OBSERVE

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SCIENCE AND TECHNOLOGY

A SPECIAL ISSUE

ODGERS BERNDTSON

OBSERVE

The Odgers Berndtson Global Magazine_

No. 13
Issue 01 2018

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INSIDE:

Food security
The future of construction
Dark factories
Women in science
And much more

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The great futurist Isaac Asimov once wrote that "the saddest aspect of life right now is that science gathers knowledge faster than society gathers wisdom". He may well have been right. If you add in technology as well then society has a lot of catching up to do.

The inexorable pace of development in science and technology that we witness today is unparalleled in human history. Some call it the fourth Industrial Revolution, or Industry 4.00, wherein the incorporation of advanced digital technologies in virtually every aspect of our daily lives is simply breathtaking.

Take a look at our in-depth piece on food security and food production to see how technology and science have become vital bedfellows as we endeavour to solve the looming global food crisis.

We also look at how women in science and tech continue to push the boundaries of what's possible; learn how the construction industry must change if it is to benefit from new technologies; understand how the so-called 'unbanked' in Third World countries are using financial technology; delve into 'dark' factories (you won't see very much!) and look what leaders must do to combat cybercrime. Our profile is of Erik Anderson, tech entrepreneur and newly appointed Chairman of Singularity University.

There's much more in this issue that we hope stimulates your mind and – like Professor Asimov – encourages you to think outside the box. There has never been a more crucial moment to do so.

Lisa Hooker
Partner, Technology Practice,
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Observe
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Science and technology news from around the globe

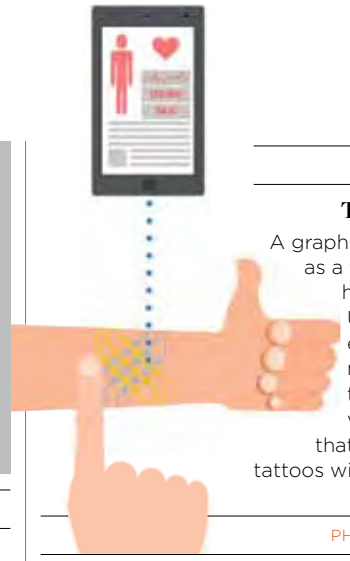
GEOGRAPHY 2050

FUTURE OF MOBILITY

The American Geographical Society's annual symposium, Geography 2050, held at the end of 2017 in New York, included some fascinating speakers. Among them was James Arbib from the think tank RethinkX. Arbib delivered a stimulating paper in which he declared that in 10 years' time Transportation as a Service – or TaaS – will be the norm, with electric, autonomous vehicles handling 95 per cent of passenger miles. Arbib declared that not only do electric vehicles last longer than gasoline-powered cars, they have fewer moving parts. It also costs far less to use TaaS than to own a car.

Meanwhile, Bruce Upbin from Virgin Hyperloop One reckons that with the advent of Hyperloop technology workers could commute from Chicago to St. Louis in 20 minutes in a magnetically levitating train housed inside a vacuum chamber. Fasten your seat belts!

geography2050.org



MEDICINE

THE POWER OF GRAPHENE

A graphene-based tattoo that could function as a wearable electronic device to monitor health has been developed at the University of Texas. Gold is often used in electronic components, but graphene is more conductive, can be hundreds of times thinner and allows the tattoo to wrinkle naturally with skin. It is hoped that as the cost of graphene falls, such tattoos will become affordable for medical use.

PHOTOGRAPHY

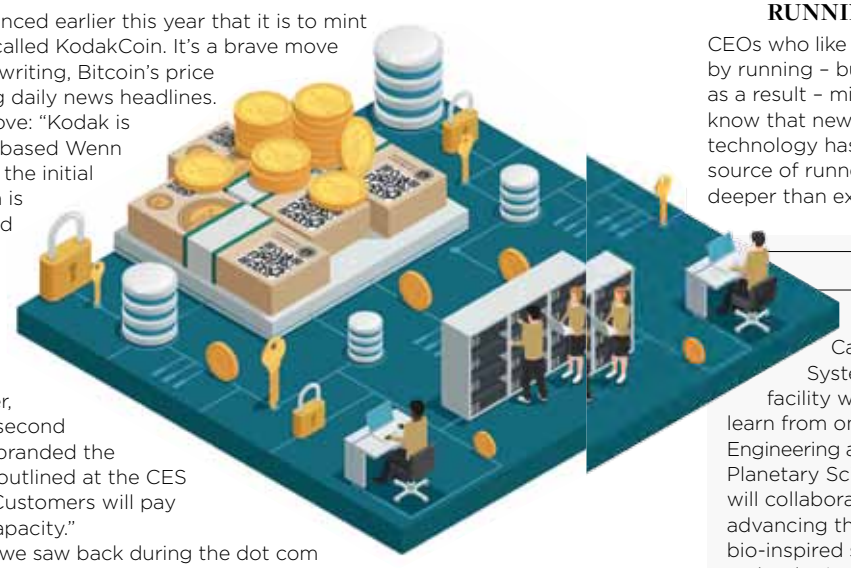
ENTER KODAKCOIN

The US firm Kodak announced earlier this year that it is to mint its own crypto-currency called KodakCoin. It's a brave move given that, at the time of writing, Bitcoin's price volatility has been making daily news headlines.

The BBC said of the move: "Kodak is teaming up with London-based Wenn Media Group to carry out the initial coin offering (ICO), which is part of a blockchain-based initiative to help photographers control their image rights. Kodak also detailed plans to install rows of Bitcoin mining rigs at its headquarters in Rochester, New York. Details of this second scheme – which is being branded the Kodak KashMiner – were outlined at the CES tech show in Las Vegas. Customers will pay up-front to rent mining capacity."

"This is a phenomenon we saw back during the dot com days in the late 1990s, where traditional companies would mention some kind of internet strategy and their stock price would jump up," commented Garrick Hileman from the University of Cambridge.

kodak.com



IMAGES: SHUTTERSTOCK/ALAMY

SCIENCE

RUNNING SCARED

CEOs who like to work off pressure by running – but suffer back pain as a result – might be interested to know that new motion-capture technology has revealed that the source of runners' back pain lies deeper than expected.

Scientists at Ohio State Wexner University Medical Center collected data using a motion-capture system and pressure-sensitive plates as participants ran around a track; the researchers then used the findings to 3D-model bones and muscles in a moving human body.

Livescience.com noted: "The models showed the different muscle groups at work during endurance running. The scientists learned that much of the back-supporting burden was carried by muscles in the body's deep core, rather than by the surface abdominal muscles that core-strengthening workouts typically target, according to the study. This could explain why some runners experience back pain even though they perform exercises thought to build core strength."

wexnermedical.osu.edu

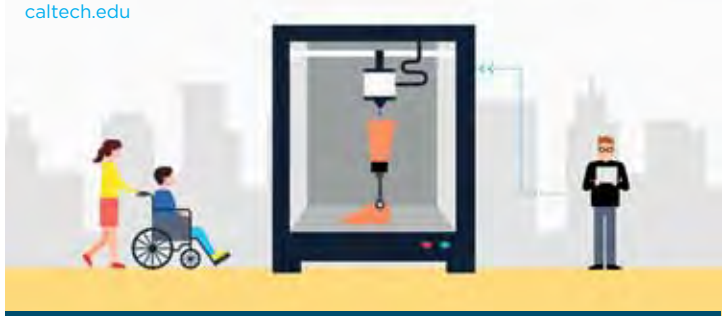
RESEARCH

AUTONOMY RULES

Caltech has opened its new Center for Autonomous Systems and Technologies (CAST), a 10,000-square-foot facility where machines and researchers will work together and learn from one another. Researchers from Caltech's Division of Engineering and Applied Science (EAS), Division of Geological and Planetary Sciences (GPS), and the Jet Propulsion Laboratory (JPL) will collaborate to create the next generation of autonomous systems, advancing the fields of drone research, autonomous exploration and bio-inspired systems. Researchers will continue pioneering work on technologies ranging from prosthetic legs that use machine learning to automatically adjust to a wearer's gait, through to a flying, self-driven ambulance.

