the field of developmental psychology and worries that with its current emphasis on deep learning, the industry risks getting stuck in a rut. Deep learning is just the beginning of AI's deployment – not the end point.

DATA CRUNCHING Amanda assesses AI-assisted research comparing results of thousands of legal cases.

What are some of the things AI could do in future?

LIKE ELECTRICITY AND THE INTERNET BEFORE IT, AI will power new tools that enable companies to do new things. Many researchers are excited by the prospect of being able to find patterns in huge data sets that are simply incomprehensible to humans. That might include spotting previously unknown connections in troves of legal, scientific or medical documents, or finding patterns associated with particular diseases buried in mountains of genomic data. "Having machine learning in the loop will turbocharge breakthroughs in science and health care," says Demis Hassabis. "It's like having the world's most relentless research assistant that never gets tired." AI has the potential to transform an enormous range of tasks involving analyzing data, looking for patterns and devising strategies in response. What does it mean for your business if speech can be translated instantly from one language to another? If hours of video can be searched, transcribed and summarized? If vehicles can drive themselves and delivery costs for goods fall dramatically? We are about to find out.

→ This piece was written using contributions from Anne Dujin and Neelima Mahajan.

AUTOMATED TRAVEL Another driverless car takes Amanda to the airport, where congestion is far reduced and parking lots are a thing of the past.



Five scenarios AI could make possible by 2028

→ **RAPID ADVANCES IN MEDICINE** occur as AIs spot patterns in genomic data gathered from thousands of patients. England's National Health Service has embarked on the "100,000 Genomes Project," which will use machine learning techniques to analyze genomic data and medical records, advancing the understanding of cancer and rare diseases. AIs could also be used to spot connections between medical research papers, which are so numerous that no human researcher could ever hope to read them all.

uses voice transcription and machine translation to enable bilingual conversations between smartphone users. Microsoft has added real-time translation between 10 languages to Skype, its internet calling service.

→ **CITIES BECOME CLEANER AND GREENER** as shared, driverless taxis reduce traffic and emissions. Driverless taxis, summoned via app, could revolutionize urban transport by doing away with the need for most people to own a car. Because cars are only used 4% of the time on average, the number of vehicles needed could plummet by as much as 90%, according to an OECD study. Parking lots would give way to parks and central housing.

→ **AI-POWERED ASSISTANTS** become indispensable sidekicks helping you run your business and personal life. Think Siri or Alexa, only much smarter, able to access all your email, messages, calendars, photos, documents and online accounts, drawing connections, making suggestions and giving you the information you need, when you need it. Such a service would be hugely valuable – but would also raise thorny questions about privacy and access to personal data.

→ **LANGUAGE BARRIERS VANISH** as real-time translation becomes standard on smartphones. About 500 million people in China already use an app called iFlytek Input, which

→ **THE DECLINE OF OWNERSHIP** as rapid, cheap delivery of clothes, tools and household items by autonomous flying or wheeled drones does away with the need for people to own many things. Why own rarely used household tools, or vast wardrobes of clothes, when you can summon what you need from a shared repository in minutes? Clothing services become commonplace, with AI-selected outfits delivered each week.

ARTIFICIAL INTELLIGENCE

Smarter Than Man Friday

We are on the cusp of an artificial intelligence revolution. The real breakthrough, however, will be the advent of personal, portable AI.

BY **Charles-Edouard Bouée**

JANUARY 2000. That's when I met Kenny Hirschhorn in London. I was working on the France Telecom-Orange merger. Kenny headed strategy for Orange. His title made him truly special: group director of strategy, imagineering and futurology. After exchanging pleasantries, he pulled out his phone and said, "You're a strategy consultant. What is this?"

"A mobile phone," I said. Kenny sighed. "I'll give you another chance." I took another stab: "Nokia." Kenny shook his head in disappointment. "This is the *remote control* of your life." He showed me a video of an executive in California getting in his car, whipping out his phone and checking his appointments. Then he viewed his wife's ultrasound images emailed by a nurse. My jaw dropped. For me, this was an Arthur C. Clarke-style fantasy.

Fast forward to 2018 and we are on the cusp of an artificial intelligence (AI) revolution. It will impact the economy, industry and society. Business leaders know that AI will have far-reaching consequences, but somehow AI is still too far off for them. But the future is hurtling toward us and soon AI will be unavoidable. It will transform business and our lives. The AI revolution will happen

when millions have access to it, the same way electricity transformed people's lives a century ago. It will revolutionize how we live, work, communicate and travel. I believe this revolution will happen within the next decade.

But how? Back to Kenny. Some of his vision is already playing out with how we use smartphones today. We have all talked nonsense to Siri, the iPhone personal assistant, to hear how it responds. But Siri is really a voice command app tending to our requests and belongs to the "gadget" category.

This is where Kenny planted the seed of an idea for me 18 years ago. The AI revolution will be powered by what I call "portable artificial intelligence." It can be defined as an extension of the self. Everyone will have "their own" personal AI: in a box in the living room, in a smartphone or even embedded in a chip pinned to your lapel.

"The balance of power between the large firms and users will shift."

Portable AI will simplify our lives in unimaginable ways. It will be enough for us to wish to take a vacation and our portable AI will do the rest: sync our calendars with those of our close ones, anticipate the dates of our kids' school holidays, choose a date and a destination based on our likes and then book the vacation package in the blink of an eye. The AI software, which could be provided by a mobile operator, for instance, will use a private cloud and will have no advertising. And so, we won't be reluctant to let it access our personal data.

As a result, our AI will rapidly build a deep understanding of who we are, enabling it to provide hyper-personalized services and give us greater satisfaction. Today, we reluctantly give bits of information to many service providers, but each of them *knows* very little about us. Tomorrow our private cloud-based AI will centralize all relevant information and orient us toward things we *want*.

The ingredients are all in place to create a portable AI revolution: a massive influx of capital, increased convergence between the work of researchers and the fantasies of entrepreneurs, an exponential increase in machine power and the miniaturization of electronic components.

The advent of portable AI will impact many sectors. Take advertising. What is the use of bombarding us with advertisements if our AI software *knows* what we want, is able to find it on its own and is equipped with a blocking algorithm for unsolicited commercial advertising? The act of buying is transformed. If our personal AI can order our breakfast cereal – exactly how we like it – and have it produced and delivered to us, what is the role of brands, stores and packaging?

The question that business leaders must ask is: What are the products and services we need to create for a world where everyone has their own portable AI? The winners will be those who do this forecasting exercise. The good news is that, as with every wave of technological innovation, the cards will be reshuffled. One is tempted to believe that large digital platforms like Google, Apple, Facebook and Amazon (GAFA) will dominate the market for portable AI. The massive investments they make in AI could convince us of that (after all, Google paid \$400 million for DeepMind in 2014!).

On the contrary, I believe that AI, particularly portable AI, could end the monopoly the GAFAs have. First, because the huge amount of data produced makes data obsolete faster. Every two years almost as much data is produced as humanity has produced in the course of history. But not all



Charles-Edouard Bouée

Charles-Edouard Bouée is the global CEO of Roland Berger. He has written a number of groundbreaking books on modern management and China – where he lived for over a decade. His latest work, *La Chute de l'Empire Humain*, about artificial intelligence, was published in 2017.

companies have the same quality of information. What we liked on Facebook a year ago may no longer be relevant. So accumulated data capital will soon no longer be a decisive advantage. It is much more essential to capture active users, here and now. We'll shift from a situation where multiple users all go to the same platform or service provider to one where every user is equipped to look for and find exactly the products and services they need, wherever they are. The balance of power between the large firms and users will shift.

Portable AI solutions could succeed because they will give us what the advertising-reliant GAFAs can't: protection of personal data, personalized services and trust. Today's digital monopolies are unlikely to win this battle because they would need to kill their business model to do it.

This brings me to the "Hirschhorn Theory," which I named after Kenny. If someone at Orange had paid more attention to his idea of "the remote control of your life," Orange might have invented the smartphone before Apple. But they didn't. To own the future, we need to think beyond current business models and realities, and try to imagine what life could look like tomorrow.

Embedded AI solutions are already being developed outside of the big digital giants in companies like Sentient in the US, Arago in Germany, SenseTime in China, Snips in France or Element AI in Canada. The question is: When will these different AI "bricks" in different areas of our lives connect with each other to take charge of all the questions we ask ourselves every day? And who will come up with a relevant business model? The race for the next \$1 trillion company is open! ■

PAYING ATTENTION PAYS OFF Tomorrow's winning models will be based on what we already know today.



CHINA STEPS UP A GEAR



PHOTO: CHENG JIABEI / IMAGINECHINA / LAIF

GETTING ON BOARD
Visitors take photos at the Artificial Intelligence Science Popularization Exhibition held by Baidu in September 2017.

China is betting big on AI. Big tech companies, state-run initiatives and the investment community are all sharpening their focus with the belief it will transform every part of the economy. Nobody wants to be left out – and some are even returning to be part of the story.

BY **Henrik Bork**

PROCESSORS AND DATA SETS are taking the place of warheads and missiles in what sounds like a new arms race. But instead of Russia and the US squaring off, it is the largest and the second-largest economies in the world competing for advantage on what could be the new battleground for influence and power: AI. While the US is still leading both in terms of innovation and investment in this apex technology of the information age, China is running fast and catching up. In fact, several key factors beneficial for progress in AI seem almost perfectly aligned for China to succeed: huge data pools ready to feed AI's hungry algorithms created by a big, culturally coherent group of digital consumers; a government that supports the development of AI with ambitious plans and subsidies; and a Chinese tech community comprising CEOs of leading internet companies and founders of small startups, all of whom are embracing AI with an almost religious zeal.

A key player in this new game is Baidu, China's equivalent to Google. Baidu claims its search engine has 760 million users who leave behind a digital trail of their daily requirements, personal interests and business needs, filling Baidu's treasure chest with zillions of terabytes of useful data. "With regard to AI, it is undeniable that data brings great advantages to big companies," says Liu Wei, vice president of Baidu and the CEO of Baidu Ventures. Founded in 2016, Baidu Ventures →

is Baidu's new early-stage investment unit that is focused exclusively on artificial intelligence, virtual reality and augmented reality projects. Liu Wei, formerly a partner at Legend Holdings' investment arm Legend Star, aims to raise \$200 million and invest it in AI startups.

Apart from the usual business goal of making a profit, Baidu Ventures is also driven to build, as Liu Wei puts it, "the biggest AI ecosystem platform in China," bringing together underlying technology manufacturers – such as makers of advanced cameras and 3D sensors – with early AI adopters in various industries in China such as intelligent retail companies and logistics providers. That is why Baidu Ventures is investing millions of dollars, and also why it is making it easy for startups to gain access to Baidu's data and AI research. "Baidu's voice recognition and automatic driving technology come from the accumulation of large business data, and these technologies have been opened to developers as open-source platforms," says the Baidu Ventures CEO.

Looking at the overall investment flowing into AI in China, the country is still lagging behind compared with the US. But the total figures belie the speed with which China is catching up. Within just a few years, from 2012 until the first half of 2016, \$2.6 billion of investment flowed into China's AI industry, according to a joint report by Wuzhen Institute and NetEase Tech. This is one-seventh of the amount in the US, but already puts China into second place internationally.

ARTIFICIAL INTELLIGENCE

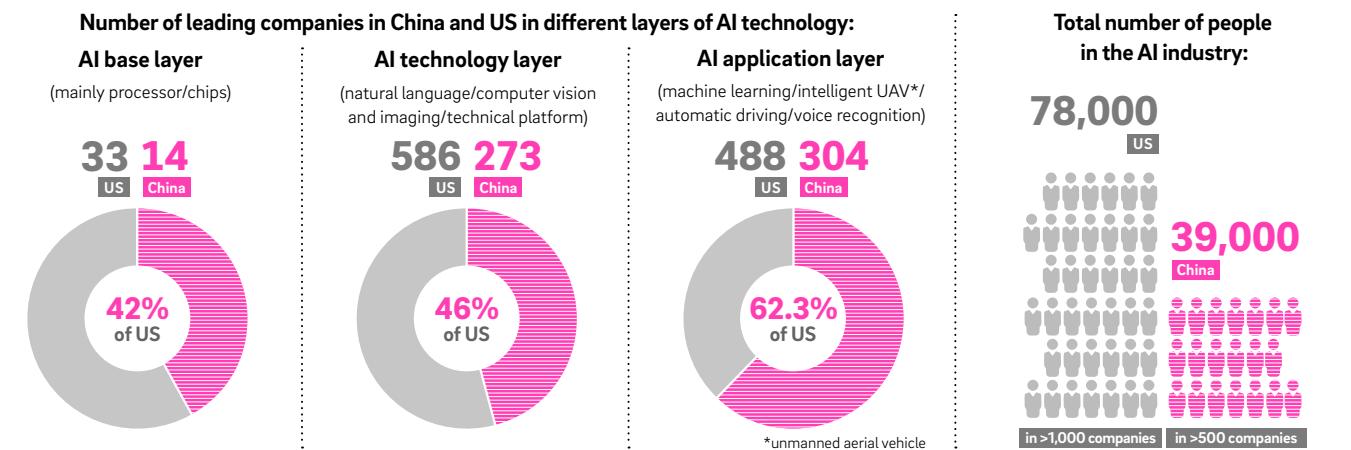
THE REVOLUTION IS BEGINNING



HINA IS ONLY JUST GETTING STARTED. A lot of prominent players in the internet industry have only recently started to adopt AI as their pet subject, but now that they are, they are doing so with a vengeance. "AI technology presents the greatest opportunity in human history, and I encourage you to pay attention to what is happening in China," said Kai-Fu Lee during the World Economic Forum in Davos in 2017. Taiwan-born Lee, who helped establish Google China before Google withdrew from China partly owing to censorship concerns, now lives in Beijing and is one of the country's most influential thought leaders on all things internet. Lee studied speech recognition, which has evolved as one of the key areas of AI research, as early as in the 1980s. Now he is leading the startup incubator Sinovation Ventures in Beijing's Haidian District, often called China's Silicon Valley. When Lee first announced the start-up fund at a press conference in 2009, mobile



Sizing up the competition: Chinese and US involvement in AI



SOURCE: TENCENT RESEARCH INSTITUTE'S REPORT ON AI DEVELOPMENT IN CHINA AND THE US

PHOTOS: GIULIA MARCHI / BLOOMBERG / GETTY IMAGES (2)

internet and cloud computing were the buzzwords. But this year, the incubator with a total fund size of more than \$1 billion has started to focus most of its activities on AI.

One reason why China is so optimistic about AI is that it is relatively easy to find real-use cases, or, as AI researchers usually call it, "applications" for AI in this still relatively fast-growing economy. There is real demand in a lot of industries, with companies wanting to improve efficiency in order to cash in on the commercial opportunities presented by the rising Chinese middle class: hundreds of millions of consumers who may not yet be as rich as the middle class in the US and Europe, but who have more and more disposable income. "It is a revolution," says Li Peng, who is in charge of financial products in Baidu's big data business unit. His team has started to offer AI-powered solutions to banks, insurance companies and other financial service providers in China.

Li brims with enthusiasm: "It used to take banks many days to identify new target customers for high-end credit cards or to assess the credit risk for a loan application, and now we can help them to do the same in just a few hours." To help find new customers for new products with increased efficiency, the big data team at Baidu will first ask their corporate clients for a sample of existing customers, for example 30,000 bank clients who have already applied for a certain credit card. Next, they build a mathematical model based on a composition of 100,000 tags, then filter Baidu's 760 million users with those same tags, easily identifying more target customers, which are later narrowed down further. "We call it big data precision marketing," says Li. This is where China excels, with practical applications of AI.

Other necessary elements for AI, like powerful computer chips and innovative research, are still mostly advancing in other countries, mainly in the US. The government in Beijing recently announced, however, that it wants China to become a "premier global AI innovation center" by 2030. The ambitious, top-down policy document issued by the Chinese State Council in July, the Next Generation Artificial Intelligence Development Plan, identifies AI as a key growth driver for the Chinese economy in the coming decade. The government promises more funding for fundamental research and also to facilitate the cooperation between the state, companies and the military. The aim is to leverage what Beijing sees as China's strength in AI: massive data resources and a big talent pool.



WORKING TO A GOAL Sinovation Ventures plans to grow its AI team from 30 full-time employees to 100 within the next year.

AN INCUBATOR OF OPTIMISM Founded in 2009, Sinovation Ventures is led by Kai-Fu Lee.



ARTIFICIAL INTELLIGENCE

"AI technology presents the greatest opportunity in human history."

Kai-Fu Lee, Founder of Sinovation Ventures

TO PROTECT AND SERVE The police robot at Zhengzhou East Railway Station can clean, monitor air quality, detect fire and also compare passenger faces to those of escaped criminals.



A PLAN FOR DEVELOPMENT

ARTIFICIAL INTELLIGENCE



THE REPORT HAS PROVOKED alarmist press articles abroad about China being determined to overtake the US and dominate the world in a key technology of the future. Yet, on closer inspection, the State Council's plan is quite honest about China's current shortcomings and "technology gaps" in AI. As a first step, by 2020, China wants nothing more but to "catch up" with advanced economies like the US in terms of AI. As a second step, by 2025, China hopes for its first breakthroughs in fundamental AI research.

Like so often, foreign observers easily go into overdrive, extrapolating huge potential from China's mind-boggling numbers while the Chinese stay much more down-to-earth. For example: All the talk about China now "cutting corners" in the race to become the world's leading AI powerhouse spurred the Chinese gaming and social media giant Tencent, who developed the leading Chinese social media platform WeChat, to order some thorough research. Headlined *What Shall We Do With the AI Bubble?*, the Tencent Research Institute's recently published report on AI development in

The alignment of big data, recent investor interest and talk about government support has started to attract a lot of promising talent in the field of AI to return to China from all over the world.