"The goal is to teach autonomous systems to think independently and react accordingly, preparing them for the rigours of the world outside of the lab," says CAST Director Mory Gharib, Hans W. Liepmann Professor of Aeronautics and Bioinspired Engineering.

caltech.edu



See our feature on 10 'under-the-radar' developments in science and tech, starting on page 22

Odgers Berndtson and Singularity University

Silicon Valley-based non-profit Singularity University (SU) will hold its third Summit in Berlin on June 4-5, 2018. The conference offers German business innovators and decision-makers a high-level programme packed with inspiring new ideas, as well as insights into the technological challenges and opportunities for industry, society and the environment.

SEBASTIAN GABSCH

"The SU Summit demonstrates the value of the latest technological trends for mankind," says Markus Trost, a partner at Odgers Berndtson Frankfurt and an expert on transformation processes through digitisation. Trost led a session titled 'The Future of HR' at last year's Berlin Summit, which was sponsored by Odgers Berndtson Germany.

SU aims to tackle challenges like poverty, education, energy, health, nutrition, environmental degradation, water scarcity and the settlement of space, using technologies including bioinformatics, artificial intelligence, neuroscience, robotics and nanotechnology.

Find out more at: su.org, singularityugermanysummit.org
See our profile of the new Singularity U Chairman, Erik Anderson, on **pages 12-15**

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Manufacturing

The introduction of so-called ‘dark factories’, entirely run by robots with no need for artificial light, is closer than you might think...

LIGHTS OUT

Dark factories? Surely a misnomer. How can factories operate in the dark? The answer is simple. Remove all human intervention in the manufacturing process and you don’t need to spend money on expensive lighting and other typical (human) needs. You can simply close the door and leave your army of programmed robots to get on and do their stuff – 24 hours a day, seven days a week, without a labour dispute or walkout to so much as bother them.

Enter the era of the dark factory. Writing recently on the appropriately named smart factory website*, Matthew Carr, Emerging Trends Strategist at The Oxford Club (a private, international network of investors and entrepreneurs), gave the following example of how dark factories are edging ever closer: “Changying Precision Technology Company [in China] might be the model for the future of manufacturing. Its mobile phone factory used to employ 650 workers. Now it needs just 60. The company eliminated 90 per cent of its human workforce and replaced it with 60 robot arms. The results are mind-blowing. Productivity increased 250 per cent, while product defects decreased 80 per cent.

“The robots run 10 production lines that are going 24/7. The only human workers left are there simply to ensure everything runs smoothly. But Changying Precision Technology believes the number of humans can be reduced to as few as 20.”

Not quite there yet, but a clear signal for what’s to come. Carr cited another eye-opening example of the push towards robot-run dark factories: “Last year, Amazon’s robot workforce increased 50 per cent to 45,000 across 20 order-fulfilment centres. Amazon’s robot army is now larger than the Netherlands’ actual army.” He does, however, qualify this astonishing statistic by adding that Amazon still currently employs 200,000 full-time and seasonal human workers.

Also in China, where it →

is evident that the push towards dark factories is gathering significant momentum, one company, Cambridge Industries Group (CIG) founded by Gerald G. Wong, pushes a vision of a dark factory that is fully automated, highly scalable and allows for flexible electronic manufacturing. His team is working hard to make this vision a reality, establishing CIG at the forefront of Industrial Revolution 4.0 (or Manufacturing 2025 as China puts it in its national strategy). Part of the production at the factory in Shanghai already runs on highly automated lines.

Yan Vermeulen, a Partner in the Odgers Berndtson Singapore office and Head of the Southeast Asia Industrial Practice, is more sceptical: "In principle I don't think dark factories are a drastic change. Factories have been getting more automated for many years. The only difference is turning the lights off, but this is more an economic decision than anything else."

More significantly, Vermeulen says that the shift to dark factories "will take out manufacturing employment in commodity segments that don't need either high manpower involvement or high technology involvement, meaning there will always be industries that either require a lot of people to assemble or manufacture, or require high-end engineers to be on site for production."

However, in the US, Jim Johnson, Vice-President and Director, North America Thermal Operations at VALEO, says: "As an industry we are thinking about [dark factories], and for our business the place it makes most sense is in our chip manufacturing, where there is no need for human interaction."

> **More automation means companies will free up cash for R&D and innovation...**

Anthony Coleman, General Manager, Print and Packaging at First Quality, has a similar view: "We are always seeking greater automation. Dark factories are something we are interested in learning more about and potentially striving for."

Mary Campagnano, a Partner in Odgers Berndtson's Dallas, Texas office, says: "Assessing plants for areas of increased automation, and then implementing it, is now a compelling candidate qualification. In the United States, there is less talk of US-based factories being 'lights out' due to the perception of fabrication or assembly requiring human reasoning. The counter-argument is that changes in workflow or discrete cellular manufacturing setups, such as those used in an assembly line, could be modified to allow robots to operate in 100 per cent dark factories. The opportunity – of course – is that every 'bot' requires significant programming, troubleshooting and ongoing maintenance directed by human talent. I see it less as eliminating human jobs but changing and elevating them."

Vermeulen adds: "More automation means companies will free up cash for R&D and innovation to stay ahead of the competition. The focus will therefore be on hiring more skilled engineers and scientists."

Michael Drew, Head of the Technology Practice at Odgers Berndtson in London, agrees: "The combination of automation and artificial intelligence has led to co-operation between machine and human in the modern workplace being more symbiotic than ever before. It's still very early in this evolution, but the movement towards coexistence with intelligent machines is gaining momentum. We are already seeing it in areas of low-skilled manual labour.

"Technological advancement is also gradually seeping into higher-skilled roles like contact centres. Software robots powered by artificial intelligence answer customer queries or problems without any form of human involvement.

"When one job function disappears, another takes its place. As long as companies are both prepared and encouraged to re-skill their workforce, and higher education can fill the pipeline of talent with the new skills needed, the job market will continue to sustain the population." ■

**smart-smt-factory-forum.com/general/cig-why-a-dark-factory-should-not-scare-you*

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- Exonomics (Exponential Economics)
- Ethics in a Changing World
- Global Policy & Development
- Future Forecasting

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A singular man

Erik Anderson is not your typical tech entrepreneur. He is involved in numerous projects, from chess apps to Singularity University, where he has just been appointed Chairman. JONATHAN ARNOLD spoke to him

Before I interviewed Erik Anderson I assumed, because his daunting track record suggested so, that he would come across as some kind of whirling dervish entrepreneur. Intense, pressed for time, full of jargon, not one for pleasantries. I confess that I felt slightly intimidated by his awesome (and it really is the right word) CV.

A daunting list

But my concerns were unfounded. Anderson is positively modest when I challenge him on how he keeps all of his various activities going. It's a daunting list. He is CEO of WestRiver Group, which provides "integrated capital solutions for the global innovation economy", and is Executive Chairman of Topgolf Entertainment Group, described as "the premier entertainment and event venue with fun point-scoring golf games for all skill levels". Across Topgolf venues in the US and UK 'players' can score points by hitting microchipped golf balls at giant dartboard-like targets on an outfield. The closer you get your ball to the centre or 'bullseye' and the further the distance, the more points earned.

Anderson is also the newly-appointed Chairman of Singularity University – the Silicon Valley-based think tank created by luminaries such as Ray Kurzweil, with affiliates around the world – which seeks, no less, to "educate, inspire, and empower leaders to apply exponential technologies to address humanity's grand challenges" (more on that below). In addition he is Vice-Chairman of ONEHOPE, a "cause-centric consumer brand and technology company most commonly known for its award-winning wine and world-class vineyard in Napa, California", and founder of America's Foundation for Chess, "currently serving 160,000 children in the United States with its First Move curriculum".

As if that weren't enough, he also serves on the Board of Play Magnus, an interactive chess app and foundation created by reigning world chess champion Magnus Carlsen. To date the Play Magnus application, which features adjustable difficulty levels for chess players of various skills, is estimated to have had more than one million downloads. Finally, Anderson is on the Board of Avista Corp, an energy management company – as we'll see, it's a project close to his heart.

Exponential change

With a roll call like this it will come as no surprise to learn that last November Anderson was named by Goldman Sachs as one of the '100 Most Intriguing Entrepreneurs of 2017' at its Builders + Innovators Summit in Santa Barbara, California; one of a number of such accolades he has received. He is as comfortable talking about the future of technology and science as he is about the learning benefits of chess, which is perhaps unsurprising given his background. He earned a master's and bachelor's degree in Industrial Engineering from Stanford University and a bachelor's degree →

Above: Erik Anderson. Opposite all images (apart from top right): Experimenting and discussing problems at Singularity University; a young schoolchild engrossed in the problems chess presents

Far left: Singularity students at Hangar One in California, one of the world's largest freestanding structures; left, top: children engaging with chess in a US school; left, below: robot work at Singularity University

(Cum Laude) in Management Engineering from Claremont McKenna College.

I ask Anderson what the term 'technology' means to him today given everything he is involved with has some kind of technological slant. "People used to think, or even today think, of technology as somehow 'outside' of themselves, that it's *away* from you. Electricity is a simple starting analogy. People hit a switch and lights go on, but they know nothing of how it's created. It was something you accessed. Technology in the future will be much more intimate and integrated *within* us. Take contact lenses. Who would have thought about putting a piece of glass or plastic in your eye? Is technology the right word? I can't think of another one. It's actually more about understanding. We've always been fearful of technology in a way. Technology amplifies everything and therefore it has a lot of risk, but there's no turning back from it."

Anderson acknowledges that "everything is just going to move faster", that we will have to move on from traditional "linear thinking" and really understand exponential change. Like many he believes such areas as AI, blockchain, smartphones, machine learning and drones will all be key to the development of future technology, but Anderson also refers to something less widely known: CRISPR, an acronym for Clustered Regularly Interspaced Short Palindromic Repeats. In short, it's technology that is revolutionising the field of genome editing.

Anderson is captivated by what this kind of work can do for us in the future. He cites the story of a young boy with a terrible genetic disease who had lost 80 per cent of his skin. "In the past, he would have died," says Anderson. "But scientists were able to genetically alter the boy's skin, eliminate the genetic problem and regrow it. The boy was put in a coma for four months while his skin was 'rebuilt'. Now he's playing soccer! Ten years ago we couldn't have imagined that. There's no more exciting time for science and tech. Evolution will take on an entirely new definition."

Ever the optimist

Says Anderson: "Will there be periods of great disruption? Sure. But I am an optimist. You either say 'I am going to get there' or you dig your heels in and try and slow it down. But it's not going to stop, and that's why mindset is so important. Singularity is a platform to transform mindsets and how you think about the world. Thirty five thousand people from 130 countries go through this learning journey at Singularity, including some of the most influential leaders in the world. Singularity is an optimistic place. We believe that technology can fundamentally change the world. We describe it as an abundant place."

A labour of love

How does Anderson decide which activities to get involved with? "Do I think they have scale, and is there a compelling value proposition," he avers, although with energy company Avista there is a rather more touching reason. "My dad worked there," he adds, "so that's kind of a labour of love because it's based in my home town of Spokane, and I liked doing that." Although tech and science are crucial, Anderson is very much a family man. His wife Deborah and children Natalie, Claire and Trevor are at the epicentre of everything.

As to the other projects Anderson is involved with such as Singularity, Topgolf, WestRiver and the various chess activities, each "has scale and purpose to them as well as a value proposition". Anderson says: "Topgolf is about transforming a sport, creating fantastic cultures and thousands of jobs. It's a global brand so there's a lot of scale there. It's fascinating to be able to take a piece of tech and create a brand and experience around it." Anderson makes a critical observation about the typical millennial user of Topgolf's technology. "For millennials the experience has to be authentic. They're not excited about top-down advertising. They like experiences that create communities in the same way Facebook or Instagram do. That's really important. The other element is about the 'why?'. What's the purpose? What's connecting people in meaningful ways? Topgolf is about these connections."

His early years in Washington State also played a significant role in Anderson's chess interests. "I grew up in the early 1970s in a small rural area outside Spokane in the Bobby Fischer era, when he was world champion. I played chess with my good friend Robbie Patterson. Sadly he died early from cancer, so there's always been an emotional connection with the game. I looked at how valuable chess was in terms of pattern recognition for young people. When I look at all the businesses I work with there's a fundamental set of patterns that allow me to think at a high level. Chess allows me to honour that early relationship.

"Chess can act as a toolkit for kids going forward in their lives. We had a pretty good analogue chess programme, but we're now partnering with a company called Quill and putting it on a digital platform that will drive cost down even further and allow parents and kids to get real-time feedback. That's the beauty of it: once it goes digital, it goes exponential."

It might be fanciful to describe Anderson as a 21st-century Renaissance man, but when I ask him what book he is currently reading he tells me it is a highly regarded new biography of Leonardo da Vinci.

It seems entirely appropriate. After all, I can think of no better place for Anderson to derive inspiration for his next project. ■

Food for thought

NATASHA D'SOUZA takes an in-depth look at how dynamic companies and inspired individuals are tackling the looming crisis in food production and security

As the global population continues to rise rapidly, food security – the supply of and access to nutrition that fulfils dietary needs – is becoming increasingly critical and complex. A convergence of issues including climate change, population growth, economic blips, resource scarcity, regional conflict and resulting population displacement are pressurising global food systems on a previously unknown scale.

The Food and Agriculture Organization (FAO) of the United Nations reveals that although global food production meets the dietary needs of our current global population, almost every ninth person in the world is undernourished. Despite the steady decline in world hunger over the past decade, new FAO figures show the estimated number of undernourished people increased from 777 million in 2015 to 815 million in 2016, affecting approximately 11 per cent of the global population, with the vast majority of the undernourished (780 million people) living in developing regions across Africa and Asia.