PHOTO: ZHANG TAO / VCG / GETTY IMAGES

SOURCE: TENCENT RESEARCH INSTITUTE'S REPORT ON AI DEVELOPMENT IN CHINA AND THE US

China delivered some sobering news. "There are no signs of cutting corners at all. In fact, China has so far made only partial breakthroughs," the report says after quoting figures and comparisons, for example the more than 1,000 AI companies in the US versus the more than 500 in China. China has so far less than half as many companies engaged in processor and chip development, as well as less than half as many engaged in basic technology, it pointed out. And the Tencent Research Institute even included a warning, quoting an oversupply of funds and not enough projects to invest them in, the telltale sign of a developing bubble.

Still, the government's ambitions have been announced and China's track record with development plans for certain industries or infrastructure suggests that, here again, Beijing at least means business. Even more so as the official embrace of AI is driven by sheer necessity. Faced with a rapidly aging population and rising labor costs, economists have warned that China might "grow old before it can grow rich." As the technocrats at the helm of China's communist party and government are struggling with slowing growth and with a difficult transition from a manufacturing to a consumer economy, they are in desperate need of new growth drivers.

AI may not be the solution to all of China's problems, and it may be a while before China leads the world, but the alignment of big data, recent investor interest and talk about government support has started to attract a lot of promising talent in the field of AI to return to China from all over the world. Take Li Yunpeng. Until recently, the 38-year-old worked as a software development director in the database division of Oracle America. "Honestly, I had already built a good life for me and my family in the US," says Li, now sitting in the new office of his AI startup SkyData in Nanjing, in the Chinese coastal province of Jiangsu. "I am still ambitious. I thought it was a great opportunity to come back to China and help my motherland with the next stage of its development. And I see great opportunities for entrepreneurs in China."

It was not difficult for Li Yunpeng to find some first clients for SkyData's products. His startup now uses AI to help the China Guodian Corporation, one of the five largest power producers in China, to maintain its windmills. SkyData's algorithms identify the need to change certain windmill parts before a breakdown can lead to downtime. Yet despite his personal optimism, Li Yunpeng cautions to keep predictions about China's rise in AI



as many companies in China are engaged in processor and chip development as in the US, according to the Tencent Research Institute.

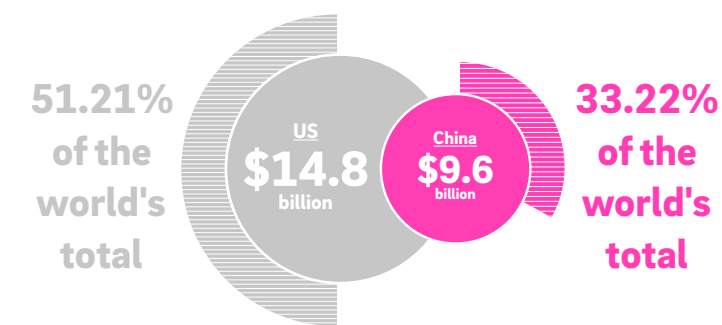
realistic. "Everybody is talking about the huge data pools in China," he says, "but for AI to blossom, you need consolidated data sources. What we find here in China are not clear ponds that we can fish with a net, but rather muddy data swamps." To catch up with the US or even overtake them in terms of AI, China would need to close a huge gap in this field alone. Li Yunpeng believes it can be done, but it will take at least five years to do so. Still, he would not want to be anywhere else at the moment. "Local governments here in China really give startups a chance. They introduce state-run companies as potential customers to us. As a startup entrepreneur in China, you get a chance even without a long track record."

Another AI researcher recently returned to China is the 33-year-old Han Dong, back from Germany to his native Shanghai. He studied computer science in Saarbrücken, worked as a research assistant at the renowned Max-Planck-Institute and the German Research Center for Artificial Intelligence (DFKI). "When I started to study computer vision and other fields of AI more than a decade ago, it was still very difficult to find a job outside of academia. That was true for a lot of Chinese talent in the US and Europe. Now all these people get a lot of opportunities back home," says Han. And it is perhaps this fact, the return of the natives more than government plans and investor interest, that could drive the rapid rise of AI in China in the years to come.

ARTIFICIAL INTELLIGENCE



Venture capital investment into AI



The difference between China and the US in AI investment is big. The US has already invested heavily, while China is now catching up. Since the first US investment into AI in 1999, AI development has accelerated globally. In 18 years, total venture capital invested into AI has reached \$28.9 billion.

Augmented

Intelligence



For the doomsayers, "AI-augmented workplace" might as well be code for "impending mass unemployment." Yet many believe that giving repetitive tasks to smart machines will free us to reimagine our working roles as human beings. There's nothing to fear. But it is time to prepare.

BY **Nicola Davison**

ILLUSTRATIONS BY **Chad Hagen**



WHEN A CHILD COMES TO HER CLINIC FOR THE FIRST TIME, Sofia Douzgou asks the parents if she can take their picture. Douzgou, a consultant geneticist who specializes in the diagnosis

of rare disorders at the Manchester Centre for Genomic Medicine, then uploads the photo to an app called Face2Gene, along with additional information about the patient and observations from the clinic. The app utilizes facial recognition software to convert the image to data, which is uploaded to a cloud and crunched against a database. Douzgou then receives a "best syndrome match" within seconds.

The diagnosis of rare disorders is a difficult business. Scientists have so far identified 7,000 inherited genetic conditions that affect about 8% of the world's population; there may be thousands more. Many of these conditions have distinct craniofacial characteristics – Down syndrome is a well-known example. Yet if the clinician has never encountered a certain disorder before, seeing what the machine thinks can be helpful. "In the great majority of times, a rare genetic condition that affects the child may not be evident before birth and can be a complete surprise to the family," says Douzgou. "We need to look for a diagnosis taking into consideration a possible differential of thousands of disorders." Face2Gene, she says, is a useful tool – but its usefulness is limited. "My job is made up of much more than just identifying a similar facial pattern among patients."

Though the idea once belonged to science fiction, in the past couple of years, as the technology has improved, organizations and businesses in diverse sectors have started to experiment with the different ways that intelligent machines can assist humans at work. Executives can now schedule meetings using "Amy Ingram," an AI-powered personal assistant developed by New York-based company x.ai. The Big Four auditors have started using tools that flag anomalies in company accounts. Pfizer recently signed a partnership with IBM in order to speed up drug discovery. The NHS in the UK is trying out a virtual team-building coach called CoachBot.

As the use of AI has become more widespread, many fears about "robots taking over" have proliferated. The fears are not groundless. In 2013, a study by researchers at the University of Oxford found that 47% of jobs in the US are at high risk of being "substituted" by computers. And it is not just the manually laborious tasks that are at risk – many white-collar professionals risk being automated, from accountants, clerks and taxi drivers to cashiers, telemarketers and receptionists.

But not everyone is convinced that the rise of AI will create mass joblessness, as the doomsayers predict. "It's not an irrational concern, in the sense that these machines, smart machines, can do any task that humans can do," says Tom Davenport, a professor at Babson College who specializes in innovation in the technology and management spheres. "But I think people don't often →

realize that humans at work do a whole variety of tasks typically, and just because you automate one or two of them, jobs don't tend to go away."

In *Only Humans Need Apply: Winners and Losers in the Age of Smart Machines*, Davenport and his co-author Julia Kirby argue that the debate should be reframed. Rather than focusing on the threat of automation, we need to seek the opportunities that will arise from "augmented" workplaces – where thinking machines assist us. Machines are good at crunching vast reams of data quickly, picking out patterns from which they can form a hypothesis. It would take a human weeks to compare the data taken from a photo of a child's face to others in a database. Yet it is hard to imagine an AI replicating the capacity for empathy required when a doctor communicates with a patient.

THE PIONEERS OF AUGMENTATION necessarily belong to sectors or industries that generate a lot of data, such as the law, medicine and agriculture. One French startup, CybeleTech, is using mechanistic modeling, big data and high-performance computing (HPC) to improve customers' agricultural output. Innovations in agriculture are sorely needed, says manager Marie Joseph Lambert, in a world with limited natural resources and a ballooning population. "If you want to increase the production of agriculture in the world with the same way we farm today, it's impossible," he says.

CybeleTech started with seeds. The big seed breeding companies spend millions of dollars each year on R&D in the search for the best new varieties. CybeleTech realized that mechanistic models were good at predicting which seeds would work best in a specific environment. From there, the company began crunching data from individual fields – data about soil type, weather, the heterogeneity of plants and so on – in order to help farmers understand how to get the best possible yield, an approach known as "precision farming."

Lambert says that the company is now looking to expand its presence abroad. He expects annual turnover this year to reach \$1.74 million, a year-on-year increase of nearly 50%. The company employs 14 people and Lambert plans to hire five more by the end of the year – a rejoinder to the latent anxiety about AI taking away jobs. History suggests that this is no anomaly. Two centuries ago, during the Industrial Revolution, textile workers known as the Luddites began destroying the machinery that they believed would obliterate their livelihood. But as more of the tasks in the weaving process became



automated, workers were able to focus on managerial and operational tasks. This led to a surge in output, which in turn created more jobs. In the US the number of weavers quadrupled between 1830 and 1900. Recent research supports this premise. A 2016 report by Deloitte found that while technology has contributed to the loss of 800,000 lower-skilled jobs in the UK, it has helped to create nearly 3.5 million new, higher-skilled ones in their place.

THE INDUSTRIAL REVOLUTION WAS DIFFERENT, says machine learning expert Anthony Goldbloom, because it was the mechanical jobs that were under threat in the 1800s. Today, it is any task that is "frequent and high volume." He explains: "Machine learning is only really useful – despite all the buzz and hysteria about it – for things that are very repetitive." Goldbloom is the founder and CEO of Kaggle, a company that hosts competitions where its data scientist community attempts to solve difficult problems using machine learning. In 2012, the community developed an algorithm that was able to grade high school essays that matched the assessment of human teachers. According to Goldbloom, machines will come to outperform humans in any task that requires predictive analysis. But Goldbloom also believes that relinquishing repetitive tasks to machines is no bad thing. "I think things that are repetitive are not the most enriching parts of our work lives," he says.



"I think things that are repetitive are not the most enriching parts of our work lives."

Anthony Goldbloom, Founder and CEO of Kaggle

PHOTO: KAGGLE PR

There are many jobs that machines can't do, Goldbloom points out – they are flummoxed by novelty. Machines need vast volumes of data to make predictions, whereas humans are able to connect threads to solve problems not previously encountered. As machines take over in frequent, high-volume work, people will migrate to roles that call for critical thinking, creativity, judgment and common sense, and that extends to the top tiers of management. "I think [AI] will completely change the way people work," says Augustin Huret, founder and CEO of MondoBrain, a company that develops "augmented intelligence" software to help executives to make decisions based on their ability to grasp the drivers and influences on a business. Managers can take this AI intelligence and combine it with their own experience and the "collective intelligence" of their colleagues. "Augmented is the ability of a manager to leverage those three intelligences for every decision on their business for every key performance indicator," Huret says. He believes that rather than being replaced, tomorrow's managers will need to develop a different skill set. "Their role is going to massively change from being good at understanding the drivers to being good at observing the world and observing their business," he says.

PREDICTING WHAT JOBS will be created in the future is difficult – after all, the idea of making a living as a website designer would have seemed strange just 20 years ago. But there are ways to prepare. Davenport advises companies to draw up what he calls an "augmentation strategy." He explains: "Augmented strategies involve looking at every work process and job and saying: 'What's the structured data component that might be better done by a machine, and what are the roles for humans?' There's a lot of 'work design,'" he says. Individuals, meanwhile, need to think realistically about what aspect of their jobs might be carried out by AI, and plan accordingly. We might "step up" to a role that requires high levels of abstraction and critical thinking or "step narrowly" into a specialist career that would not be economical to automate.

In almost all cases, Davenport says, people-jobs will be less codified and structured. And, hopefully, more fulfilling. "I think that there's a bright future for people who are willing to change their skills and who are willing to work to either add to the work of smart machines, work alongside them, manage them or to do something that they can't do," he says. ■



Management in the age of AI



In the context of automation, discussion is often focused on the fate of the worker and the "huge demon of Mechanism," as Scottish philosopher Thomas Carlyle put it in 1839. Yet past experience tells us that management is just as susceptible to technology's disruptive force.

It was the first Industrial Revolution's automation of manual jobs that created the need for managers who could oversee large numbers of workers while controlling operations across the factory floor. Frederick Winslow Taylor, whose "scientific management" system dominated manufacturing industries at the beginning of the 20th century, wrote that mass production would "involve new and heavy burdens" at management levels.

In the second half of the 20th century, with the rise of computers and the modern office worker, management became more sophisticated still, with

demand for people who could use abstract reasoning, creativity and "soft skills."

With AI augmentation, the role of management is set to evolve once again. Middle managers will need specialist skills to avoid being made redundant once smart machines are put to work on repetitive tasks. Meanwhile, top-tier managers will be required to implement their company's augmentation strategy. "They'll be the ones who decide where and how much and what kind of smart machines will be deployed throughout the organization," says Tom Davenport. As AI becomes better at assisting with decision-making, managing a broad network of human specialists – many of them independent contractors – will become central to the executive role. Zhang Ruimin, chairman and CEO of Chinese company Haier, has described the role of the CEO of the future as the company's "designer."

Friends or Foes?

ARTIFICIAL INTELLIGENCE

Martin Ford's influential 2015 book, *Rise of the Robots*, painted a bleak picture of a jobless future where automation takes over. While his predictions might serve as a warning, there is also a view that interaction with our robotic friends could introduce a new harmony between man and machine. We take a look.



PHOTO: REMO CASILLI / REUTERS

ABB

A GUIDING HAND

→ AT THE OPERA

Originally developed as a "robot co-worker," YuMi's advanced control systems quickly found applications away from assembly lines. Here Maestro Andrea Colombini prepares YuMi – its name is a play on "you and me" – for its conducting debut with the Lucca Philharmonic Orchestra in September 2017. Ford says, "AI and robotics have the potential to eliminate tens of millions of jobs," but few would have guessed conductors to be among them.

ARTIFICIAL INTELLIGENCE

MIXING THINGS UP

→ IN THE KITCHEN

Ford says the jobs under threat are "routine, repetitive or predictable... from fast-food workers, to taxi drivers, to financial analysts to radiologists." These kitchen workers at Shenyang Agricultural University are preparing lunch with the help of a noodle-slicing robot, an augmentation to the workplace rather than a replacement.



PHOTOS: VCG/IMAGO; AURORA FLIGHT SCIENCES CORPORATION

ARTIFICIAL INTELLIGENCE

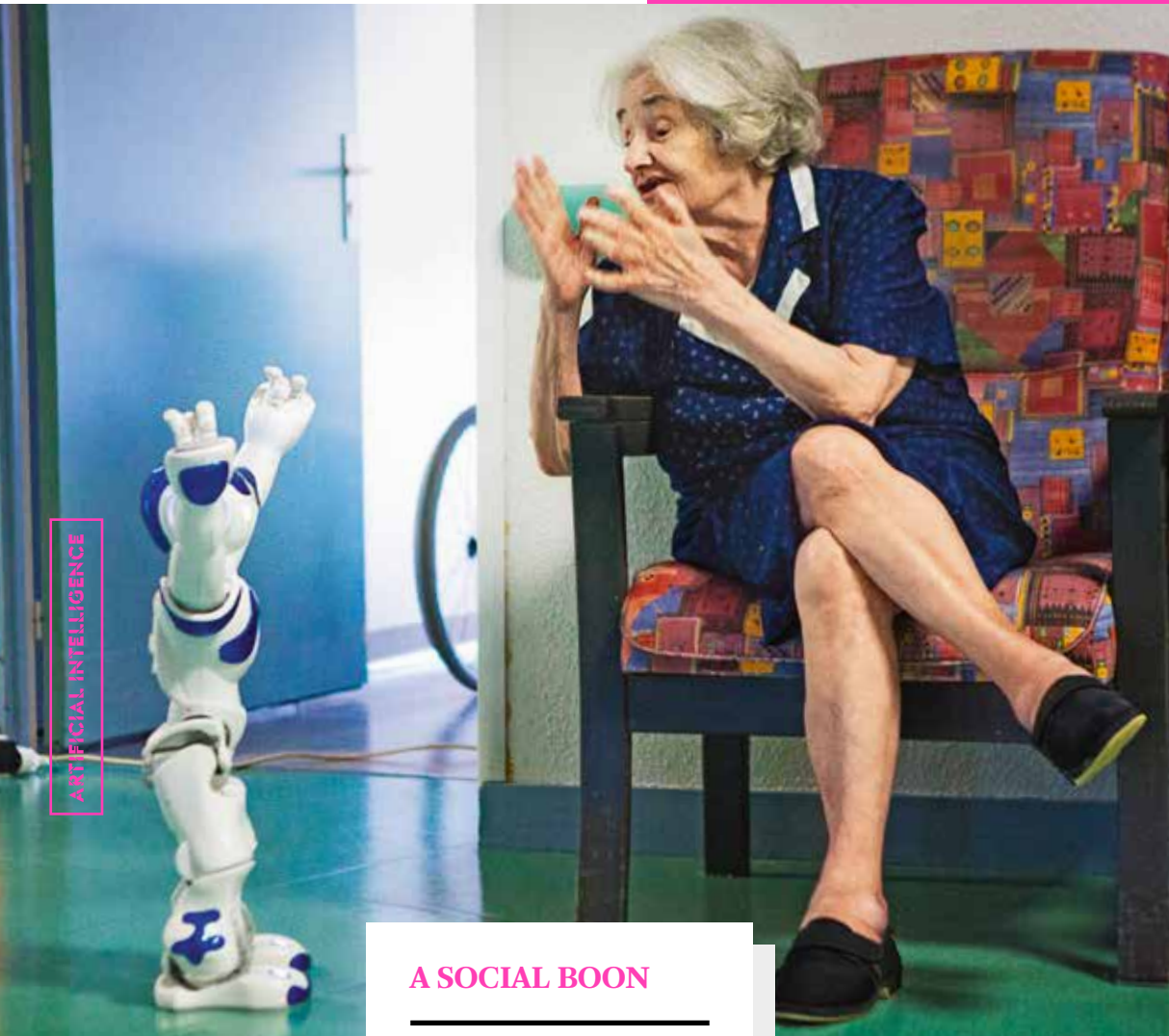


TAKING CONTROL

→ ON THE FLIGHT DECK

Autopilot systems aren't new in aviation. The US Department of Defense has developed the Aurora Flight Sciences' Aircrew Labor In-Cockpit Automation System (ALIAS), which may soon eliminate the need for pilots altogether. Ford identifies a key question here: "There are very real issues concerning the ethics of using autonomous systems in military applications."