"More than ever, significant advancements in science and technology are essential towards ensuring global food security," says Ron Woessner, a Partner at Odgers Berndtson's Minnesota office. According to Woessner, with global population growth projected to reach around 10 billion by 2050 and the impending need to double food production within that timeline, a timely and well-orchestrated implementation of new technologies is required. Both science and technology have long played a major role across every aspect of the food security framework, from food availability (genetic modification, soil fertility, irrigation technologies) to food accessibility (post-harvest and agro-processing technologies) to food stability (biofortification – the process by which the nutritional quality of food crops is improved through agronomic practices, conventional plant breeding, modern biotechnology, and climate-smart solutions). Although genetic modification (GM) is not new, there are significant developments that demonstrate how the science is still 'leading edge'. →

PHOTOS: ALAMY/SHUTTERSTOCK/REX

"I heard it said once that a well-fed nation has many problems, a starving nation has just one," remarks Carl Casale, former CEO of CHS Industries, the Fortune 100-listed agricultural co-operative in the United States. Casale, an agribusiness veteran and a former Executive Vice President and CFO at Monsanto, believes the "tradition-bound" world of agriculture is on the verge of "a perfect storm" in part due to the socio-economic, cultural and technological shifts occurring in parallel. He adds: "Agriculture has historically been resistant to change because farmers, owing to the very nature of their work, are incredibly risk-averse. Think about it: they only have limited opportunities to do it right. One wrong move and their entire crop, if not entire farm, could be at risk."

With an ageing farmer population in much of the developed world (according to Casale, the average farmer in North America is 58 years old), increasing consolidation of small farms and acquisitions by large (often tech-savvy) corporates, and the steady inroads made by technology, Casale believes the next decade will usher in the kind of transformation that tech startups have wrought on all manner of industry. "Transformational technology such as blockchain, for example, allows a level of accuracy and traceability that we have never seen until now. That kind of transparency creates major ripple effects on everything from pricing to people's knowledge about the nutritive value and ethical production of their food."

The rise of GM

The kind of dramatic change that Casale foresees is one known all too well by Sir David Baulcombe, the celebrated British bioscientist credited with the discovery and characterisation of a ribonucleic acid (RNA) silencing system that protects plants against viruses. RNA plays a vital role in protein synthesis and gene regulation in both plants and animals. Baulcombe's work on genetically modified (GM) plants spans more than 30 years, winning numerous accolades and, by some accounts, stirring several controversies.

"Initially there was significant scepticism towards the usefulness and applicability of GM technology," recalls Baulcombe. "Slowly, as more and more GM crops were being produced, evaluated for their safety and nutritive value and then released for use by farmers, there has been an incremental increase in the public's acceptance. I anticipate that over the next five years or so GM crops will become more the norm than the exception, but only time will tell."

Genetic modification was the first early reckoning for the sweeping change that scientific inquiry brought to agriculture, ushering in the development of new high-yielding crop varieties resistant to climate change, disease and pestilence. Its earliest success was during the 'Green Revolution' of the 1960s and 1970s, which saw substantial increases in rice and wheat yields across Asia, saving almost a billion lives on the continent.

Despite decades of research on GM crops, today only nine varieties are available globally, ranging from cotton to sweet corn, with several more still held back by long-drawn regulatory checks. For instance, in November 2017 the Indian government's Environment Ministry halted release of GM mustard – under development for over a decade – despite clearance in 2016 from India's top biotechnology regulator declaring the transgenic mustard plant "safe for consumption".

An Indian farmer checks mustard flowers at a farm at Walla, near Amritsar, in November 2016

As Regius Professor of Botany at the University of Cambridge and a Royal Society Research Fellow, Baulcombe's current research includes hybrid tomatoes and genetically engineering maize to resist a lethal disease endemic to Kenya, Uganda and neighbouring African countries. "Maize disease or 'necrosis' is a major problem in East and Central Africa. We are looking at doing a trial of some GM varieties over the next year," he explains. "When it comes to genetic modification, we are just at the tip of the iceberg."

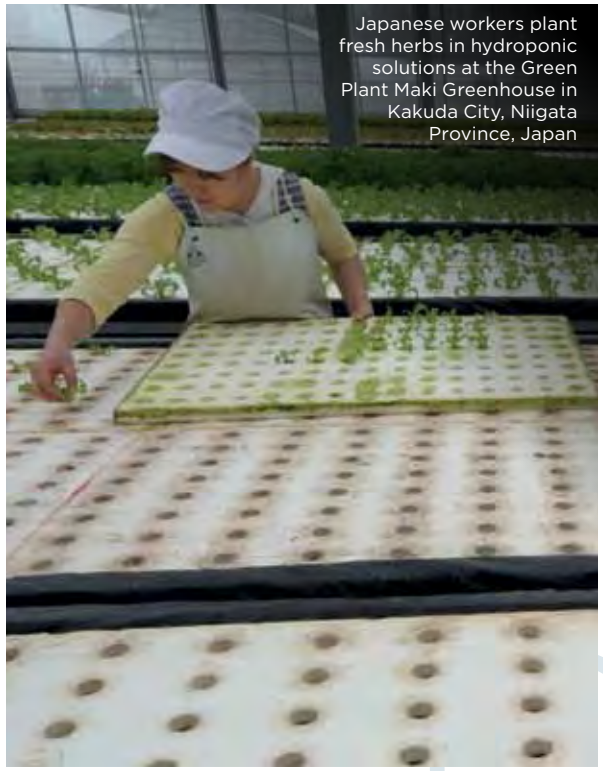
"It's an open secret that farms are typically managed with chainsaw precision versus scalpel precision," says Sherman Black, the new CEO of early-stage American ag-tech startup Conservis. Black, a veteran IT professional, returned from retirement last year to lead the enterprise and believes this role is "my most noble one yet, spending the last chapter of my career helping farmers grow better food".

> When it comes to GM we are just at the tip of the iceberg...

Conservis provides farmers with a cloud-based software solution that enables compliance, tracking, traceability and performance management, allowing them to track field activities, manage inventories and analyse yields, all at the touch of a button. "It started with a handful of farmers asking the founders to help with workflow management," recalls Black. Today, industry leader Conservis is used by some of the most successful agricultural producers, managing over US$8 billion in land, equipment and crop assets primarily across North America, with initial traction in Australia.

A shift in agriculture

So are farmers joining the digital bandwagon? Not as quickly as Black would like, but he contends the industry is on the cusp of a major shift when it comes to food production. "Much of agriculture today is essentially a manufacturing process: we operate like it is the '80s and '90s. Think of the tremendous →



Japanese workers plant fresh herbs in hydroponic solutions at the Green Plant Maki Greenhouse in Kakuda City, Niigata Province, Japan

leaps we made when it came to the mobile phone. Just 10 years ago, who would have thought we'd want all this functionality in a single phone? The shift in agriculture will be very much like that. Farmers are no different to anyone else: once you reach the threshold of inevitability, you either get on board or get bought out by a larger and more tech-savvy co-operative."

The cloud and big data technology championed by Black plays a prominent role in the precision farming domain. Once the mainstay of industrialised farms, new applications of precision farming are finding success with small farmers, even in developing nations. A Tata Chemicals trial in the northern Indian state of Uttar Pradesh revealed that use of a precision 'leveller' can improve yield by almost 300 per cent compared to yields from the traditional method where farmers used a wooden plank hooked to an ox to level fields, an imperfect technique that leads to uneven water distribution. With almost 500 million small-scale farms producing more than 80 per cent of the food consumed in large parts of the developing world, such exponential effects could result in enormous gains for global food security.

For Black, the case for technology-aided precision farming is a clear-cut one: "A digital service doesn't depreciate; the more you use it the more valuable it is, as opposed to a tractor." He passionately extols how data can amplify and sometimes unlock value across the entire food production chain. "Think about access to capital, something virtually every farmer right now considers a major challenge. If I own a small farm and I'm looking for funding, potential lenders look for precise information and real-time data about my farm, and that data burden increases once you have a loan. Data tells a story, and both bankers and farmers alike need to know real numbers, do their profitability analysis, scenario analysis, all with just a few clicks. Data allows for accuracy. Mobility is the mantra for product design today. The days of having to drive your car from one field to the next or rely on staff to manually record data ought to be a thing of the past."

Casale contends that technology is both a multiplier but also a barrier to entry, especially for older-generation farmers. He is particularly excited about blockchain: "It will have a profound impact, both on understanding food production and on transparency from a food safety standpoint."

Monitoring every crop

From pulling data via Bluetooth to using geomapping, Black and Casale are not the only ones believing in the power of big data and computer imaging when it comes to food security. Dr. Fumiya Iida, a lecturer in Mechatronics [technology combining electronics and mechanical engineering] at Cambridge University, sees computer vision and image analysis as "the most important technological progress for the purpose of food security. Images obtained from satellites, drones and other types of machines can now be processed automatically by computers with relatively low cost, which allows us to monitor crops and logistics chains, thereby securing the quality control."

Iida believes that although technology has just started being deployed in some agricultural sectors, early implications are impressive. "Sooner or later we'll be able to monitor every crop, especially high-value ones such as vegetables and fruits, across the entire production and logistics chain, from seeding to the supermarket."

Robotics is another nascent yet fast-growing technology quickly penetrating the farming world. It appears the age of robotic farms is well and truly upon us as researchers in Shropshire, England proved this year, sowing and harvesting a field of barley relying entirely on robots.

Iida, who recently received a Royal Society Translation Award to investigate the potential to commercialise his latest creation – a robot capable of working on a farm – has been seeking ways to develop what he terms 'soft robots' – robots made from materials such as rubber and sponge, as opposed to the rigid materials found in conventional robots. One of Iida's latest collaborations yielded a self-sustaining soft robot, complete with a mouth and an artificial gut.

Precision agriculture (PA) using GPS during planting and seeding with site-specific crop management (SSCM) in Lancashire, UK

Farmer using technology in a tractor for soybean harvesting in Minnesota, USA

Science: food security

Baulcombe anticipates that emerging, experimental technologies, such as artificial photosynthesis, are especially radical solutions for food and fuel in the future and demonstrate "hugely interesting" early results. "Existing crops and plants are not as efficient as they could be. There is incredibly exciting and cutting-edge work being done at the University of Illinois that is exploring how we can maximise the results of this fundamental process by which plants manufacture carbohydrates, and therefore energy. Imagine achieving massive increases in yield without increasing land area."

Inspired by disruption

While revolutionary changes in science and technology hold much promise for food security, real change can only come about by the people in charge leading both cohesively and conscientiously on the field (literally). "Ultimately science and technology cannot yield impact on its own – it takes visionary leadership to drive it forward," states Odgers Berndtson's Ron Woessner. "Tomorrow's agricultural leaders have to have a global mindset and incredible translative capacity, someone who can both communicate and empathise with farmers, financiers and consumers."

Inspired by the phenomenal disruptive ability of technology, an entire cadre of new leaders and young entrepreneurs are leveraging (sometimes simple) technology to enhance food security in some of the world's most challenging environments.

Woessner believes that a new era in agriculture – anchored in a world where commerce, science and technology are changing at breakneck speed – hinges on a collaborative mindset.

"Leadership is not about one person doing everything, it's about enabling everyone around you to realise a common vision. Food security is a common goal we share with everyone around the world," he says.

Casale agrees. "This perfect storm ahead needs a fundamentally different leader, one who is far more adaptive, forward-looking and inquisitive. The core skills are not so much about functional knowledge as they are about transformative leadership. When you couple that with technology, that's when seismic change happens." ■

THE SHAPE OF THINGS TO COME

Observe tracks down 10 of the most intriguing, under-the-radar research projects in science and technology

FACE DETECTION CHINA
Chinese company Megvii has developed Face++ technology allowing people to buy anything from cinema tickets to fried chicken using only their face. If users have previously added their photo to a database, a Face++ 3D camera quickly identifies them as they wait to pay by measuring characteristics such as the curve of their cheekbones. It is currently being trialled by Alibaba and KFC.
bit.ly/2ny71tM

ANOTHER REASON TO LOVE SPINACH USA
Scientists at Worcester Polytechnic Institute are using spinach leaves to create beating human heart cells. They say that the similarity in vascular network structures between plants and animals means that it is possible to use multiple spinach leaves to grow layers of healthy heart muscle to treat heart attack patients.
bit.ly/2BHVXzr

CLOAKING TECHNOLOGY AUSTRIA
Researchers from the Technical University of Vienna are using special light-wave technology to make objects invisible. Powering a laser beam with a specific wave pattern on to an object from above can make it 'hide' from view. The university says it opens up new possibilities for active camouflage, making fans of *Star Trek* and *Harry Potter* very excited.
bit.ly/2nvJzhJ

WATER FROM AIR USA
The Massachusetts Institute of Technology (MIT) has developed a new foam-like material that can obtain fresh, clean water by taking moisture from the air. It can be deployed over arid desert regions, which can help alleviate water shortages in the world's driest locations.
bit.ly/2oIVxpB

NEUROPIXEL PROBES UK
University College London has developed new neuropixel probes that can record the activity of hundreds of neurons throughout a human brain. Previous probes were restricted to measuring one neuron at a time. The development will allow scientists to better understand how people learn and why they make decisions. It could also help treat depression and Alzheimer's Disease.
bit.ly/2rUuE5b

SHUTTERSTOCK

STRESS RELIEVER USA
MIT neuroscientists are looking at decisions made under chronic stress. They have found that they could restore normal stress-free behaviour in people by fixing impairments in their brain circuits. It could help people suffering from depression, addiction and anxiety, which can all lead to poor decision-making.
bit.ly/2A5pBCh

LIQUID BREATHING TECHNOLOGY RUSSIA
The Russian Foundation for Advanced Research Projects is developing oxygen-rich liquid that can be injected into the lungs of submariners and divers to allow them to breathe and not drown underwater. Controversial experiments involving dogs have resulted in them spending 30 minutes breathing by themselves underwater.
bit.ly/2nAEtjt

LIQUID ROBOTS CHINA
Scientists have moved into *Terminator* territory as they work on creating liquid metal robots that can run, jump and change shape to fit their surroundings.
bit.ly/2nt3ttq

SWEET-TASTING QUINOA SAUDI ARABIA
The King Abdullah University of Science and Technology believes trendy superfood quinoa could help boost food security and feed the world's growing population. It has identified a gene within quinoa that can be manipulated to change the way the plant matures and make it taste sweeter. Quinoa is known for growing well in poor-quality soil, thus offering a new food staple for countries with scarce food supplies. (See our feature on pages 16-21)
bit.ly/2BIvt0B

TELEPORTATION CHINA
A group of Chinese scientists have successfully teleported particles of light between the ground and space satellites. It could lead to the creation of a 'quantum internet', much faster and more secure than the worldwide web.
bit.ly/2rXGgUY

Putting SWP at the core of your business

Berwick Talent Solutions' recent survey on the adoption of Strategic Workforce Planning yielded some concerning results, as KATE PARKER explains

Simply put, Strategic Workforce Planning (SWP) is about getting the right number of people with the right skills, in the right place at the right time and for the right cost. There are a number of recognised methodologies and toolkits which exist to guide organisations through the implementation of SWP. To be effective, there are key success factors to consider. SWP must be:

- Aligned tightly to strategic priorities
- Owned by the business, facilitated by HR/Strategy/Risk and supported by Finance
- Underpinned by workforce analytics – quantitative, qualitative and anecdotal data
- Supported by a robust change management methodology

When Berwick Talent Solutions recently asked 225 senior HR and talent acquisition professionals around the world how they viewed SWP the responses were worrying. Just four per cent of businesses, the survey showed, have fully embedded SWP into their organisations.