ARTIFICIAL INTELLIGENCE



A SOCIAL BOON

→ IN ELDER CARE

The Zorobot is a personal robotic caregiver designed to work with the very young and the very old. It has also found a place working in the hospitality industry. But while you may encounter it pointing the way to your hotel room in the near future, some have found their way into elder care facilities where they seek out and interact with residents and even lead exercise classes.

ARTIFICIAL INTELLIGENCE

A SAFETY NET

→ ON DANGEROUS DIVES

The OceanOne robot went on its first dive to a 17th-century shipwreck in 2016. Stanford's high-fidelity, bimanual underwater humanoid robot with haptic feedback recovered countless artifacts, while its human controller sat safely on deck above. It is hoped the robot will take on underwater tasks too dangerous for humans and open up a new realm of ocean exploration.



PHOTOS: AMELIE BENOIST / BSIP/MAURITIUS IMAGES; OSADA / SEQUIN / DRASSM

ARTIFICIAL INTELLIGENCE



MAKING IT HAPPEN

→ AT THE CHAMPIONSHIP

Brain-computer interfaces, robot prostheses and powered exoskeletons were all part of the bionic assistive technology seen at the Cyathlon in Zurich in 2016. Physically impaired athletes from 25 countries took part in six races that put bionic technology to the test, but it wasn't just athletes taking home the gold that day: The companies that produced their tech were also awarded medals.



GROWING CHANGE

→ ON THE FARM

This robot is sweeping food towards dairy cows, shown here at Berlin's 2017 International Green Week food and agriculture fair. But what will happen to the milkmaid? It all raises questions of inequality, unemployment and the idea of a universal basic income. As Ford reminds us: "Our challenge is to build an inclusive future in which advances in AI and robotics benefit everyone at every level of our society."

Imitating the Mind of a Child



What if a machine could learn to explore the world like a child? That's the question at the heart of the next wave of research in artificial intelligence.

BY **Hal Hodson**

ILLUSTRATIONS BY **Sarah Illenberger**

FACEBOOK'S NEW YORK OFFICES are stacked at the top of a pretty building at 770 Broadway. Inside, rows of monitors stretch into the distance and cast-iron staircases wind up and down between the floors. Dotted with coffee shops and comfy sofas, the space has the feel of a high-end department store. But instead of shop assistants, it's packed with computer scientists. Welcome to FAIR (Facebook Artificial Intelligence Research) lab, where the social network's most advanced artificial intelligence software is built.

Facebook first demonstrated this power, referred to interchangeably as "machine learning" or "artificial intelligence," in early 2016. The company's team working to bring the internet to people in developing countries was having a problem: It didn't know where these unconnected people were. Maps are often out of date, failing to reflect population growth and where internet coverage is needed, and new maps are prohibitively expensive to produce with human labor. So Facebook tried something different. It used AI to draw maps of 20 different countries automatically, using satellites. After Facebook's machine learning systems were shown what settlements look like from space, they could then proceed on their own, churning →

through masses of imagery to build maps faster than any human or team of humans ever could.

Such feats of work are a testament to modern machine learning. But for all its power, Facebook's world-mapping AI has a severe weakness – it did not understand what it had done. If asked to explain itself, it wouldn't even understand the question. Unlike a human, Facebook's superhuman mapping system is completely incapable of even ordering a cup of coffee, let alone speaking French or shooting hoops. This is typical of modern artificial intelligence, which is built around a technique that apes the human visual system: deep learning. Data can be used to train a machine to solve one very narrow task to extremely high levels, but that trained mind is then completely inflexible, unable to turn itself to anything else.

THE SALVES FOR THIS INFLEXIBILITY, it turns out, are a four-minute walk from Facebook's offices, at the NYU Center for Child Language. Gary Marcus, a psychology professor at the university, thinks that the blueprints for more flexible artificial intelligence can be found in minds with which humans are already very familiar: those of children. "The amazing thing is that kids can learn a language in a few years with a modest amount of data," says Marcus. "Kids are doing this in a way that seems almost impossible from the perspective of modern machine learning." Marcus has long advocated for more nuanced alternatives to deep learning, and now other luminaries in AI are starting to see things his way. Geoff Hinton, the founding father of deep learning, sent a shock through the AI community when he told attendees at a Toronto AI conference in September that he has become suspicious of the deep learning methods on which his career is built. "My view is throw it all away and start again," *Axios* editor Shannon Vavra reported Hinton as saying. "The future depends on some graduate student who is deeply suspicious of everything I have said." For Marcus, this admission is past due. "What I see over and over is progress over narrow domains of AI. The way it works right now is that people get a large amount of data for a very specific problem and they get a solution for that problem as long as the problem doesn't change."

98.9%

The highest rate of accuracy achieved in Kaggle's Dogs vs. Cats competition in 2014, an open challenge to write an algorithm to classify cats and dogs in a set of unlabeled photos.

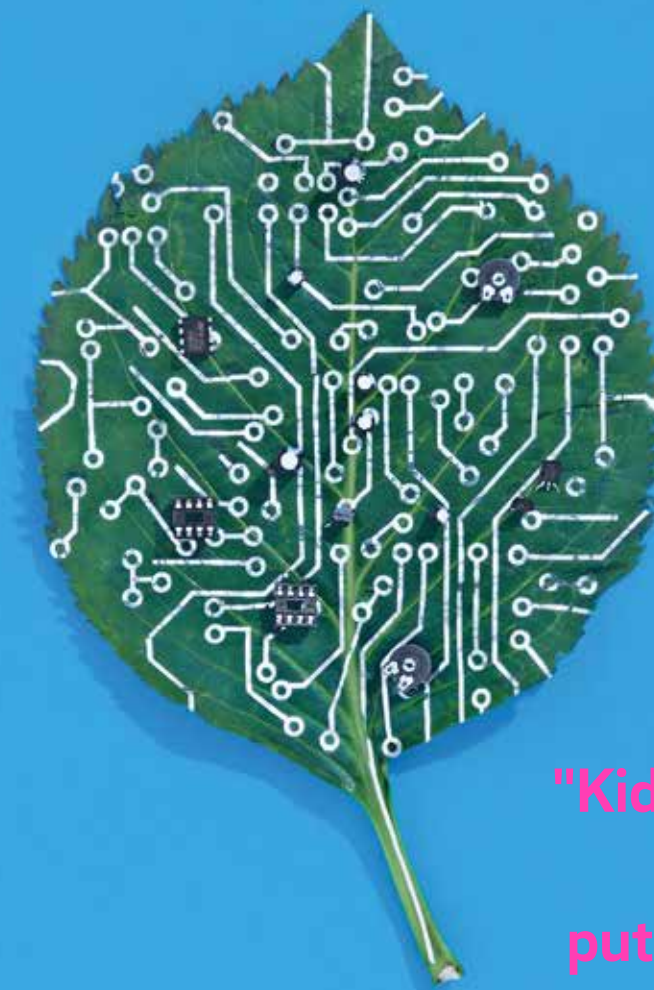
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thousand images of cats and dogs were given to participants to use as the data set. It poses the question: How many animals would a child have to see before being able to tell the difference?

Deep learning has already delivered astounding results, and the popular press and the tech world is understandably enamored. That's reasonable; intelligence is what has allowed humans to become the dominant species on this planet, and capturing any small slice of it in software is naturally exciting and useful. Marcus' point is that deep learning is just one small way in which machines have the potential to be intelligent. Given the power and potential of intelligent software, the world should be pressing ahead and looking for new kinds, not just busily installing deep learning algorithms. "I would not talk about what comes after deep learning, but about how deep learning needs to be extended to help us build human-level AI," says Yoshua Bengio, one of the founding fathers of deep learning and a computer scientist at Université de Montreal.

Figuring out new kinds of algorithms is hard. It took decades for Hinton and a small band of devotees to take deep learning from fringe science to the heart of the tech industry. Algorithms modeled on other kinds of thinking will take time too. "Kids just observe the world and they put together themselves how language works," says Marcus. The problem is that we know very little about the human brain. Danko Nikolic, an AI expert, says that we don't yet understand how humans learn. "I think we need a breakthrough in neuroscience and psychology to create better AI," he says. "We are a bit like scientists studying physical phenomena before Newton and the scientific theories of the 18th, 19th and 20th century," says Bengio. "We are lacking strong compact and global theories, but we are drowning in a sea of observations."

THERE ARE HINTS, HOWEVER. Marcus is currently developing a second AI startup, as yet unnamed, to pursue new algorithms. His first, Geometric Intelligence, was acquired by Uber in 2016, to kick-start its AI efforts. "We are still in formation, so we haven't launched yet. I don't want to say too much. But we're definitely interested in this problem of bringing together new technologies to build hybrid architectures that are better equipped to relate knowledge and perception. Instead of just focusing on how brains process information, it →

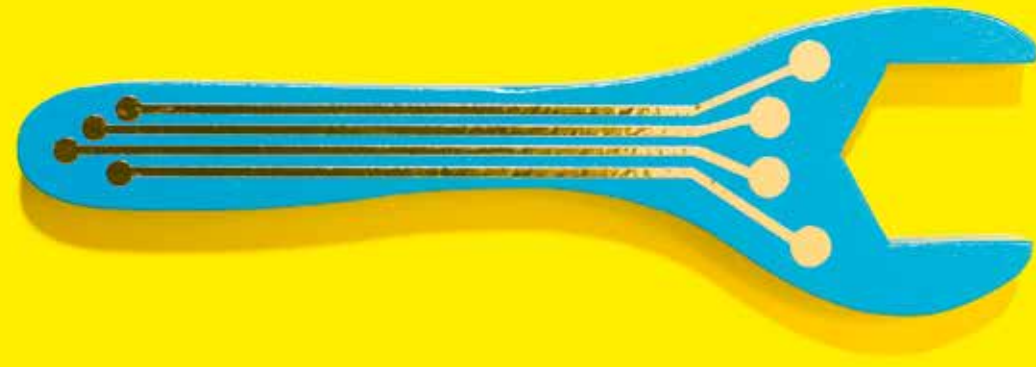


"Kids just observe the world and they put together themselves how language works."

Gary Marcus, Professor of psychology at NYU

"In the future, the network architecture will be changing fluidly several times per second, depending on the inputs that just passed by."

Danko Nikolic, Professor at the Max-Planck Institute for Brain Research



may be fruitful to look at how human beings end up being born with the equipment, mental and physical, to make sense of the world. Children seem to be born knowing that objects persist in space and time," Marcus says. To create machines that come equipped with useful abilities off the bat, rather than having to learn them from piles of data, some are turning to another powerful idea from biology: evolution.

Marcus' co-founder at Geometric Intelligence, Kenneth Stanley, imagines artificial minds of the future will be bred rather than trained. This works by generating many hundreds of deep learning systems, each with random characteristics. They are then set to work at a task, like learning to walk a robotic body without falling over, for instance. At first, almost all of these artificial minds will perform very badly. But a couple will excel. From these, a whole new set of descendent minds are

100 billion

is the number of neurons in the human brain. At present, it is possible to measure only 700 neurons concurrently – which gives an indication of how little is known about the workings of the human brain right now.

generated, and the process begins anew. The eventual goal, after many repetitions, is to evolve deep learning systems that are suited to particular tasks from the get-go, just as children are evolved to learn language very early in their development.

In July, researchers from DeepMind, Google's AI research arm based in London, presented a system called PathNet to a conference on evolutionary AI held in Berlin. PathNet trains normal deep learning systems to play video games, but then forces components of those trained systems to compete against each other to try and solve other tasks. This ability to transfer learning is key to creating artificial intelligence which can easily switch between tasks, as humans can, needing less data to learn new abilities.

Jean-Michel Cambot of Tellmeplus, a French AI firm, has a similar system. He uses older, more straightforward mathematical AI systems to test

multiple machine learning systems against each other to see which performs best, an approach he calls "meta active machine learning." He says that a large aircraft maker is already using the system to search their production lines for flaws faster than human inspectors could, saving money on dud parts. Nikolic suggests future AI systems will be able to learn and adapt on the fly, based on new data they encounter in the world, just as humans do. "After the training, the networks today stay fixed: You have one and the same network running in production," he explains. "In the future, the network architecture will be changing fluidly several times per second, depending on the inputs that just passed by."

WORK HAS BEGUN in getting deep learning systems to explore the world as children do, poking and pushing at objects and learning from what happens. Research published at the International Conference on Learning Representations in April 2017 showed the first design of a system which used deep learning to make guesses about the mass and number of objects in a simulated environment. Through trial and error, the system learned to estimate an object's mass, or to estimate the number of objects in a scene.

A growing swathe of research like this aims to create artificial intelligence built to human needs, AI that understands more of what we might ask it to do. Marcus likens deep learning's current foreignness to a chimpanzee's mind, which is evolved for life in the forest rather than life in human society. "You can raise a chimpanzee in a human environment but it will never learn language," says Marcus. "I think that's because the learning mechanisms, the machinery for learning is different in a chimpanzee from others." Marcus expects that the current focus on deep learning will wane when it fails to create a safe driverless car, or build home robots, and realize that existing AI techniques are just not enough. "At some point people are going to want something like domestic robots," he says. Current AI doesn't have a hope of providing that. Machines with more childlike minds might. ■

→ Using contributions from Neelima Mahajan.



Intelligence in animals

Neural networks, the building blocks for the deep learning techniques which have taken the tech world by storm, are modeled on a rough picture of how the human brain processes visual information.

But, what about other brains? In a paper published in the journal *Cell* in June, DeepMind boss Demis Hassabis and colleagues wrote that a better understanding of biological brains – human and animal – has a big role to play in forging more intelligent artificial ones.

The paper gave two reasons to intertwine biological and artificial neuroscience. First, if biological computing structures can be linked to some useful cognitive function – memory, for instance – then the form of that structure is a likely candidate for use in AI. Second, biology also offers a way to validate the promise of existing AI algorithms. "If a known algorithm is subsequently found to be implemented in the brain, then that is strong support for

its plausibility as an integral component of an overall general intelligence system," Hassabis wrote.

An octopus, for instance, houses much of its grey matter in its arms – each of the eight can act independently and intelligently. These alien brains can solve problems at similar levels to chimpanzees, but have arrived at that level of intelligence via a different evolutionary route. Learning about what kinds of features octopus intelligence picked up along the way might unlock new possibilities for AI.

At Lund University in Sweden, researchers have figured out that even ravens and their "bird brains" can plan in a general sense, figuring out not just how to store their food, but how to use tools and do other tasks that have nothing to do with their ecological niche. This field of "cognitive zoology" is relatively young. Who knows what useful algorithms may lie in the minds of animals, so long considered inferior to us clever humans.



SMARTER THAN THE AVERAGE TODDLER?
Some birds have shown signs of being able to plan.

The New Melody Makers

LILTING PIANO INTRODUCES

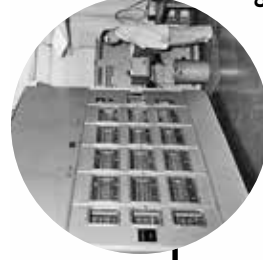
THE SONG. It's a pop song much like any other: For-boding percussion joins in for the first chorus, an acoustic guitar gradually changes the texture of the music and for just short of three minutes, it builds to its climax. You wouldn't raise an eyebrow at hearing it on the radio, in a shop, in a bar. Yet *Break Free* by Taryn Southern is also a pop song unlike any other.

Break Free comes from Southern's upcoming album IAMAI, the first mainstream pop album on which every single musical element, bar Southern's lyrics and vocal melodies, was provided by artificial intelligence; every note of instrumentation was composed by a program created by the US tech firm Amper Music. What's surprising isn't that this has happened, but that it has taken so long to happen. It's already been 60 years ↗



AI: keeping time

AI has been in music for decades – long before terms like Auto-Tune and apps like GarageBand entered the public lexicon. But from the very first experiments to the first fully AI-written pop song, human visionaries were there to spot the potential.



1957

Composers Lejaren Hiller and Leonard Isaacson unveil *Illiac Suite*, a string quartet composed by the ILLIAC computer at the University of Illinois. They set certain parameters – for example, an ostinato eight-note pulse as the rhythm. Then the computer assigned the pitches.



1980

Composer David Cope, suffering from writer's block, turns to a computer for help. He becomes obsessed with the possibilities and in 1993 releases *Bach By Design*, an album made by a computer programmed to replicate Bach.



2016

Sony CSL Research Laboratory makes the first pop song created by AI. *Daddy's Car* was not without human stylistic input, however – arranged and produced by Benoît Carré, it was designed to sound like the Beatles.

PHOTOS: COURTESY OF THE UNIVERSITY OF ILLINOIS ARCHIVES; DAVID COPE; SIPA / ACTION PRESS

PHOTOS: STEVEN SENNE / AP PHOTO / PICTURE ALLIANCE; EAMONN MCCABE / REDFERNS / GETTY IMAGES



1965

The 17-year-old Ray Kurzweil – later an eminent inventor and futurologist – plays the piano on the US TV show *I've Got a Secret*. His secret: The piece he played was composed by a computer he had built.



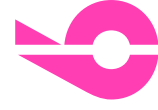
1996

Musician and composer Brian Eno releases the album *Generative Music 1* made using SSEYO Koan software. "Generative" was used to describe system-generated music that would change each time it was played.

But what comes next? Will *Break Free* be an oddity or will it prove the harbinger of music's next great revolution? "Few people argue that AI music will be indistinguishable from human-created music in 100 years, or sooner," Silverstein says. Finer points out that so much of what we take for granted in pop music – programs such as Auto-Tune that pitch a singer correctly even if they can't hit the note or the GarageBand app that enables kids to form bands without being a musician – mean computers are already deeply embedded in pop.