The purpose – and value – of SWP cannot be overstated. Its overarching aim is to define and optimise the workforce in order to execute the organisation's strategy – today and in the future. Indeed, never has there been a more critical moment for organisations – wherever they are and in whichever arena they operate – to adopt a robust and proactive SWP programme. →

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We are living in a volatile, uncertain, complex and ambiguous world, where businesses are trying to make sense of the constantly changing challenges brought on by political, economic, societal and environmental change. Implementing SWP can help businesses to mitigate risk, see around corners and prepare for uncertain futures. So executing a robust SWP methodology should be high on the corporate agenda, right?

The fact that only four per cent of survey respondents reported that they have formally embedded SWP in their businesses should surely be of concern. The minority who have successfully managed to implement it have compelling case studies of its efficacy. The full report illustrates how select businesses across the retail, infrastructure and public sectors have boosted profitability, transformed capability and gained competitive advantage through strategic workforce planning.

And when one considers that participation in the survey came from a wide range of businesses, from start-ups and SMEs to multinational corporations spanning 20 industry sectors, this is no isolated 'blip' in an otherwise SWP-enabled world.

The biggest headache for HRDs and CPOs continues to be talent acquisition and retention, and the implementation of SWP could genuinely help to counter this. While formal adoption is scarce, there is a far higher degree of conceptual buy-in. Sixty per cent of those who responded recognised the intrinsic value of SWP. More than 75 per cent of respondents cited a lack of time, resource and capability as the greatest challenges to implementing SWP, but only 10 per cent have looked to engage external consultancy to support their efforts. A pilot project to demonstrate 'proof of concept' would be perhaps the best way for organisations to build the case internally pending a wider-scale rollout.

Looking ahead, digital disruption shows the biggest growth in terms of anticipated versus current challenges. Any 'futuring' activity around the workforce must consider the automation of roles and wider adoption of AI, a case in point being a multinational delivery services business that identified its 'courier' role as being both 'strategic' and 'pivotal'. This is likely to be profoundly disrupted by the transformation of last-mile delivery by the rise of drones and 'robovan' technology.

Critically, SWP should be a vital part of your business's activity. Ignore it at your peril.

Read the full report at: berwicktalentsolutions.com ■

Berwick Talent Solutions supports its clients with project and multiple recruitment campaigns, market mapping and talent pipelining.

Kate Parker is Head of Berwick Talent Solutions

> The biggest headache for HRDs and CPOs continues to be talent acquisition

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Fuengirola (Málaga)

Are innovative and agile FinTech businesses the solution to achieving financial access for the world's 'unbanked'? MATT HIGH reports

ALAMY

The last 12 months represented a landmark year for advances in financial technology, not least due to Bitcoin's meteoric growth. Bitcoin itself may ultimately prove too volatile, but the blockchain technology that underpins it is part of an innovative industry that in 2017 saw some $6.5 billion of investment in the first six months alone.

Indeed, a number of so-called FinTech innovations are set to contribute to the disruption and widespread digitalisation of traditional financial services. Blockchain, for example, is being trialled by banks and governments worldwide, with government-backed cryptocurrencies being mooted for 2018 and Ernst & Young and Maersk reportedly launching a blockchain-based marine insurance platform this year.

AI and machine learning, while in the adoption phase, is rapidly being incorporated into financial institutions. From chat-bots that improve the customer experience, to intelligent algorithms that use data to increase security and predictive analytics that 'think' for themselves, intelligent systems are on the rise.

Last year also saw the rise of 'robo-advisors': automated, autonomous financial planners and investment advisors that use algorithms to give independent financial advice. Data, naturally, is the foundation of such innovations, with analysts predicting an increased use of so-called big data to understand consumers and organisations and provide a more effective financial service.

One group, the so-called 'unbanked', stands to benefit from this sea change in financial technology, as Ed Glass, Principal in the Technology Practice at Odgers Berndtson in London, explains: "These innovative technologies are increasingly driving the rapid digitalisation of the daily life of those who, until recently, have had no access to credit or banks, and provides the 'unbanked' with access to finance that can help solve poverty and drive growth around the world."

As of 2015, there are two billion individuals globally with no access to any form of bank account or financial services; that's close to a quarter of the world's population.

Further, in emerging economies worldwide there are more than 200 million small and medium-sized businesses that lack sufficient access to financial services that would enable them to grow.

For the world's 'unbanked' – predominantly from Africa, China, India and Southeast Asia – there are numerous barriers to financial inclusion: remote living far from banking infrastructure; lack of money and a reliance on cash; distrust of traditional banking; and religion. It is in these markets that financial technology is seeing explosive growth. Innovative businesses offering digital finance services, mobile banking and remittance solutions provide new opportunities for the unbanked.

In China, for example, where one in five of the adult population remains unbanked, investment in technology was valued at US$8.8bn between July 2015 and June 2016. The same applies to Latin America, particularly Brazil, where the number of companies developing such technology has risen from 54 to 247 in the last two years.

> FinTech solutions are placing banking in the hands of the consumer

Africa, according to Leon Ayo, CEO of Odgers Berndtson Sub-Saharan Africa, has "more than 300 such businesses, with start-ups having secured more than US$92.5m in investments since 2015.

"A mistrust of the formal banking sector in Africa makes the rise of financial technology unsurprising," he adds. "Such solutions are placing banking in the hands of the consumer, bridging the trust gap and bringing financial services to the unbanked."

Mobile and smartphone growth

With so many living in remote conditions – 71 per cent of China's 234 million unbanked adults live in rural areas, for example – it may come as little surprise that mobile and smartphone technology is a key platform for innovative FinTech solutions. "India is home →

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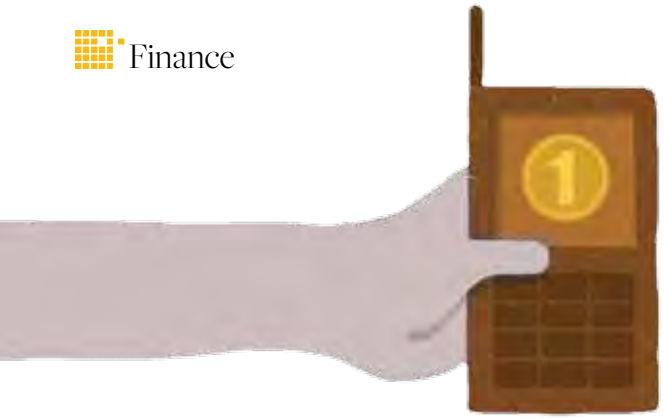


to more than 1.3 billion people, with 250 million adults lacking access to a bank account," explains Laurent Le Moal, CEO of PayU. "And yet 220 million have a smartphone; innovative companies are recognising the wealth of data that these smartphones can reveal."

Such data is enabling companies like PayU, which provides services for local and cross-border merchants, POS credit and alternative payment methods, to provide improved financial access to unbanked individuals.

"Recognising local behaviours and preferences allows us to identify opportunities," says Laurent. "We focus on working with what people already have and use that to overcome legacy challenges and give access to financial services.

"For the unbanked, the main issue is access to credit," he adds. "Individuals are subject to legacy structures and traditional processes. The challenge is to overcome this using alternative means, and we believe the only way to do so is through innovative technology."

In Africa, rapid mobile adoption is enabling digital finance solutions to reach unbanked individuals. Sub-Saharan Africa, for example, recorded only 34 per cent of adults having a bank account in 2014, yet the region accounts for close to 10 per cent of worldwide mobile subscribers.

"Studies show that mobile money can help alleviate poverty," says Ishbel Matheson of WorldRemit, a digital money-transfer operator specialising in remittances. "With mobile money accounts, recipients need neither a bank account nor access to a traditional financial institution to access funds.

"The phones that enable mobile money don't need to be smartphones either, a simple handset is sufficient. The spread of cheap data-enabled mobiles means the scope for building wider, more complex services through a handset has just begun.

"Mobile money can be used to pay for education fees, healthcare costs, groceries and more. One study has even shown how mobile money is empowering women seeking financial independence in a male-headed household."

WorldRemit's service, which is entirely cashless on the send side and is completed via an app or online, allows migrants to send money home to families and communities. "Our founder, Ismail Ahmed, has seen first-hand the transformative effect that remittances could have on families and communities, enabling people to pay for education and household groceries, build houses and better themselves in general," Ishbel adds.

Consumers and businesses

It's not just individuals who are benefiting. In Africa, subsistence farmers are now using technology to trade, pay and receive money and thus grow their businesses. For these individuals, says Steve Round, a director of FinComEco (described as a fully integrated financial and commodities ecosystem), "what is needed is the ability to not only access the financial system but also to generate more income. SMEs require support not only in moving from pure cash to accepting card/mobile payments, but also in accessing low-cost loans.

"The bringing together of a farmer, warehousing and exchanges makes perfect sense: individuals can access low-cost loans to buy better inputs, gain access to local warehousing through local partners and also have access to exchanges, all on one platform," says Round. And it works: a pilot project in Malawi has already produced an increase in income for farmers of more than 30 per cent.

"For me, the two key issues of the unbanked go hand in hand," says Le Moal. "It's important to achieve access to credit for the individual, but also a way for merchants to connect with their consumers.

Removing challenges for consumers and merchants has a positive impact on small businesses and on local economies too."

While the rise of FinTech companies is undoubtedly rapid, it is understandable when placed in the context of the emerging markets they are serving. "Africa is a ripe market for such companies because they're not being very disruptive to large existing systems in the West," says Round. "They operate on a clean canvas, meaning they can set up quickly and with less investment."

"Like any disruptive organisation, start-ups like WorldRemit don't start with legacy issues," Matheson adds. "Legacy operators have to turn around their business to keep pace with the new technology that began away from the high-street, cash-based operator."

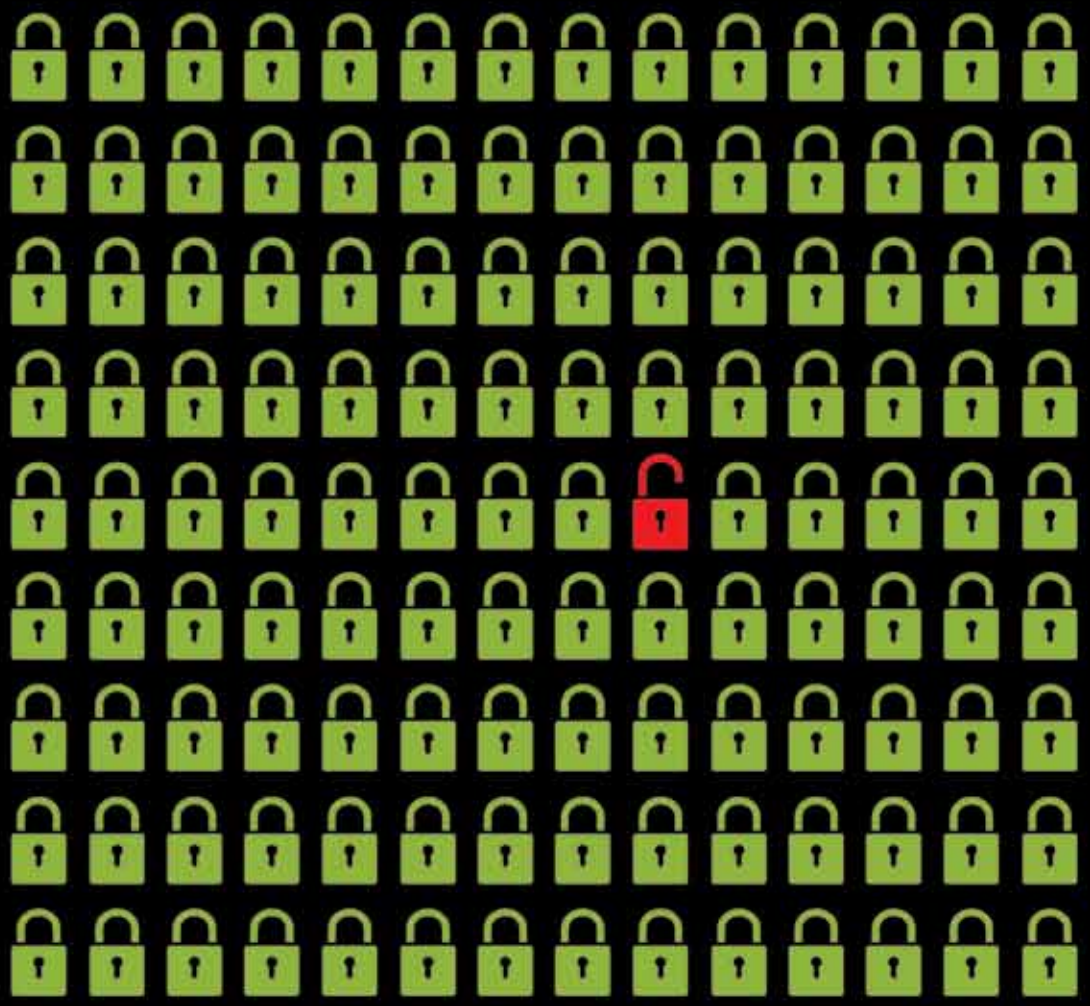
The drive for global financial inclusion has never been greater. Spearheaded by the World Bank's Universal Financial Access 2020 initiative, which is committed to transforming the lives of one billion unbanked by 2020, innovative companies are at the forefront of achieving this.

"To create a thriving economy, you need a thriving financial system for both individuals and businesses," Round concludes. "Creating financial inclusivity is key to this at both government and local levels, enabling transactions to take place."

Adds Le Moal: "Governments, businesses, organisations, consumers and merchants each have a responsibility to help the so-called unbanked and achieve financial inclusion." ■

> "The drive for global financial inclusion has never been greater"

ATTACK! ATTACK!