It's one thing, of course, for Amper to create *Break Free*. But will AI ever be able to create its own *Like a Rolling Stone* or *Purple Rain*, or any of the songs where the genius of the creator is as important as the songs themselves? "I firmly believe we, as a human society, will forever value the creation and expression of art; it's core to our human existence," Silverstein insists.

So it seems the Bob Dylans, Adeles and Beyoncés aren't on the way to being phased out. Not yet, anyway. ■



short pieces of music are the components for artist Jem Finer's *Longplayer*. The sections are played by computers to a set of rules and create a piece of music that will play without repetition for 1,000 years.

data, processing power and models have led to more success, which leads to more funding, which leads to more expertise being drawn in, which in turn means there are more improvements in models and data and processing power. I think we will all be very surprised by how things continue to improve."

Then comes a philosophical question: What is music? Is it just a series of notes, or is it a reflection of humanity. Jem Finer, creator of *Longplayer* and *Score for a Hole in the Ground*, two installations that create music without the need for human input after an initial setup, and formerly of the folk-punk band The Pogues, says: "It's both things. When I write a computer program that spews out loads of notes that are filtered into some semblance of composition, the machine's doing that of its own accord. But it's only doing that because I've told it to. It's an expression of humanity."

There are a variety of reasons that AI music is becoming commercially viable now, suggests Ed Newton-Rex, the CEO of Jukedeck. Firstly, cheap, mass-produced AI music has a market owing to the growth of digital media. Then there's the technology itself: The availability of more data, the increased processing power to deal with that data, and the way these allow "neural networks" to become more efficient in replicating the workings of the human brain. It's now become a virtuous circle, he continues. "Improvements in



JOURNALISTS VS. ROBOTS

The Struggle to Keep Up

BY Wolfgang Zehrt

ARTIFICIAL INTELLIGENCE

ARTIFICIAL INTELLIGENCE

ICON: MIKE ASHLEY / THE NOUN PROJECT

If you think disruption of the media business is old news, think again. It's only just getting started, and the largest threat – or opportunity, depending on how you look at it – is looming within sight: robot writers.



ASK ANYBODY to describe a journalist to you and you'll get as many answers as the people you question. The stereotype fits a number of images and descriptions: There's the US cliché of a trench coat-wearing scribbler in a trilby hat with a press ticket in the band; then there's the hard-playing, hard-drinking hack of London's Fleet Street; and what about the fearless seekers of truth all over the world who are prepared to die – and sometimes do – to get their stories out? However tenacious they are, though, we all think of journalists as human beings, and that the role they play is a vital component in a functioning democracy: speaking truth to power and promoting freedom of thought as well as speech.

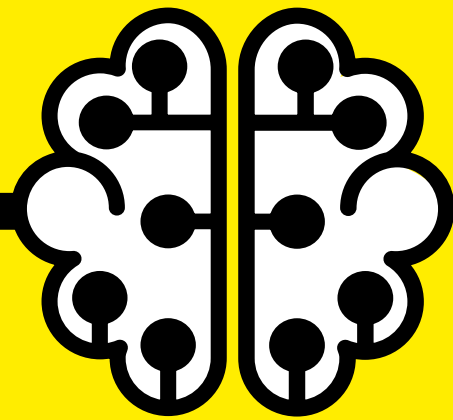
In recent years, however, there seems to be an ever-growing set of conditions that threaten to damage the fourth estate, the way journalism works and those sweating over their keyboards. The disruption of the business model with the advent of the internet and digital publishing was one such threat. The specter and accusation of "fake news" striking at the integrity and trustworthiness of the media was another. But added to these is a new and possibly much more mortal threat. It isn't so much about business or about how the news is delivered – online, print, mobile – but more about how the news is *written*. How it is produced. How it is generated.

According to a recent BBC news report, by 2022 some 90% of all news content will be written by "robots." Digitization and the rapidly increasing amount of data it has made readily available is enabling large parts of today's reporting to be

created by a computer: the weather, football and stock markets have been the first areas in which "natural language generation" programs have been able to deliver good, readable stories.

Today, a computer at the Norwegian NTB news agency even writes a large proportion of its election reporting. That said, editor-in-chief Mads Yngve Storvik stresses that he can't see a robot being able to conduct an interview any time soon. At the US news agency The Associated Press, a computer already produces 10,000 economic and baseball reports every month. And under new owner Jeff Bezos, billionaire founder of Amazon, *The Washington Post* is rapidly developing a new content management system (CMS) that has put automated content generation at its heart right from the get-go.

Robot journalism will likely lead to thousands of media job losses around the world. However, it might not mean that all is lost for the journalists who can find the right way through. Investigative stories such as *The Panama Papers*-style reports, or outstanding portraits and profiles – the kind of content that differentiates a publication from its competitors – could thrive in this new media age. No matter how good, a stock market report will never win any journalism prizes, whether it was written by a robot or a human. Leaving aside such specialist reporting, though, can the news media become fully automated? The dream might be for day-to-day, high-frequency and personalized news business to be handled by computers that never need to stop for breaks, but will it always need that special human touch? What about the questions of judgment and tone? →



According to a recent BBC news report, some 90% of all news content will be written by "robots" by 2022.

10

thousand economic and baseball reports are produced by a computer at US news agency The Associated Press each month.

While machine learning already works well when it comes to replicating the style and voice of very specific media (tabloid, serious, B2B), artificial intelligence still finds it difficult to summarize the most relevant messages from documents and data if a human has not previously provided examples to explain what the key findings might be. Software has so far not had the world knowledge to realize, for example, that a rate drop of more than 3% in a day would normally be unusual for a stock market heavyweight such as a major auto manufacturer, but that it may well occur in conjunction with new revelations such as a diesel scandal. However, software can now look for a suitable quote from analysts on precisely this rate trend and can incorporate it perfectly, both in terms of content and language. This is something that would have been unthinkable just a year ago.

The robot journalist is getting ready for the next step in its evolution, but its human colleagues still have to tell it which subjects are worth writing about and what data should be used. That could soon change. It is already employing relatively simple-to-use algorithms to automatically work out topics that take into account the frequency of keywords in internet searches while cross-checking the potential theme against the intensity of discussion of the event on social media. Current topics that are shaping opinions can thus be identified with a great degree of reliability: The robot simply has to track down images from databases using the right keywords. Fully automated video content could also be created in this way.

THERE IS ANOTHER SIGNIFICANT REASON for developing fast new media content that is rapidly updated. Thomas Scialom, a researcher at the French natural language generating startup Récital, put his finger on it: "Mobile media use means that there are ever fewer visual aids to help readers understand content, and the amount of information is also limited by the size of the screen. At the same time, the time spent reading content on a mobile is also falling." Shorter information, written specifically in the tone of the target audience and with personalized, targeted content – that's not something a human

writer can produce, but an AI journalist can. For example, why should someone read a report about all of the Nasdaq rates if you only need a report on trends for Apple shares? Could a graphic provide that information? Automated text generation can do far more: The report on Apple shares can not only summarize historic trends, but also provide rankings – is it only Apple shares that are under pressure today, or is the trend also affecting China's Tencent? Is Amazon on the up and Alibaba plummeting? Does it have something to do with the start of the vacation in the US or China? Has disappointing economic data been released? The more sources that are used, the better an article will be than a graphic.

Anglo-German business news agency dpa-AFX was one of the first to develop a template solution: It was simply a case of filling in the gaps in pre-written sentences with new data. The sentences provided today are much more varied and sophisticated, but this basic principle is only slowly being replaced. Hamburg-based computer linguist Patrick McCrae explains, "The perfect solution for content automation must consequently not only have extensive opportunities for language diversification, but also have the ability to incorporate powerful analysis. Text generation will not progress far beyond the dynamic filling-in of gaps in the

texts unless artificial intelligence is involved. Truly interesting texts with diverse content will be created if surprising, non-trivial findings can be extracted from the relevant data sources. That's exactly why we need artificial intelligence." Here's a powerful example: One German digital publisher can generate a view of the monthly employment and training markets at the touch of a button for 411 regions across Germany, focusing on different professional groups or levels of education, if desired. The software makes discoveries in the mountain of data with each analytical pass that a human editor would have only spotted by chance, if at all.

BUT THE BIGGEST CHALLENGE in this relatively new world of automated writing, and one that is causing even the likes of Google and IBM's Watson to thrash their disks, is free text creation written from flowing text sources, and not just from data stored or handled in a particular way. McCrae frames the problem clearly: "Automated text comprehension without any limitations in terms of the subject is a problem that computer science has yet to solve."

Yet if the problem were to be solved, it would deliver a great prize: a kind of perpetual media motion where new texts could be created with a seemingly endless output of flowing text. It could be the salvation for news agencies, which could start with one single text created by software and then turn it into 120 different versions for 120 newspaper customers. But will software be capable of understanding flowing text, including irony, sarcasm or annotations? Scialom sums up the problem quite simply: "The biggest challenge is currently getting machines to understand unstructured data." Once this challenge has been met, only a small band of journalists will be relevant, likely writing highly specialized and unique contributions for which readers around the world will be willing to pay a decent price. We will just have to wait to see what publications will have survived for them to be writing them for. ■

Wolfgang Zehrt is a Berlin-based journalist and consultant for automated content.

Unexpected: Young adults unsettled in parts of economically strong Bavaria

While youth unemployment throughout Bavaria is on an historically low level, it remains unchanged at a high 16% (August 2017) in Lower Bavaria (Munich: 2,9%). This is particularly noteworthy because Lower Bavaria is on a good second place regarding to employment rates in the state of Bavaria in general.

Although the start of the new training year in September will decrease the rate, the Lower Bavarians will still be in last place in youth unemployment. This, obviously, also affects the consumption of young adults.

While the research institute GfK expects a further increase in consumption expenditures for all of Germany, there are other signals from the young adults in Lower Bavaria. For example, cars defined as typical "beginner cars" remain an average of 9 weeks longer than the previous year at the used car dealer. The explanation cannot be that younger adults buy more new cars, because in the starter price class up to 16,000 Euros, the approval numbers in August have fallen by almost 20%.


A similar picture emerges in the demand for low-priced single-apartments: while comparable apartments have been offered on the market for an average of only 7 weeks in the

last 5 years, now it is already 11 weeks. According to the latest official survey for 2014, the Lower Bavarians came to an annual income of just under 21,000 euros. In neighboring Oberbayern, household net income is significantly higher, at around EUR 25,000.

This part of Bavaria is particularly dependent on the automobile industry. At the Dingolfing-based BMW factory, some 18,000 employees produce up to 1,400 vehicles per day. With around 6,500 employees, the automotive supplier ZF Passau produces systems for the automotive industry, while the automotive supplier Dräxelmeyer has 6,000 employees. At these factories, for example, job openings for job applicants have fallen by almost 30% in the past 12 months.

Lower Bavaria is losing an above-average number of young residents from some parts of the state, even though the population will remain stable overall. In the 19-25 age group, which is particularly important for employers, there is a clear warning sign: from today's 89.1 the proportion of these entrants will reduce to 72.7 out of 1,000 persons within next 10 years (Statistisches Landesamt). Only a few bigger towns in this part of Bavaria will remain unaffected by this development.

THIS ARTICLE WAS WRITTEN ENTIRELY BY AI AUTOMATION, without any human intervention or correction during or after the writing process. Human input involved finding data sources and instructing the machine how to analyze them. An analytical piece like this can now be written without supervision – additional data sources can be added simply to expand the scope of the article.



New Laws for Machines to Live By

ARTIFICIAL INTELLIGENCE

ARTIFICIAL INTELLIGENCE

With the breakneck pace of experimentation happening in the field, artificial intelligence is fast becoming something of a Pandora's box. Though the technology is in its infancy, examples are already emerging that suggest the need for regulation – and sooner rather than later.

BY **Dan Matthews**

ILLUSTRATIONS BY **Tavis Coburn**

EXPERTS, 116 OF THEM from the fields of artificial intelligence and robotics, wrote a now celebrated and frequently quoted letter to the United Nations in August. In it, they warned of the prospect of autonomous weapons systems developed to identify targets and use lethal force without human intervention. Signatories included the great and good of AI, including Tesla boss Elon Musk and Head of Applied AI at Google DeepMind Mustafa Suleyman. The letter anticipates a "third revolution in warfare" that could change conflict to the degree that gunpowder did. It states autonomous weapons "will permit armed conflict to be fought at a scale greater than ever, and at time-scales faster than humans can comprehend." This, coupled with the risk of systems being hacked or falling into the hands of despots and terrorists, provides grounds for an early global ban.

If "intelligent" weapons sound like science fiction, they are not. Around the same time as the technologists penned their letter, Kalashnikov Group – famous for its eponymous machine gun – unveiled a formidable-looking AI cannon. The company says its "fully automated combat module" can spot and kill a target without a human finger on the trigger. This raises complex questions, both ethical and practical, about what limits should be placed on AI. Should robots be trusted to make decisions? Would their choices be better than human ones? Even if democracies curtail development, will authoritarian regimes follow suit?

Whatever the answers, they need to address not just military scenarios, but every other sphere in which AI could impact society: health care, transport, government, legal and medicine, to

name only a handful of areas where the technology is already being developed. And the answers need to come sooner rather than later.

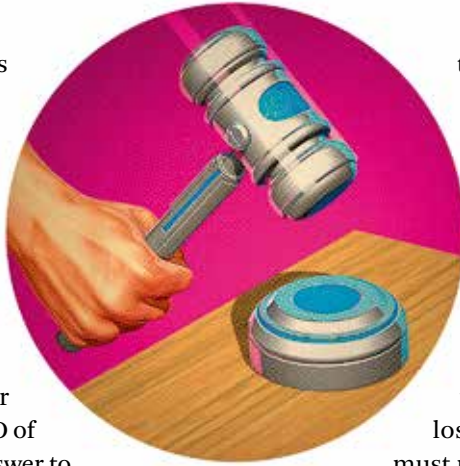
THREE-QUARTERS OF A CENTURY AGO, science fiction author Isaac Asimov provided a useful starting point for the governance of AI with his Three Laws of Robotics: Robots may not injure a human being, must obey orders (unless they go against the First Law) and must protect themselves (unless to do so conflicts with the First or Second Law).

But even these simple rules will encounter difficulties when applied in the real world, according to Greg Benson, professor of computer science at the University of San Francisco. Take autonomous vehicles. "A self-driving car might have to decide between potentially harming its passengers or a greater number of pedestrians. Should the car protect the passengers at all costs, or try to minimize the total harm to humans involved, even if that means injuring people in the car?" He points out that if people knew autonomous vehicles were coded to treat their safety equitably with other road users, they probably wouldn't buy one.

Two main challenges now face policymakers and non-government organizations wrestling with governance. One is AI's moral maze and the infinite scenarios that are still to be addressed; the other is the rapid speed of technological progress. "Computer technology has advanced at such a rapid pace that government oversight has not been able to keep up," says Benson. "To build a bridge you must be a licensed mechanical engineer; however, software developers require no such license to work on many types of systems that can affect human life." →

SOME EXPERTS BELIEVE regulation needs fine-tuning, but not necessarily wholesale change. Firstly, because blocking AI would stifle innovation and, secondly, existing laws are flexible enough to cover the foreseeable future. If a person fires a gun and it injures someone else, that person is culpable under law – not the gun or its manufacturer. The same applies to a line of code. As Babak Hodjat, the inventor behind the Apple Siri technology and CEO of Sentient Technologies, explains: "The answer to the question whether a robot is capable of committing a crime can only be 'yes' if we assume a 'self' for an AI system. If we do not allow this, and such an allowance is completely up to us humans, then robots cannot ever commit crimes." If we can say for certain that humans will always be responsible for the actions of robots, then existing laws can be adapted to cover new threats. But if it's possible to breathe life into robots, equipping them with emotions and morals, the game changes and regulators will have to work a lot harder.

Most AI works via structured algorithms, which provide systems with a defined course of action in response to a set of variables. But one branch of AI, neural networks, has been developed to mimic a biological brain and works without



task-specific programming. "When a software is written, programmers are usually able to retrace its functioning, which is not the case with neural networks," explains Jean-Philippe Rennard, a professor at the Grenoble Ecole de Management whose work focuses on biologically inspired computing and its application in economics and management. "We do not really understand how they reach a result. This loss of comprehension – and of control – must persuade us to be prudent. How could we control tools with functioning we only partly understand? If the threat is not imminent, it will certainly exist in the future."

THERE IS EVIDENCE that action is required even at a more prosaic level. Big data and machine learning – the latter is a subset of AI – were employed during general elections in the US and UK to gauge voter sentiment via social media and influence voting patterns on a grand scale. Does the systemic nature of this emerging tactic constitute voter manipulation, especially when set in conjunction with so-called "fake news"? The answer to that question has profound implications for modern democracies, especially if foreign powers can intervene. "AI already provides a significant competitive advantage in its ability to understand customers in the business world," says Scott Zoldi, chief analytics officer at analytics software firm FICO. "In the political arena, it has an ability to sway public opinion or garner support for a candidate and their agenda. Each of us leaves huge digital footprints, which allows algorithms to classify us into archetypes. This amount of data is incredibly valuable to understand how to best reach, persuade and convert voters and the public."

YET ANOTHER DIMENSION is the role human workers will play in an AI world [see article p. 28]. Experts are split on whether this will spell mass unemployment and perhaps the need for a universal basic income, or augment what people already do and provide new opportunities in more creative fields. Daniel Kroening, CEO of Diffblue and professor of computer science at Oxford University, says a universal wage won't happen: "It is a shibboleth of technology that every technology revolution promised that humans would be freed from the burdens of employment. The more advanced the society, the harder everyone seems to work." Rennard,

however, argues that a future universal wage is "a self-evident fact, which is partially rejected because of social inertia."

BUSINESSES AND COMPANIES, NOT POLICYMAKERS, are taking the lead in directing AI's growth – and they are making efforts to show responsibility. Google, Microsoft, Facebook and Amazon created the Partnership on AI to Benefit People and Society in September 2016 to guide innovation toward positive outcomes in climate change, inequality, health and education. Yet successive examples hint that solid regulation could be required soon. In July 2016, a Tesla engineer was killed in a crash involving an experimental autonomous vehicle; earlier in the year Microsoft released an AI chatbot on Twitter that quickly spouted racist and violent language. And Baidu found itself entangled with the law after its CEO tested a driverless car on public roads.

Many experts agree action is needed and that regulators are playing catch-up. In July 2017, Elon Musk told a gathering of the US National Governors Association: "By the time we are reactive in AI regulation, it's too late.... Normally the way regulations are set up is when a bunch of bad things happen, there's a public outcry, and after many years a regulatory agency is set up to regulate that industry. It takes forever. That, in the past, has

been bad but not something that represented a fundamental risk to the existence of civilization." Yet, questions remain over who should regulate, what must be covered and how the mechanics of global governance will work.

Harry Armstrong, head of technology futures at innovation foundation Nesta, says the only substantial regulation relating to AI is enshrined within the EU's General Data Protection Regulation (GDPR), due for implementation in May 2018. It stipulates that someone who is made subject to a machine-made decision also has the right to an explanation by a human, but Armstrong argues the language used within the GDPR is open to interpretation. Nesta has proposed a Machine Intelligence Commission to build a better understanding of AI's impacts. "Its work would look at key sectors like transport, employment, health and finance to make recommendations to existing regulatory bodies and government departments about potential risks and abuses," says Armstrong.

Governance is never an easy thing to get right, but while regulators at the local, national and global levels chew over the societal ramifications of a world driven by AI, technologists are racing forward at breakneck speed. Kroening sums up the challenge ahead. He urges lawmakers to "hurry up and get more people thinking about the implications, which are almost endless." ■



companies and institutions are involved in the Partnership on AI to Benefit People and Society. They range from online and tech giants such as eBay and Sony to Amnesty International and the ACLU.

ARTIFICIAL INTELLIGENCE

ARTIFICIAL INTELLIGENCE



"Whether a robot is capable of committing a crime can only be 'yes' if we assume a 'self' for an AI system."

Babak Hodjat, Siri inventor and CEO of Sentient Technologies

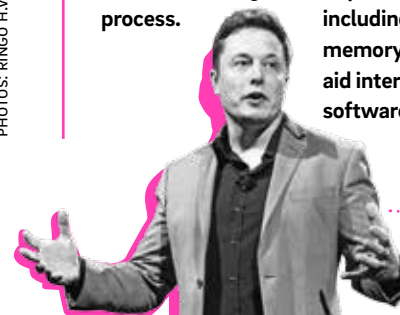
PHOTO: DAVID PAUL MORRIS / BLOOMBERG / GETTY IMAGES

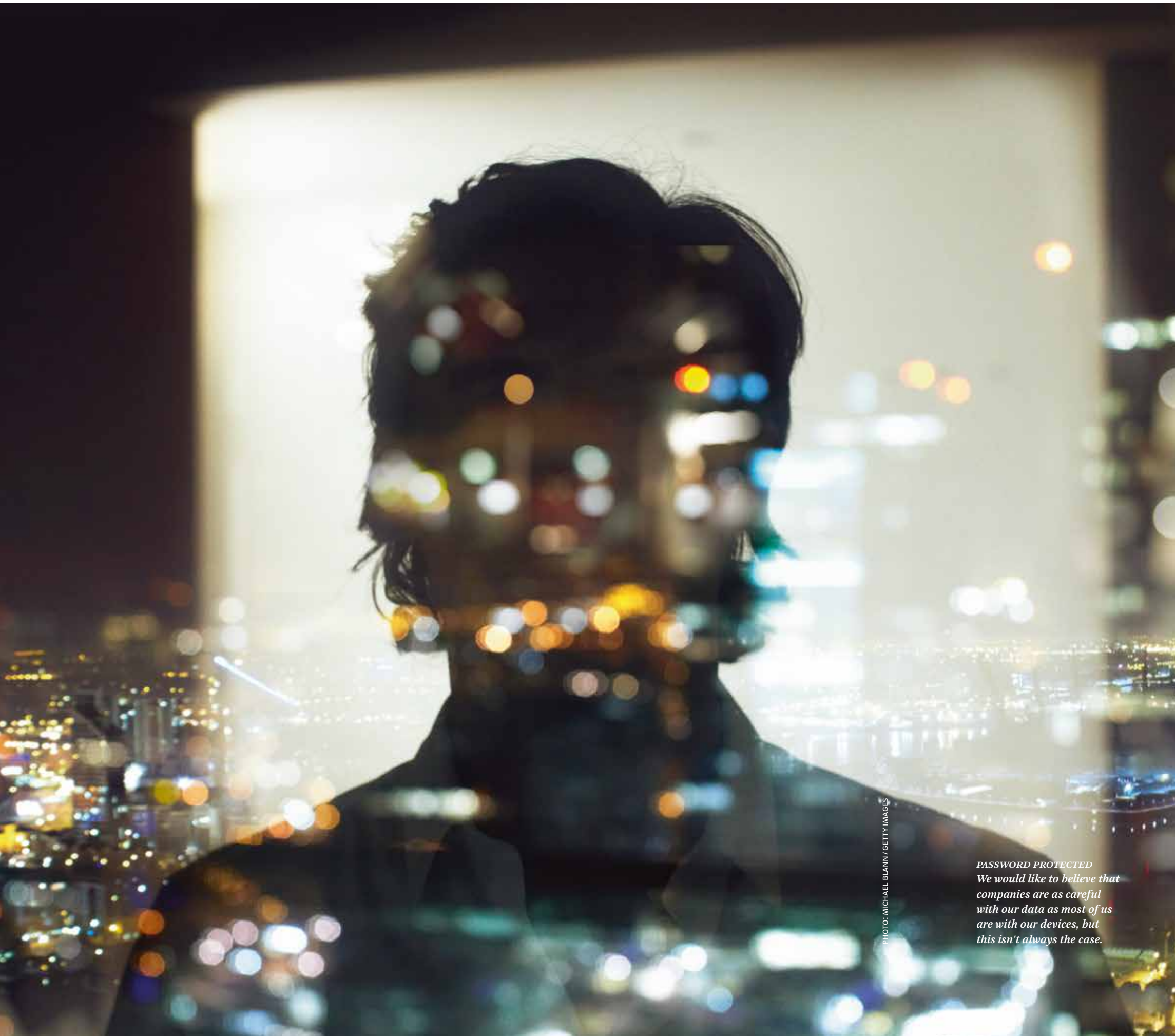
PHOTOS: RINGO H.W. CHIU / AP / DPA; CHRISTOPHE MORIN / BLOOMBERG / GETTY IMAGES; LABSIX / MIT



One year in AI: new initiatives and the challenge for regulators

- **JANUARY 2017**
Researchers at the Alan Turing Institute call for the creation of a neutral regulatory body to monitor the uses of AI by companies and investigate when people feel they have been treated unfairly by an AI decision-making process.
- **MARCH 2017**
Elon Musk announces his backing of Neuralink, a startup creating devices to implant in the human brain to help people keep pace with advancements in AI. The enhancements could eventually improve brain power, including enhanced memory, and could aid interactions with software.
- **JUNE 2017**
Microsoft creates a campus for new AI firms with a capacity for 1,000 startups. Facebook, Apple and Amazon already have similar projects in place. The campus will offer startups mentoring, research collaborations and potential investment to help speed up the implementation of AI concepts.
- **JULY 2017**
Google Launchpad creates an AI studio to develop startups in machine intelligence. In November the accelerator announces its first tranche of four businesses, all from the health care and biotechnology space.
- **OCTOBER 2017**
In a further sign that tech companies want to regulate AI before governments do, Google's DeepMind announces the creation of a new internal ethics group. The group brings together academics and NGOs to "help technologists put ethics into practice."
- **NOVEMBER 2017**
Researchers at MIT publish a paper declaring they had managed to confuse Google's AI into classifying a 3D printout of a turtle as a rifle. The finding raises concerns about potential AI security issues.





*PASSWORD PROTECTED
We would like to believe that
companies are as careful
with our data as most of us
are with our devices, but
this isn't always the case.*

PHOTO: MICHAEL BLANN/GETTY IMAGES

A Question of Trust

Data is big business. But as consumers become more aware of their digital footprints, a competitive advantage is sliding to those who promise privacy.

BY **Steffan Heuer**

THE WORLD IS A SCARY PLACE right now when it comes to digital data: Hackers make off with the personal information of one in three Americans, Google recently released a smart speaker with built-in microphones that turn on at random times to record and transmit audio to its corporate servers, and Facebook now acknowledges it helped spread fake news and ads designed to influence the US election. All of these scenarios make you sit up and pay attention to how the rapid advances in being able to store, mine and monetize data are ushering in a new and confusing landscape for corporations and customers alike. What once was the domain of a few privacy advocates putting large platform players and startups on the spot for their transgressions and oversights has broadened into a much wider array of voices that includes →

2.5
quintillion

bytes of data are generated every day, including consumer data from purchases, web visits, mobile app interactions and social media posts.

90%

of the data that exists in the world has been created in the last two years alone.



"If a company usurps all of the value of the data and doesn't give anything back, then people will say 'no, thank you' over time, as they do with any other crappy product."

Viktor Mayer-Schönberger, Professor at the University of Oxford Internet Institute

legal experts, technologists and entrepreneurs. They all wrestle with the fundamental question: Is there such a thing as "data ethics"? What exactly does the term mean, and how can such arguably fuzzy values be turned into a competitive advantage?

LIKE ANY EMERGING FIELD, a lot of efforts are underway to lay claim to the proper definition of "data ethics." One of the first comes from Luciano Floridi of the Oxford Internet Institute. Building on a workshop held in late 2015, he published a seminal essay entitled *What is Data Ethics?* According to Floridi, it's a new branch of ethics "that studies and evaluates moral problems related to data, algorithms and corresponding practices in order to formulate and support morally good solutions." Floridi identifies three central issues: consent, user privacy and secondary use by entities a consumer might not be aware of – as in the case of ad networks that track browsing and habits.

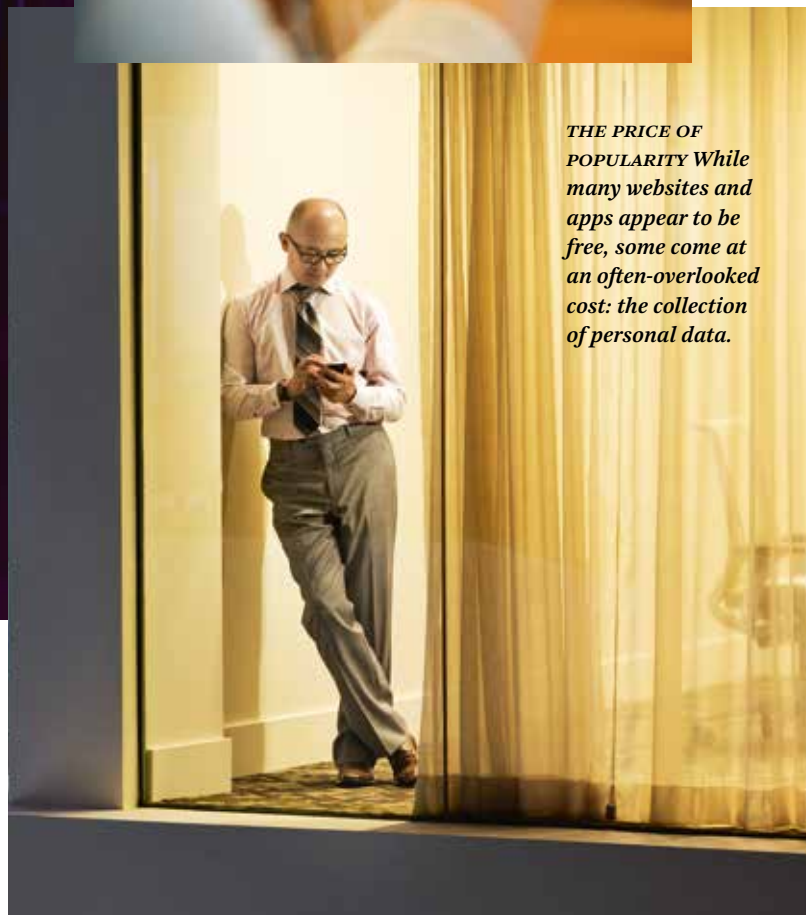
If that sounds like too abstract an approach to real-world business problems like real-time segmenting, profiling and targeting of users, there's also the more hands-on approach by Danish data activists Gry

Hasselbalch and Pernille Tranberg. Their book *Data Ethics: The New Competitive Advantage* presents dozens of companies that already practice more responsible and transparent methods of handling data. "Ethical companies in today's big data era are doing more than just complying with data protection legislation," Hasselbalch argues. "They also follow the spirit and vision of the legislation by listening closely to their customers and implementing credible and clear transparency policies for data management. They're only processing necessary data and developing privacy-aware corporate cultures and organizational structures. Some are developing products and services using Privacy by Design." Tranberg admits, however,

PHOTO: DON SMITH / GETTY IMAGES



THE PRICE OF POPULARITY While many websites and apps appear to be free, some come at an often-overlooked cost: the collection of personal data.



that getting it right is still a process of trial and error. "In some sense, data ethics in 2017 is similar to the dawn of the environmental movement. We are beginning to wake up to the downsides of this amazing resource called data that everybody loves to compare to oil or gold. Extracting any resource comes with nasty, toxic side effects. We're learning how to do things better, so everything is in beta right now."

Austrian-born lawyer Viktor Mayer-Schönberger, who teaches at Oxford and is the author of the influential book *Big Data: A Revolution That Will Transform How We Live, Work and Think*, won't have any of that. "I have no idea what data ethics means. It's one of those buzzwords that pretends to help us navigate these new

PHOTOS: GEORG IJEVIC, JETTA PRODUCTIONS / GETTY IMAGES

waters, but it doesn't do much." Instead, he suggests something more tangible: "What companies should and are focusing on is the use of data. What value does it add to a company and society at large?" In his view, every company needs to have a strategy for data use that goes beyond proclamations. "If a company usurps all of the value of the data and doesn't give anything back, then people will say 'no, thank you' over time, as they do with any other crappy product."

His market-driven, transactional interpretation is one that almost all companies dabbling in ethical data handling can agree on. It also makes it easier to gauge if a company indeed has a competitive edge. Despite the enormous market share of the big platform players such as Amazon, Facebook and Google, a wide range of early adopters spanning the worlds of enterprise and consumer applications already exists. No matter what their intentions are, they've taken the cues of a more privacy-focused environment in Europe, often driven by the EU's General Data Protection Regulation (GDPR), which will come into effect at the end of May 2018.

Take Swiss messaging service Wire, which offers end-to-end encryption that competes with the likes of Slack, Microsoft Teams or Skype but is designed to meet Europe's new, stringent data protection framework. Wire was launched by Skype co-founder Janus Friis and recently expanded from a free consumer product to a paid enterprise version. "We don't talk about ethics when we speak with corporate customers," says Head of Marketing Siim Teller. "For consumers, the important issue is privacy, while for companies it's security and compliance. That's the point we stress." The ethical handling of data shared via the service, then, is more of an implicit selling point.

THE PROMISE OF RESPONSIBLE DATA use is much more pronounced for a consumer-facing company such as Berlin-based Clue. Launched in 2013, it runs a popular fertility-tracking app used by more than five million women around the world and has raised in excess of \$30 million. "One of the key things our service is built around, besides a scientific approach, is trust. You build trust through transparency and compassion," explains Gregoire Marino, the company's trust and safety manager.

Clue is up against a lot of competition, with dozens of apps and services focused on women as prime advertising targets, but many of them have been found to be either insecure or intentionally leak sensitive data to third parties. Clue, on the other hand, earned high marks from the US-based privacy watchdog Electronic Frontier Foundation (EFF). That →



"What we need are standards that allow us to assess the risks and rewards of sharing and combining data."

Andreas Weigend, *Data expert*

praise most likely translates into business success and growth, says the company's spokeswoman Lisa Kennelly. "It's challenging to directly attribute growth or retention to one specific story, but we have heard [lots of] feedback from users that they choose Clue over other apps because of our commitment to privacy and responsible data handling."

Being honest while remaining a viable business is a key point for data expert Andreas Weigend, former chief scientist at Amazon. His recent book *Data for the People: How to Make Our Post-Privacy Economy Work for You* stresses that there's no turning back from the world of widely shared information that he calls "social data" – bits by us and about us. "What we need are standards that allow us to assess the risks and rewards of sharing and combining data, and provide a means for holding companies accountable." One of the two crucial dimensions is transparency about data use and reuse, meaning users ought to be able to see and inspect what Weigend calls the "data refineries." That doesn't mean the average consumer needs to pore over thousands of lines of code, but rather should get a simplified view derived from inspections and certification processes that are familiar from Fair Trade products. Such a labeling push will most likely create a new growth industry for auditors.

TRANSPARENCY IN DATA HANDLING and letting customers act on what a company knows about them can be a competitive advantage. Take contact management service Gentoo App, which synchronizes up-to-date contact info but lets users decide what parts of their personal information they want to share with whom and revoke access anytime, for instance not giving a professional acquaintance a mobile number or private email address. That's a much more granular level of control than, say, LinkedIn offers.

William Skannerup, Gentoo App's co-founder and CEO, thinks that this approach is better business for the long term. "It may put us at an economic disadvantage to not perform analytics, selling or trading the data we store, but we're confident that it puts us in a better position for the decades ahead," he explains. He's certain that young companies like his have a profitable niche to grow in since the controversy over data security and privacy will draw a clearer line between companies that collect and sell data for internal and external use and those that store and protect data for internal use only.

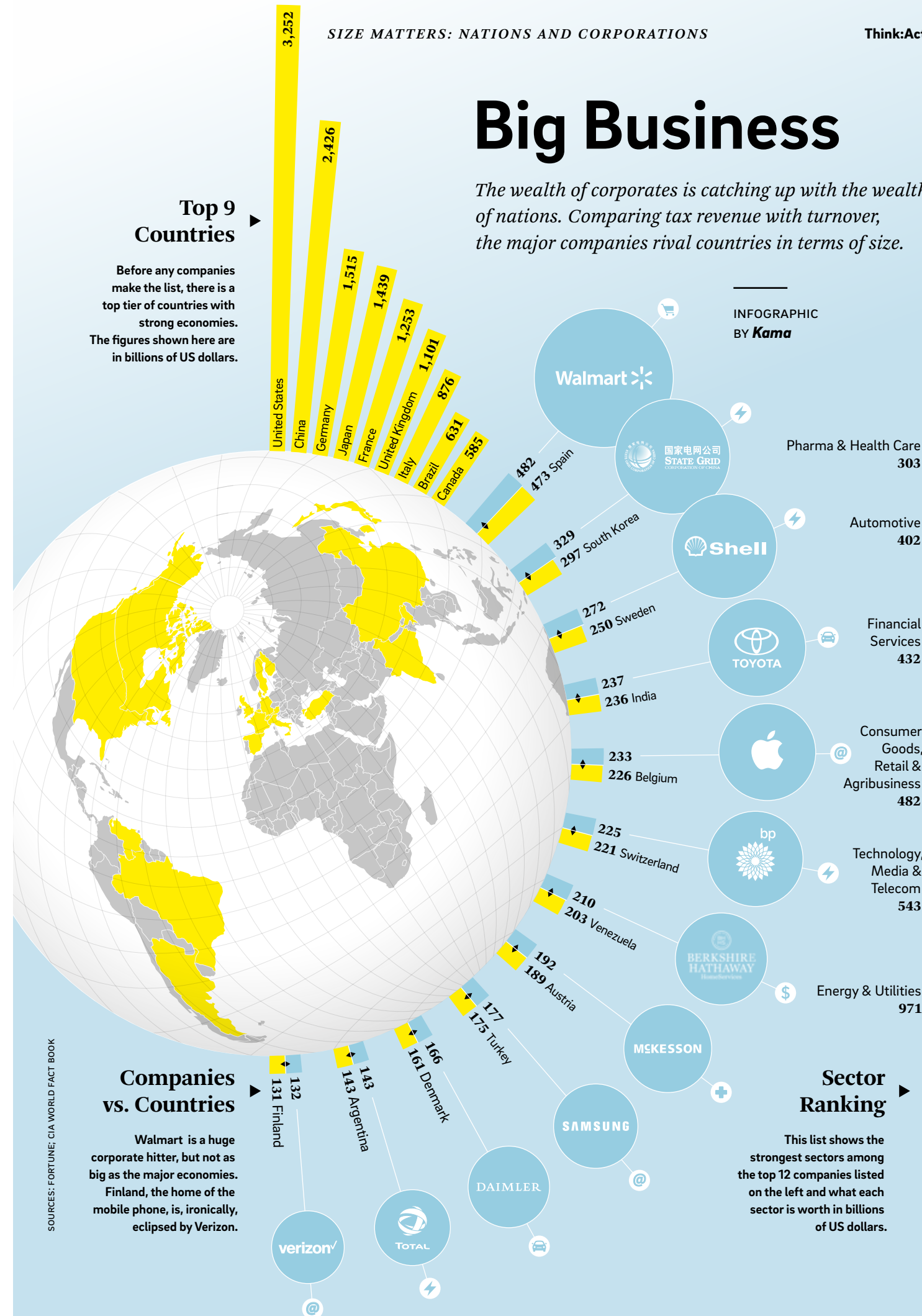
It will likely be a while before this new crop of companies espousing more stringent data handling practices generates a billion-dollar success story. "Large companies that have built successful data empires have no doubt realized the ethical implications of these practices, but they have been pretty slow on the draw in terms of taking concrete steps," says Raegan MacDonald, senior policy manager with the Mozilla Foundation, the birthplace of the Firefox browser. She sees growing awareness for a new, emerging class of companies that adopt ethical approaches, even if they don't make much marketing noise over their commitment. "From the user's point of view, the motivating factor doesn't matter."

Mozilla's Firefox may have sunken to fourth place in the battle of the browsers, but it's in good company when it comes to data ethics writ large. Apple recently joined the fray by blocking cross-site trackers in its latest version of Safari, rattling one of the key pillars of the current data regime for its massive user base of iOS devices. More ideas will find their way into the realm of digital business as the scholarly debate heats up. The US National Science Foundation announced it's funding research into big data ethics with \$3 million, while the International Conference of Data Protection and Privacy Commissioners has declared digital ethics its focal point for 2018 in order to make sure that "our values, based on a common respect for the individual and human rights, remain a core component of innovation." And yes, there will soon be more successful apps for that. ■

Big Business

The wealth of corporates is catching up with the wealth of nations. Comparing tax revenue with turnover, the major companies rival countries in terms of size.

INFOGRAPHIC
BY **Kama**





Gender on the Pay Agenda

Paying women less for the same work has been illegal in many countries for decades. Yet figures show that overall women still earn significantly less than men. What causes this gap? And what are companies doing to address it?

BY **Janet Anderson**

ILLUSTRATIONS BY **Frank Höhne**

SALESFORCE CEO MARC BENIOFF told the World Economic Forum in January 2017 that every CEO today needs to look at whether they are paying men and women the same. Wage discrimination has been illegal in many countries for decades, yet the pay gap persists. According to the International Labour Organization, the global average is still somewhere around 20%. The World Economic Forum's *Global Gender Gap Report 2016* shows that although progress has been made in many countries, parity will not be reached any time soon – at the current rate, it will be over a hundred years before we close the gap. Why does it matter? If the average working woman earned the same as the average working man over her lifetime, this

would improve family finances, bring greater financial security to those at the lower end of the pay scale and boost children's prospects. It would also improve women's pensions, reducing the number facing poverty in old age.

There is also a benefit for employers. According to research by Glassdoor, three out of five people would not apply for a job where they believe a gender pay gap exists. Clearly, it boosts an employer's brand to demonstrate that they pay fairly. Not only that, a number of studies have shown that gender-diverse companies produce higher financial returns – diverse teams bring different points of view, reflecting the diversity of customers. Closing the gender pay gap is not just the right thing to do, it is also the smart thing to do. →

"Corporate structures were largely defined in the 1950s and 1960s.... As a result, there are unintentional but subtle ways in which the playing field is tilted."

Benjamin Frost,
VP and general manager, reward products, Korn Ferry

LOOKING BEHIND THE NUMBERS is critical. US-based recruitment consultant Korn Ferry holds data on 20 million salaries at 25,000 organizations in over 100 countries. Their analysis from 2016 revealed that while the average woman's salary in the UK was 29% lower than the average man's overall, when comparing women and men at the same level, with the same function, and in the same company, the difference was reduced to just 1%. Similar results were found in France and Germany. The gap appears to have all but vanished. How? "Today the problem is not so much unequal pay for equal work, but rather the fact that men and women are not doing the same sort of jobs, in the same companies, in the same functions," says Benjamin Frost, VP and general manager, reward products, at Korn Ferry. In short, more men than women work in high-paying sectors and more hold senior roles.

Which poses the question: What is it that leads women to lower-ranking jobs at lower-paying organizations? The answer, it seems, is simple. It starts with



Leading the way on gender equality

In 2017, Equileap, an organization that aims to accelerate progress toward gender equality in the workplace, ranked 3,000 companies in 23 countries. French cosmetics company L'Oréal took the top position. It earned the award by ensuring strict equality in all measurable areas – access to promotions,

relocations, training and salary reviews. In France, its gender pay gap on a like-for-like basis was 3.21% for management and nonexistent for other employees in 2016. How did L'Oréal achieve this? Long-term effort. "At L'Oréal we share the strong belief that diversity in all functions and at all levels enhances

creativity and innovation. But having a conviction is worth nothing without concrete actions," says Jean-Claude Le Grand, L'Oréal senior VP of talent development and chief diversity officer. It also has measures in place that ensure equal career opportunities, such as paid parental leave and flexible work.

education. Higher-paying salaries are generally in science and technology industries, but statistics in most countries show that fewer girls study these subjects at school compared with boys, so they are not qualified for jobs in IT, engineering or R&D.

And even if women do enter these professions, they still face what Frost describes as "headwinds." "Corporate structures were largely defined in the 1950s and 1960s when the world was very different. As a result, there are unintentional but subtle ways in which the playing field is tilted to male and away from female strength," he says. He believes that companies need to be more proactive when it comes to getting staff into the talent development pipeline, rather than relying on people pushing themselves forward. Evidence shows that women are much less likely to do that. They are more likely than men to self-select out. "This creates a gap that never gets closed," he says. He also believes that there are not enough realistic role models: The myth of the superwoman is a damaging message.

THE BIGGEST FACTOR making a difference in a woman's earnings over her lifetime is family. And it's not just child care. Much of society's unpaid work is still carried out by women, meaning many take part-time work, and part-time work is associated with lower pay and fewer chances of career progression.

But, why should this be the case? Harvard economist Claudia Goldin believes that value in the workplace is determined to a large extent by how interchangeable an employee is. The more unique an employee's skills, the easier it is for them to command a higher salary. At the same time, it is precisely because the employee cannot easily be substituted that the job is more likely to

require a full-time commitment. If a person can only work restricted or flexible hours, they need a role where they are substitutable, and these roles often come with a lower salary for just that reason.

PERHAPS THE FIRST STEP when it comes to addressing the gender pay gap is transparency. Publishing data is, of course, only a first step. It won't change anything on its own, but it does shine a light on the problems and enables employees, employers and the government to understand better where the biggest differences are, helping to identify where women's career progress stalls and to start making changes to address this. Goldin points out that technology and other factors also make a difference by lowering the cost of substitution, even in highly skilled work. In the US, where drugs are more standardized and computer records are centralized, it is possible for pharmacists to share roles. This leveling effect means that pay differentials are lower between women and men pharmacists and is an example of organic change within an industry leading to a better outcome in terms of the gender pay gap. But, Goldin has argued, this kind of change cannot simply be mandated across industries.

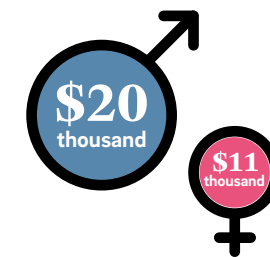
Salesforce continues to monitor its compensation after its first internal pay audit in 2015 revealed discrepancies between men and women's pay. It has now committed to auditing its payroll every year and adjusting salaries where an unjustifiable gap appears. One impact this has had is that managers of teams in which a pay discrepancy has emerged are starting to ask how they can do things differently to prevent it in



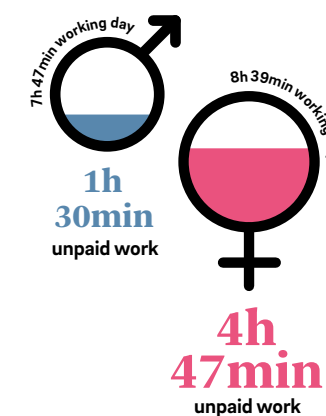
What's driving the disparity?

With like-for-like pay gaps having all but disappeared, other issues are driving the disparity: unpaid work and part-time employment. How much impact does this have on women's access to higher-paid jobs? And their time to dedicate to them?

AVERAGE GLOBAL ANNUAL EARNINGS



HOURS SPENT DAILY IN PAID VS. UNPAID WORK*



*The largest proportions of unpaid work are routine housework and child and elder care.

SOURCE: WORLD ECONOMIC FORUM 2016 REPORT, COMPARING DATA FROM 144 COUNTRIES

the future. And the US-based outdoor clothing retailer Patagonia, for example, has combined several approaches – fully paid family medical leave, fully paid maternity leave, free on-site child care and a company culture that rewards collaboration. Over half the managers are women and 100% of new mothers return to work after maternity leave.

Many women leave work when they have their first or second baby, and most intend to return. The difficulty is finding what the US economist Sylvia Ann Hewlett has called "on-ramps" – the routes back into a career. Often women end up re-entering at a lower level and miss the career trajectories that lead to high-paying jobs. UK bank TSB is tackling just this issue with a campaign that seeks to identify women who are returning after an extended period of absence and help them with the transition.

IT IS NOT JUST WOMEN who we should be helping to enact change, but also men, argues Anne-Marie Slaughter, professor at Princeton and a vocal advocate of gender parity. The real revolution, she says, would be to stop seeing the home as a gendered space but rather as both a male and female domain, just as we now see the workplace.

Perhaps we are beginning to see a generational change in what employees want from work. Some studies indicate that it's not only women who are prepared to sacrifice salary for more time to do the things that are important to them. Millennials appear to want not just a work/family balance, but a work/life balance as well. If employers find they have to offer this kind of flexibility across the board, at all skill and function levels, the pay differential between part-time and full-time work might begin to disappear – and with it, the gender pay gap. ■



'We're preparing
Henkel for the
digital future'

PHOTO: MAYA CLAUSSEN

Henkel CEO Hans Van Bylen is taking this flagship German company through its digital transformation and he aims to complete it by 2020. In a wide-ranging interview he shares his plans for investment, why the US is still the most important market regardless of who the president is, and why he gives his staff a 'safe space' to make mistakes.

INTERVIEW BY **Julian Gutberlet**

DIGITIZATION IS BECOMING MORE AND MORE IMPORTANT, especially in the consumer goods industry. Henkel, which is based in Düsseldorf, hometown to brands such as Schwarzkopf, Loctite and Persil, is one of the leading players in this business. Hans Van Bylen took over as CEO in 2016 with the aim of getting the company ready for the future. He plans to advance Industry 4.0 – or the digitization and automation of manufacturing – by investing in technology and marketing and ploughing millions into startups. But his vision goes beyond that. Read on to find out why brand identity is ever more important on the internet, where he sees opportunities for growth and what he has learned from past mistakes.

Mr. Van Bylen, you were appointed as CEO at Henkel in May 2016. How are you steering the group towards the future in these increasingly volatile times?

We have a diverse and balanced portfolio with three divisions: Adhesive Technologies, Beauty Care and Laundry & Home Care. In November 2016, we defined our new strategic priorities and a set of ambitious, concrete financial objectives for the next four years to 2020. Our focus is on growth, digitization and agility. We have a wide range of projects and measures behind it and we are well on track to implementing them.

Where is it not progressing quite as you wish?

We have a turnover of around \$24 billion. We have more than 50,000 employees in over 100

countries. 2017 was a successful year for Henkel. Our adhesives business has developed very well thanks to our innovative and highly effective technologies in a variety of industries. We've also performed well in many markets and sectors with our consumer goods business. But the retail business in our Beauty Care division is currently performing below expectations. We're working on creating stronger growth dynamics to this sector.

Henkel has a reputation for caution in its acquisitions. What made you pursue the second-largest acquisition in the company's history, the takeover of the US laundry and cleaning products group Sun Products for \$3.8 billion?

Since the beginning of 2016, we have invested a total of some \$7 billion [in acquisitions]. For us, the key factor is whether acquisitions are a strategic fit for us and whether the price is reasonable. And, of course, the company must be available. Sun Products met all these criteria. The acquisition significantly strengthened our business in North America and made us a strong number two in the attractive American detergent market.

Which divisions of your company do you think are poised for growth?

We want to continue to grow our core businesses organically. However, we are still keeping an eye open for acquisition targets. In both the Beauty Care and Laundry & Home Care divisions there are still opportunities around the world →

to strengthen our portfolio in a targeted way in individual markets or categories. In industrial adhesives, where we are the global market leader, we primarily acquire new technologies that will enhance our portfolio and that we can then market worldwide. For instance, we recently acquired two companies – Sonderhoff, a manufacturer of foamed-in-place gasketing solutions, and Darex, a leading supplier of sealants and coatings for the metal packaging industry.

You want to spend around \$180 million on Henkel's startup support program by 2020. What is the focus for this investment and what are the company goals beyond this move?

Venture capital is an important area for us, because we want access to innovative technologies and business models. In our consumer goods business, the priority is on areas such as the Internet of Things, social media or e-commerce platforms, through to personalized products and services. In the adhesives division, technological innovations such as 3D printing, functional coatings or printed electronics are taking the lead. We have already secured a number of promising cooperation deals in this area and are actively following them up.

Your competitors' plans for the future focus on digitization. What plans do you have in this area?

We intend to accelerate our digitization within the company to enable us to grow successfully and strengthen our relationships with our customers and consumers. By expanding Industry 4.0 – the digitization of the entire supply chain – we

Around
\$24
billion

The turnover that Henkel recorded in the 2017 financial year under Van Bylen's leadership.

Around
\$180
million

The amount that Henkel wants to invest in startups, especially in the fields of technology and e-commerce.

want to optimize processes, making them faster and more efficient. Finally, we have also set ourselves the goal of taking the digital transformation of our company to the next level. To that end, we have established a range of strategic initiatives between now and 2020 and have already made good progress in all areas over the course of 2017. We appointed a chief digital officer in the middle of the year, who reports directly to me and is set to accelerate digitization across all divisions.

Henkel's online market is doing much better in Asia than in Europe. Why is this business area so sluggish at home? What are you learning from e-commerce in China and Korea?

In terms of shopping behavior, Asian consumers are much more digitally advanced than anywhere else in the world. That has really helped us with our Beauty Care business in China. To compete against the market's established companies in this market, we initially took a purely digital route. With great success! Today, more than 50% of our Beauty Care turnover in China comes from digital transactions. However, we see this trend is continuing in other countries too.

Internet sales are becoming increasingly important. Henkel is also building on this sales channel. Why are you skeptical about establishing your own online retail outlet?

We are not planning any online sales on our own platform in the field of consumer goods. This is because those wanting detergent or shampoo often buy other everyday items at the same time. Consumers want to order their goods all together and pay for everything at once. Online retailers and our retail partners with their own platforms can do this much more efficiently than we can. However, in the medium term we see a clear trend towards omnichannel concepts. This development means online and physical retail growing together. Evidence of this can be seen today. Established retailers are building up their online channels and investing in e-commerce. At the same time,

established online retailers, such as Amazon, are buying up retailers with physical outlets. It's not the same in the industrial sector. Here, we operate our own very successful online platform for adhesives. We already have a turnover of more than \$1 billion per annum and see a good rate of growth.

How important is branding for online sales?

Strong brands are still very important – irrespective of whether they are sold in brick-and-mortar shops or online. That's why we are focused on strengthening our brands through investment in the products, in innovation and in the brands themselves. It is increasingly important to position our brands consistently in the digital marketplace and to build engagement with customers across different platforms.

The US president has extended his "America First" policy to include trade between nations. Are you feeling the effects of this protectionist approach on the US market?

The US is a very important market to us. We have more than 8,000 employees there, making products primarily for the US market. In that respect, we are not directly affected by protectionist measures, but it goes without saying that we are in favor of free trade.

We have also seen a re-nationalization process in parts of Europe. What effects do you anticipate with regard to networked European companies?

The concept of a unified and strong Europe has suffered in recent years. Many people don't see the benefits it creates. If it comes to a rejection of a united Europe, that will not be conducive to a strong economy. This is also clear from the problems that have arisen due to Brexit. I hope that the political decision-makers will be able to find constructive solutions here. We all benefit from free trade and close cooperation.

You have worked for Henkel since 1984. What advantages do you think this long association brings to you now that you are CEO? Are there any disadvantages that come with it too?

STAFF SHOULD NOT BE AFRAID to make mistakes here: Henkel CEO Hans Van Bylen.



Hans Van Bylen

Hans Van Bylen (born in 1961 in Belgium) joined Henkel in 1984 as a product manager. After positions in marketing, he joined the management team in 2005, where he was responsible for the Beauty Care business. In May 2016, he replaced Kasper Rorsted as CEO of Henkel.

If you take a look around at the top of other major German companies, you'll see that I'm no exception. A deep understanding of a company, its employees, its customers and products and its culture is a great asset when it comes to shaping the future. It's also important that you don't think you know everything. That's why it's an advantage to work in a diverse team and encourage open discussion. That always results in better ideas and solutions.

Why is it important to you to give your employees "more courage to make mistakes"?

I have always enjoyed a great deal of trust and entrepreneurial freedom. That is something I would like to pass on. Our employees around the world have a great deal of potential and should have the courage to try things and implement creative ideas quickly and without complication. That's often how amazing products or campaigns develop. And no one should let their enthusiasm be affected by the occasional setback.

What mistakes have you learned from the most?

There have been a few projects that we have successfully implemented, where I have asked myself afterwards why we weren't brave enough to have taken this step sooner. It shows that supporting an entrepreneurial approach is a very decisive factor in competitive success. ■

"Strong brands are still very important – irrespective of whether they are sold in traditional shops or online."



Goodbye, Groupthink

Author and organizational psychologist **ADAM GRANT** wants you to maximize your innovation potential. Here, he weighs in on inspiring generosity and empowering original thought.

BY **Bennett Voyles**

ILLUSTRATIONS BY **Mario Wagner**

OVER THE PAST FIVE YEARS, Adam Grant has become one of the world's most influential organizational psychologists. His titles include *Give and Take: Why Helping Others Drives Our Success*; *Originals: How Nonconformists Move the World*; as well as *Option B: Facing Adversity, Building Resilience, and Finding Joy*, which he co-wrote with Facebook COO Sheryl Sandberg. Grant focuses on two issues that are near the top of most corporate agendas these days: fostering ethical behavior and encouraging more innovation. He likes to call himself a "precrastinator" – or, rather, one who finishes large projects early – and says that as a result of this obsessive focus, he often runs a bit late. In this way, Grant gave us good warning: The following interview with *Think:Act* began a couple of minutes later than scheduled.

You earned your Ph.D. in three years, became a full professor at Wharton at the age of 29 and published three bestsellers before your 37th birthday. How did you do it?

First of all, I got really lucky in that I discovered this field that I'm passionate about when I was an undergrad, so when I got to grad school, I'd already read a lot and I'd already done three years of research. I had a huge head start. Secondly, I'm a big fan of deep focus work – it's something I think I learned growing up playing video games. I would often get up in the morning and start writing, and write until dinner time, and I would do the same with data analysis or other things I was working on. Also, a huge amount of productivity comes down to how many hours you work, and I worked 90-hour weeks for seven or eight years. →



And you avoid distractions?

I didn't even read the news for six or seven years. To this day, I only turn on the TV if I already know what I want to watch. I guess I've always been ruthless in prioritizing how I spend my time. I have a plan for what I want to do in a given window, and unless there is an emergency, I stick to that. When I'm focused on a task, I have a chronic inability to disengage from what I'm doing until it's done. The upside of that is I've been able to finish a lot of the things that I've started. The downside is, I'm almost always late, as you saw this morning.

How did you come up with the topics of your books? You seem interested in so many things. Narrowing your focus must be a challenge.

That's been pretty easy because when I sat down to write a book it was about a subject that I'd been doing research on for at least a decade. What's tougher is deciding what research to do next. For that, I jot ideas down in a little notebook and then periodically review the ideas every few months. Over time, I notice patterns.

In *Give and Take*, you write about the importance of giving behavior in today's businesses. What's the most important thing a manager can do to encourage this?

You want to be careful about who you hire. The data suggests that having the right people on your bus isn't as critical as keeping the wrong people off that bus. You let one selfish person into a team and all of a sudden everyone becomes a little bit paranoid and it starts to undermine and erode the everyday helping that would otherwise go on.

Is there a good question that can help you identify takers?

There are a few, actually. One I learned from Alex Gorsky, CEO of Johnson & Johnson: "Give me the names of four people whose careers you've improved." Takers are more likely to

"Many ideas have been rejected in one context and then turned out to be huge hits in another."



list people more powerful than them because that's how you get ahead, you kiss up. Givers are more likely to say: "I don't know if I fundamentally improved anybody's career but here are the four people below me who I've worked the hardest to develop and mentor." Givers invest more energy in helping people who can't necessarily help them back.

Another question that I think is pretty revealing is to ask people to predict the selfish behavior of others. In general, takers anticipate more selfish behavior from others. That's in part because they tend to project their own motivations onto others. So, when you ask: "What percent of people are thieves?" They're thinking: "Oh, I stole a few hundred bucks last week, so it must be pretty common." If they give a high estimate, you ask them to explain themselves.

In your 2016 book *Originals*, you describe how maverick innovators get their ideas adopted. But how do you even know if you have an idea that's worth adopting?

Creative ideas are inherently uncertain. Many ideas have been rejected in one context and then turned out to be huge hits in another.

I think the first thing to do is to ask, how are you evaluating ideas? If you're making decisions based on intuition, then I'd be pretty concerned because intuition is basically just subconscious pattern recognition. When you start to check those patterns, you will often find that they are not diagnostic of the current circumstances that you are evaluating. You probably developed them in a different industry or a different domain and they don't really apply to this situation.

If you want to get better at judging ideas, ask your peers for feedback. Peers tend to be less risk averse – they're more open to reinventing the prototype that may define what a good idea looks like.

If you want to get better at judging your own ideas, Justin Berg, an assistant professor of organizational behavior at Stanford, has done some very cool new research. He shows that if you rank them from your most favorite to your least favorite, the most promising idea is generally the one you ranked second. That's because the idea you love the most is the one that you're blindest to the flaws in, whereas that No. 2 idea you see a little bit more clearly.

Do you run your ideas by anyone?

Yeah, always. I have a bunch of collaborators that I run ideas by, a literary agent and various others, and ultimately, the most important judge of my ideas is my wife.

Of course, coming up with ideas is only half the battle. You've noted that if you don't have much power in an organization, it can be tough to gain acceptance for your ideas.

If I have an idea I think is promising, I would go to somebody above me whose judgment I trust, but who also has the power and the resources to make this happen. I would say: "Look, I've got this idea, here's why I think it's really interesting, here are the barriers that I'm running into to get it implemented. If you were in my shoes, what would you do?"

This can work well because, to paraphrase Benjamin Franklin, we all admire the wisdom of people who come to us for advice. Secondly, advice-seeking really motivates perspective-taking. In order for that person to give me advice, it's necessary for them to look at the problem from my vantage point. And that makes it much more likely then that the person is going to step up and help me or at least give me some valuable recommendations.

Is there a way organizations can encourage more innovation?

I would love to see more organizations run innovation tournaments. I hear a lot of managers talk about them, but I see very few implement them. One of the best that I've come across is at Dow Chemical. What they do is they announce, for instance, that they are looking for ideas for saving energy or reducing waste that cost no more than \$200,000 and pay for themselves within a year. Over a decade, they ended up investing in 575 ideas that saved the company an average of \$110 million per year. That is staggering.

Interestingly, a lot of these ideas did not come from people in innovative jobs. They came from people working on a factory floor who saw something that was broken or had an insight but never knew where to take those thoughts until the tournament was announced. I would be thrilled to see more managers running these.

You've been doing some intellectual crowdsourcing yourself...

A few years ago I started a newsletter called *Granted*. I share monthly insights on organizational psychology, mostly pointing out articles I found interesting and the stuff that I wrote, and along the way I started getting more and more reader emails with interesting questions. At some point it dawned on me: If one person asked this question, there's a decent chance that other people might be intrigued by it too. Instead of just sending my response to one person, I thought: "What if I shared it with a more diverse group of people who were interested in it?" So I started this new feature in the newsletter called "Wondering" where I invite people to ask questions and then I weigh in on the ones where I have strong evidence or a clear opinion. That's been really fun and it's got me thinking about a whole bunch of new topics that were not on my radar before. ■

How values lead to better innovation

①

Generosity: Success is increasingly dependent on how we interact with others. It's a simple equation: The more you contribute to others, the more you get in return.

②

Inventiveness: Everyone has original ideas. Fight groupthink and inspire creativity and change by building a culture that welcomes dissent.

③

Courage: Recognizing a good idea can be hard; speaking up about it can be even more difficult. Learn to manage doubt and support resilience in yourself and others.

**The case for keeping your culture flexible**

A strong culture can be an asset – but it also runs the risk of turning into an echo chamber.

Support long-term innovation and growth in your organization by remaining open to new, original ideas.

Aiming for the Perfect Moon Shot

Space race 2.0 is underway. This time around it's not governments footing the bill, however – it's companies. Will the commercialization of space turn us all into space tourists? Perhaps. But it might also benefit terra firma.

BY **Fred Schulenburg**



**ASTRONOMICAL
AMBITION** The
SpaceX Falcon 9
rocket launches from
Cape Canaveral,
Florida, in 2016.

TWENTY MINUTES into the presentation the focus turns to the specifics of the passenger experience. "You could conceivably have five or six people per cabin, but mostly we would expect to see two to three," explains Elon Musk as he guides his audience through the detailed projected image, moving on to reference other features such as the essential storage facilities, the galley and the "entertainment area." The delivery is so matter of fact that it almost sounds like a routine sales pitch for an upscale tourist offering. What Musk was describing at a conference in late September in Australia was, in fact, nothing short of extraordinary. The billionaire founder and head of SpaceX was spelling out his plans to send BFRs (Big Fucking Rockets) to Mars. Within the next decade Musk says that he hopes to send a fleet of rockets to the red planet, loaded with equipment and materials to establish a base camp, to be followed later by humans.

It would be easy to dismiss this as fantasy. But Musk, who made his fortune through a series of smart investments in groundbreaking technology ventures such as PayPal and his battery-powered Tesla cars, has form. The 46-year-old South African-born Canadian American has already demonstrated his credentials in space through the successful launch of rockets by SpaceX, which has established itself as a low-cost provider in the sector.

Musk is also not the only rich person to be directing terrestrial wealth toward the stars. The ranks of billionaires with bold ambitions for space exploration also include Jeff Bezos, CEO of Amazon, Richard Branson, founder of Virgin Group and Microsoft co-founder Paul Allen. The wealthy are just one of the driving forces behind a "new Space Age" that is not only capturing the imagination of the public with its eye-catching plans, such as



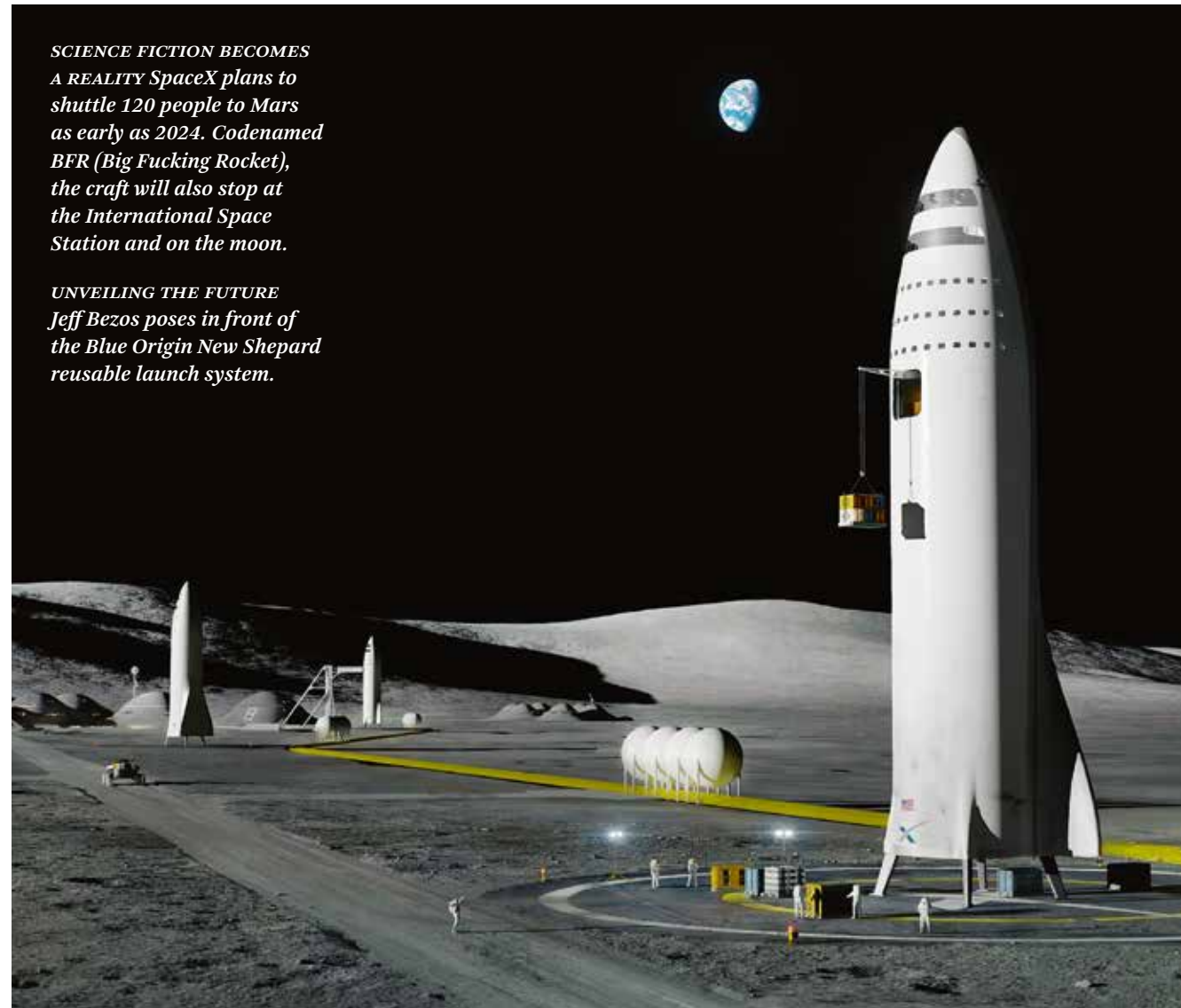
Elon Musk

Having founded SpaceX in 2002 and Tesla in 2003, investor and inventor Elon Musk is pushing the boundaries of transportation both on Earth and in space.



Jeff Bezos

Jeff Bezos founded the aerospace company Blue Origin in 2000 – six years after founding Amazon. He currently invests \$1 billion in Amazon stock per year into the venture.



SCIENCE FICTION BECOMES A REALITY SpaceX plans to shuttle 120 people to Mars as early as 2024. Codenamed BFR (Big Fucking Rocket), the craft will also stop at the International Space Station and on the moon.

UNVEILING THE FUTURE Jeff Bezos poses in front of the Blue Origin New Shepard reusable launch system.

Musk's mooted mission to Mars, but is now also grabbing the attention and money of some hard-nosed investors.

This is a marked change for a sector that, after the flush of big state investment and public enthusiasm that accompanied its early decades during the Cold War, lost its sparkle as attention waned and funds were cut. Now with plans for the first fee-paying commercial travelers to go to space in 2018, the mind-boggling ambitions of the likes of Musk, visions of manufacturing and mining facilities beyond the earth's atmosphere and a new generation of mini satellites that can sit in the palm of your hand, space is back. "Here's to the crazy ones," is how Ted Cruz, the hawkish US senator from Texas, opened a recent congressional committee on public-private partnerships in space, borrowing a phrase from Apple founder Steve Jobs as he celebrated the renaissance of the Space Age.

PHOTOS: BRIAN DOWLING; TODD WILLIAMSON; ROBERT LANG; ROBERTO COLOMBARI / STOCKTREK IMAGES / ALL: GETTY IMAGES

PHOTOS: AP PHOTO / PICTURE ALLIANCE; MATTHEW STAVER / BLOOMBERG / GETTY IMAGES

TO SOME EXPERTS IT NEVER WENT AWAY, it just changed. Carissa Christensen, CEO of Bryce Space and Technology, has been analyzing the development of the space sector for over two decades. During that time she has seen how the evolution of areas such as satellite communications brought with it an "institutionalized commercial space economy" in which private sector companies worked alongside state entities. "People don't realize how relevant the space economy is," says Christensen. "There is hardly an aspect of life now that is not touched by satellites."

More recently, however, she says there has been a change with the arrival of two new types of investors. The first are the billionaires, who are passionate about space and are now changing the market with new business practices. The second is venture capital, which once avoided space ventures on the grounds of the sheer cost. That has now



THE NEW SPACE RACE

→ IN NUMBERS

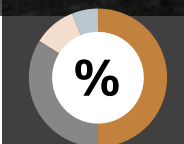
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In the private sector alone **\$13 billion**

has been invested in space startups since 2000.

.....

ACCESS AT A PRICE Satellites represent only half of typical program costs.



.....

47%

of the global share of launch revenues in 2016 belonged to the US, driven largely by SpaceX.

changed, thanks in part to innovations such as reusable rocket parts, which reduce the cost of launches, or the development of smaller "mini" satellites – some as small as 10 cm cubed and one kilo in weight – which are playing an increasingly important role in the data economy. "These two factors have combined to make for an interesting development," says Christensen.

A lengthy report put out by investment bankers Goldman Sachs entitled *Space: The Next Investment Frontier* documents the changes taking place in launch and satellite manufacturing that are driving down costs and, as a consequence, lowering the barriers to participation. Renewed government interest in supporting space combined with the privatization of exploration is spurring investment. In the private sector alone some \$13 billion has gone into startups since 2000, with the bulk falling in the last decade. →

"There is hardly an aspect of life now that is not touched by satellites."

Carissa Christensen, CEO of Bryce Space and Technology



GLIDING TOWARD THE GOAL
The Virgin Spaceship Unity on its first glide test over the Mojave Desert in December 2016.



AT THE CONTROLS Rahul Narayan holds a demonstration for the media at the TeamIndus lunar mission command center in October 2017.

"We initially saw the moon mission as the end point. Now it is the starting point."

Rahul Narayan, Founder of TeamIndus

PHOTOS: AP / PICTURE ALLIANCE; MANJUNATH KIRAN / AFP / GETTY IMAGES; XPRIZE, GREG DOHERTY, DAVID M. BENNETT, CARLOS MALVAR, NAOYUKI NODA / GETTY IMAGES (4)

GOOGLE LUNAR XPRIZE
→ A QUICK LOOK

\$20 million

will be awarded to the first team to land on the moon, travel 500 meters and send back high-definition video.

ADDITIONAL PRIZES

"Milestone prizes" will also be distributed in addition to an overall second place award.

- \$5 million Second place
- \$1.75 million Lunar Arrival Milestone
- \$3 million Soft Landing Milestone

The result is a dizzying world in which "space tourism" and asteroid mining will become viable. The upbeat assessment pulls few punches, stating that the "space economy is also now inflecting and we believe will become a multi-trillion dollar market within the next two decades." Among the possible changes in the space economy pointed to are Sir Richard Branson's ambitions to offer paying passengers a seat on a suborbital spacecraft for \$250,000 – a bargain when compared to the \$35 million cost of a "tourist seat" on a Soyuz rocket. Or the \$25-50 billion valuation put on the platinum that might one day be mined from an asteroid.

THE NEW SPACE AGE IS SET TO BE MORE GLOBAL than its earlier editions when the sector was largely dominated by the US, Russia and the EU. Now participants are as likely to come from India and China. One of these newcomers is Rahul Narayan, founder of TeamIndus. His Bangalore-based group is working on a project to land a spacecraft on the moon as part of the Google Lunar XPRIZE competition. This is a global challenge to any privately funded team to develop low-cost methods of space exploration. The goal is to successfully land a craft on the moon's surface, then have it travel 500 meters and transmit high-definition video and images back to Earth. First prize is \$20 million.

Narayan, whose background was in software, says that TeamIndus was born out of the desire to see what was possible and to see if it could be done from India. "It was a dream," he says, a dream that has now made it into the competition's final five. Funding initially came from the founders and their families. Since then other investors have come in and the company is looking to sell payload space. All in, the venture will cost between \$65-\$70 million, of which they have raised about half.

The team's ambitions have changed over the course of the project. "We initially saw the moon mission as the end point. Now it is the starting point," says Narayan. The lunar project may have no direct commercial benefit, but the impact this will have on India as a country will be considerable. The abilities built up by TeamIndus will be

READY TO "ROVE" TeamIndus is all set to launch its unmanned lunar rover, and its bid for the Google Lunar XPRIZE competition.



Richard Branson

Sir Richard Branson added Virgin Galactic to the Virgin Group's portfolio in 2004. It plans to offer space tourism flights using the SpaceShipTwo.



Paul Allen

Microsoft co-founder Paul Allen funded SpaceShipOne, the first manned private space-flight in 2004. Stratolaunch Systems followed in 2011.

capable of being used across the space economy, including in remunerative areas such as the deploying of satellites. But for him the real benefit of the competition is that it is "a testimony" to incentivized enterprise: "Space was the only industry that had not been disrupted by startups." He sees a new trend in which smaller operators will be able to bite into the share of bigger players, and where non-US companies can flourish.

With the private sector taking up more of the initiative, the role of state enterprises such as NASA is changing. "NASA's role today is totally different from what it used to be," Charles Bolden, a former astronaut who stood down as head of NASA earlier this year, told the *Financial Times*. "We used to be competing, for example, with Roscosmos [the Russian space agency]. Today we are the integrator. NASA is the agency that brings the other space agencies of the world together, particularly for human spaceflight."

THERE ARE OF COURSE OUTSTANDING QUESTIONS. The cost of space tourism may be set to fall but is unlikely to be within the reach of anyone but the very wealthy. There is also some unease that an endeavor that used to be about expanding human knowledge and understanding may become little more than an entertainment experience – "rich person's bungee jumping" as some critics have dubbed it. And as for astral mines and factories, that may also be a while away. "At some point large numbers of humans will live and work in space," says Carissa Christensen. "But I do not think that point is in a time frame that is relevant to today's business cycle." She is skeptical about an "asteroid gold rush."

Yet while the more ambitious goals may take a long time to reach, a number of the benefits that space has delivered to the real, earthbound economy came almost as by-products. Rahul Narayan argues that this will continue to be the case. "Its benefits will be unpredictable," he says. And in his presentation in Australia, Elon Musk also offered up an unexpected consequence of his mega bet on the huge rockets. As well as one day heading out to Mars, it could actually be deployed on Earth to take passengers anywhere on the planet in around 30 minutes. The mind-boggling technological achievements may end up being enjoyed closer to home as passengers in the future settle into one of those cabins ahead of a 39-minute flight from New York to Beijing. ■

Food for Thought

Take a deep dive and find out more in related articles, studies and magazines.

INDUSTRIAL INTERNET OF THINGS

Opportunities in a challenging landscape

The Industrial Internet of Things (IIoT) is set to become a multibillion industry in the next three to five years. Rapid advances in technology are enabling manufacturers to connect more and more devices to rich cloud services. IIoT platforms will offer major opportunities for industrial companies – as long as they know how to handle them. We investigate how IIoT ecosystems are developing across five business layers, from cloud service providers to end users. We then set out the questions that companies must ask themselves in order to successfully navigate the complexity and zero in on key success factors.

→ DEFINING YOUR FUTURE ROLE

Our study presents a four-step approach to navigating the complexity: <http://rb.digital/2fMRTp3>



CONSTRUCTION

Building information modeling: act now

Building information modeling (BIM) is about to change the face of the construction industry. It will speed up the process of managing building projects, increase efficiency and ultimately cut costs. Yet BIM

poses a threat to many existing business models. Those who fail to adapt risk being left behind. Roland Berger expert Philipp Hoff warns that "companies without access to the system will see themselves disappear from the market in the medium term. They will not be visible on the platform, and the process of collaborating and coordinating

with them will therefore cost others time and money." BIM is more than just a set of digital tools for people to use. It's about effecting real digital transformation within companies.

→ ACHIEVING REAL TRANSFORMATION

There is no "one size fits all" solution. Develop one that's right for you: <http://rb.digital/2wsHR77>

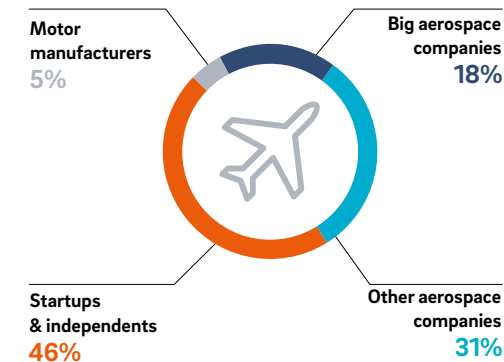
AVIATION

The next chapter in flight development

We are on the cusp of a revolution in the aerospace and aviation industries. Electrically propelled aircraft will become the new norm. The move towards electric aviation has just begun. A significant number of barriers remain. Market demand is limited for the short-haul flights that are currently feasible. Technologically speaking, new batteries, motors and configurations must still be developed. We evaluate the landscape and possible applications. We then group the potential technological and regulatory changes into four scenarios, mapping the future of electric aircraft and implications for the industry.

Most developments are undertaken by independents in traditional aerospace geographies.

By aircraft maker type



→ PREPARING FOR THE NEXT TREND

Understand the coming revolution. We present four scenarios: <http://rb.digital/2xw3SNZ>

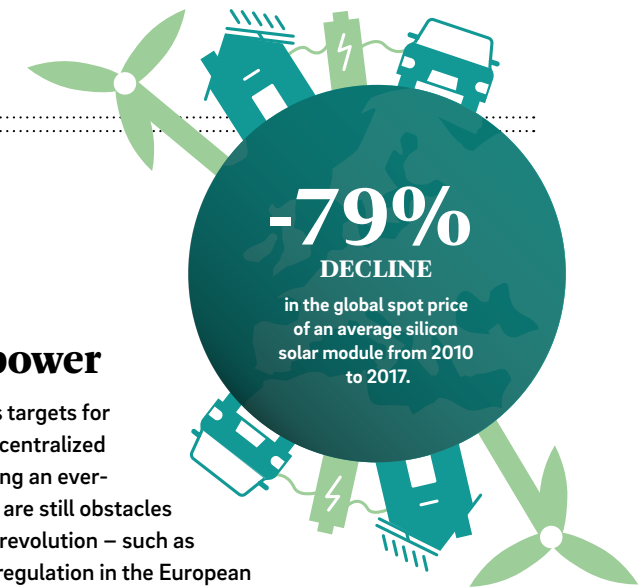
ENERGY

Flipping the switch on centralized power

The EU has set ambitious targets for the energy transition. Decentralized energy systems are playing an ever-increasing role. Yet there are still obstacles on the path to an energy revolution – such as the lack of standardized regulation in the European energy market. We asked 50 experts to identify key factors influencing the development of European decentralized energy systems through 2035. They responded with 13 critical uncertainties and 16 future trends, which we then group into four future scenarios. One thing is certain: Policymakers and market players must act to make decentralized energy in Europe a success.

→ SHINING A LIGHT ON THE FUTURE

From a slow-moving market to a green revolution. Learn about the scenarios reshaping the industry: <http://rb.digital/2ztQLBN>



REGENERATIVE MEDICINE

From treatment to healing

Regenerative medicine promises novel therapeutic approaches that can replace or restore the function of tissues and even entire organs. This is a major shift for the industry – with implications for the treatment of damaged organs, cancer, genetic disorders and autoimmune

diseases. Yet Big Pharma is currently less active in this field than other players. There is a real risk that they might miss out on the opportunities. We assess how players can evolve from drug product manufacturers to providers of therapeutic interventions. We also investigate what strategies will be necessary to secure their future position.

→ SHAKING UP THE HEALTH CARE SECTOR

Don't miss out on the next wave in the industry. Reexamine your position and develop a strategy: <http://rb.digital/2xUEcyf>

Should We Fear the Singularity?

Writer and scientist **VERNOR VINGE** coined a term in 1993 to refer to artificial superintelligence rising and fundamentally changing civilization. Here he answers three questions on the reality of his idea: **singularity**.

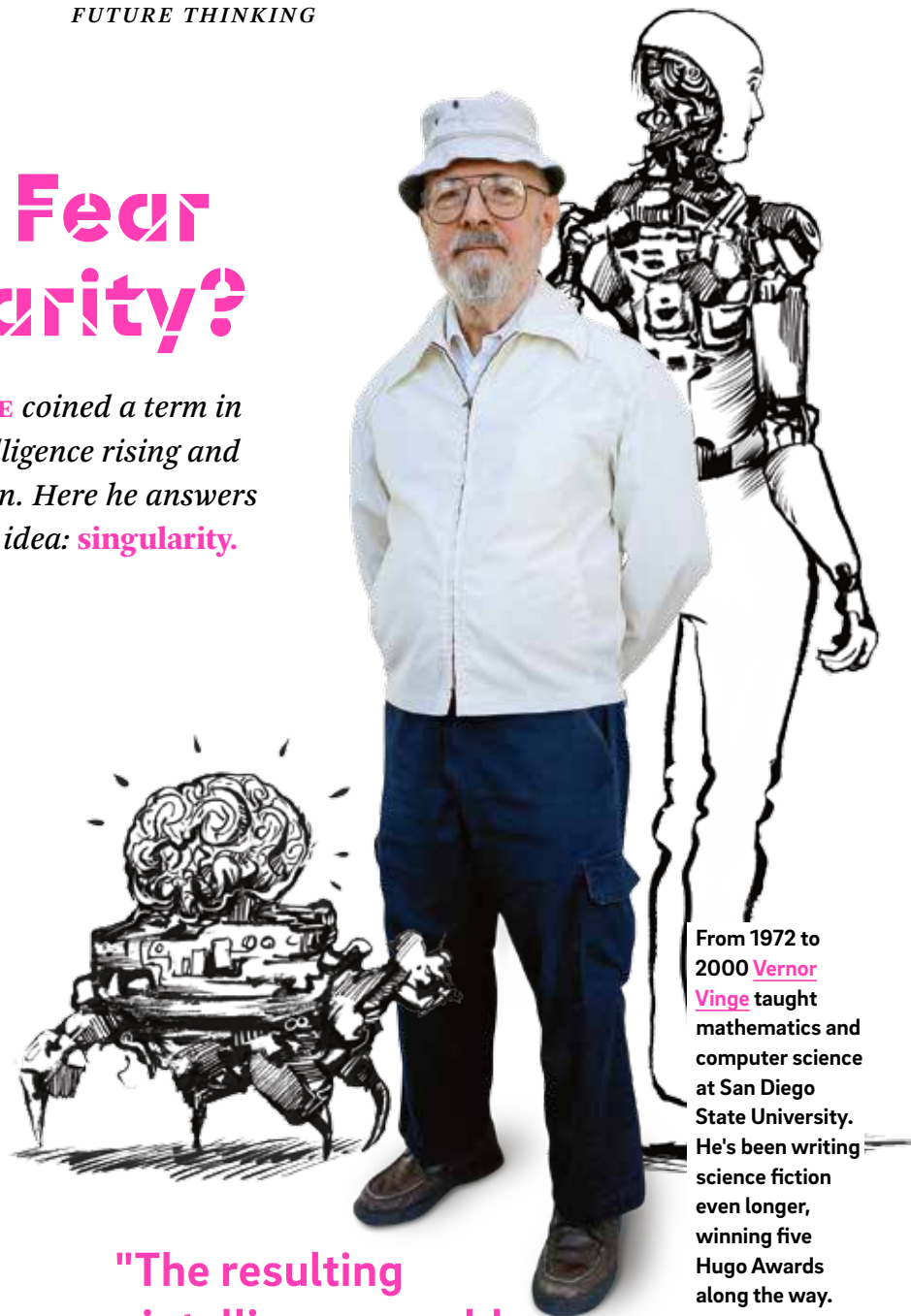
1 Is the concept of the singularity something you take seriously?

Yes, where "singularity" means the rise, via technology, of superhuman intelligence. If such a development is possible, I'll be surprised if it hasn't happened by 2030 – and all that could prevent or postpone it would be the civilization-ending catastrophes that we spend so much time worrying about.

2 How would you deal with the possibility of the singularity?

Thinking about the singularity is intrinsically different from other technological prognostication. Even if we have little hope of understanding the post-singularity world, we can influence the initial conditions. Perhaps the most dangerous issue is the transition speed: A "hard takeoff" into the singularity might take just a few months (or a few hours!), too fast for any human planning. A "soft takeoff" might last years or decades, giving planners time to guess which way to jump.

There are a number of different scenarios. One is that the internet and its human users "wake up" as a superhuman group mind. This could be the softest of takeoffs. Or maybe humans develop user interfaces as intimate and convenient as access to our own biological minds. Call this Intelligence Amplification (IA). The resulting superintelligence could still be us (and so it's time to



"The resulting superintelligence could still be us."

think about being nice). Then there is the pure AI scenario – the machines wake up. A lot of serious thought has been put into this possibility. Or perhaps the internet of things grows to support sensors and effectors everywhere. Individual nodes may not be superhuman intellects, but the result is waking up in a digital Gaia. The upside (and the downside) is that our real world could take on the volatility that we associate with financial markets.

3 What optimistic future do you see for a world with the best possible implications of the singularity?

Cheer up! Of all the existential threats we face, the singularity may be the only one with significant upside possibilities. In fact, those positive possibilities are breathtaking, addressing fundamental questions we've had throughout human history. Some things are so positive they're a little scary. ■

PHOTO: TERRY AND MARY SMITH; ILLUSTRATION: SASAN SAIDI



We have produced two unique covers for this special issue of **THINK:ACT** on AI. The composite images of a male and female face seek to portray how important human intelligence will still be in an AI world. Whatever the future holds, there is a need for balance between the technological and the human, the male and the female, the artificial and natural. These two images were created by Turkish photographer and artist Erkin Demir.

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Published in February 2018

*A home transformed by the lightning
the balanced alcoves smother
this insatiable earth of a planet, Earth.
They attacked it with mechanical horns
because they love you, love, in fire and wind.
You say, what is the time waiting for in its spring?
I tell you it is waiting for your branch that flows,
because you are a sweet-smelling diamond architecture
that does not know why it grows.*

Poem written by 

(based on an algorithm written by Zackary Scholl)