Renowned US cyber security expert Marc Goodman talks to KATJA HARTERT about the inexorable rise of cyber attacks and why companies need to band together to fight the hackers

Katja Hartert: With internet crime now an everyday occurrence, how would you describe the development of hacker attacks in recent years?

Marc Goodman: What we've experienced in the last four to five years is an exponential rise in cybercrime cases. The number of hacking victims has also increased significantly. At first only around 200 people were affected, later it was a million. The most recent hacker attack on Yahoo was aimed at a billion customer accounts. In other words, one seventh of the world's population was a victim of this attack. This is on an unprecedented scale.

KH: In a globalised world where everything is connected, there are more and more dangers. What are your main fears?

MG: The biggest danger stems from the fact that we are providing hackers with an ever-greater surface area for attacks, since the number of virtually networked electronic devices is growing steadily. Previously, we only had to worry that our work computer might be attacked. Then came the desktop computer at home, then the laptop, then the smartphone. Now cars, airports and children's toys can be the target of a cyber attack. While computers are still relatively secure, the digitally networked refrigerator is only minimally protected. Everything can be hacked – by 2020 there will be 50 billion more digital devices on the Internet of Things.

PHOTOS: SEBASTIAN GABSCH

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KH: And what kind of mistakes are companies making when it comes to protecting their digital assets?

MG: They wilfully disregard the risks and simply seem to place their trust in the fact that any hacker will attack another company, not it. On the other hand, they reckon that they can tick the box next to the issue of cyber security if they have a Chief Information Officer (CIO) and a Chief Security Officer (CSO) in house. But this is a misconception – the issue of cyber security is the responsibility of *all* executives and employees. One of the best ways to protect against hacker attacks is relevant and creative training for front-line employees. Companies do train their employees at the moment, but these courses mostly only address regulatory changes and the consequences of not complying with them.

KH: What should companies do instead?

MG: Internet security should be a key part of the strategic development of any company. It's also very important that companies large and small regularly practise emergency routines and make sure that all procedures are documented. Before it does anything, every company needs to decide for itself how it would react to ransomware if it got hacked. Would it pay up or not? Recent ransomware attacks suggest these problems will become real for many companies.

KH: You have said that improving security standards is not enough of a priority for companies. What exactly do you mean by that?

MG: Most companies do not think about the issue and as a result see no reason to take action. This assessment is reasonable given the security-consciousness of average consumers – they are only interested in what's 'cool', not what's 'safe'. As a result, companies focus on bringing cool products to market and postpone thinking about security until a concrete problem forces them to address it. →

KH: Are some industries more vulnerable to cyber attacks than others?

MG: Financial services providers have the highest security standards because they know they are the preferred targets for hackers. Schools and hospitals are least protected. Data misuse in hospitals around the world has skyrocketed.

KH: In Germany, four blue-chip companies – Allianz SE, BASF SE, Bayer and Volkswagen – have jointly founded the German Cyber Security Organisation (DCSO) to exchange ideas and co-operate more closely. What do you make of it?

MG: It's a great idea, and long overdue. In the US we have information-sharing consortia, industry committees in which companies from the same sector regularly come together to exchange information and experiences. Let's say VW, for example, discovered a problem with the door-locking software in its cars. It would be pretty stupid for VW not to share this information with its competitors. At the end of the day, all companies are fighting the same enemy – the hacker. Hackers have been exchanging information and experiences for a long time. Coming together to exchange information is the only chance companies have to fight hackers and to defend their corporate systems.

KH: It seems unlikely we'll see a global cyber defence group soon. Why is that?

MG: There are initiatives at European level, in the UN Security Council, and one from the Red Cross. But these institutions move much too slowly. Compared to the developments in cyberspace, they're all moving at a snail's pace – and the gap is getting bigger and bigger. It's a problem we must tackle. For example, our politicians should be better informed about technology. In the US, most politicians are lawyers. In China, the top 15 members of the Communist Party's Central Politburo hold higher degrees in natural sciences, mathematics and engineering. They have the real expertise to draft laws.

KH: How will cyber security change employment? Will new kinds of jobs appear?

MG: Data ethics will become a new job requirement, for sure. Today we are increasingly confronted with the question of how we as private individuals can protect our data from hacker attacks and from full-blown espionage. Looking further into the future, neuro-ethics will also become a new profession. Researchers are currently working on ways to connect the human brain with the internet. For example, we could one day put on headphones and then use our brainwaves to play a video game. ■

This is an edited version of a longer piece that first appeared in *positionen*, Odgers Berndtson's German language publication.

To read the full interview, go to odgersberndtson.com/insights

ABOUT MARC GOODMAN

A US citizen, Goodman earned an MBA at Harvard University and a master of science in the management of information systems from the London School of Economics. As a consultant for Interpol, the UN, NATO, and the US government, he became aware of how criminals and terrorists are always one or two steps ahead of the police in terms of innovation. In 2011, he founded the Future Crimes Institute to bring together experts and prevent the misuse of products and services on the internet. Singularity University near San Francisco, where Goodman teaches, is pursuing a similar goal.

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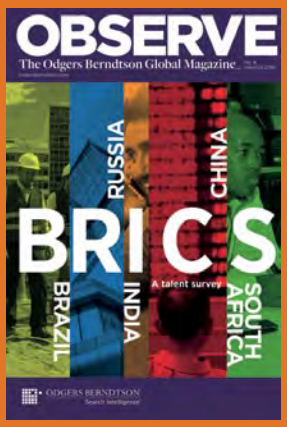

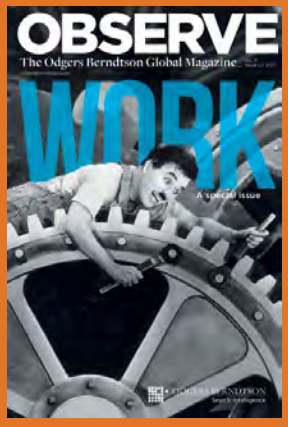

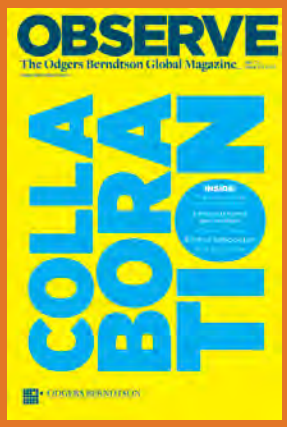

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Across the globe women continue to break new ground in science and technology, as KEIRON PIM explains →

ALAMY

Margaret Hamilton in 1969, standing next to the navigation software that she and her MIT team produced for the Apollo project

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Gender

There's a thrilling history of science and technology to be written peopled only by female characters: from a pioneering alchemist known as Mary the Jewess, who lived circa 200 AD, through to the chemical physicist Rosalind Franklin, who helped reveal the structure of DNA; and from Ada Lovelace, the 19th-century mathematician whose work paved the way for computing, to Grace Hopper, the 20th-century American mathematician who developed the world's first commercial computer.

That story continues today, when wherever you look women are pioneering extraordinary work that expands human knowledge and makes our world a better place – whether by using fingerprint recognition to connect people to their medical records, or revolutionising how we power the mobile devices that are now central to our lives.

The shortlist for last year's 'Women Startup Challenge', run by the American non-profit organisation Women Who Tech and Craig Newmark of Craigslist and the Craig Newmark Philanthropic Fund, offers a snapshot of the field's rising stars. The winner, Alexandra Grigore, co-founded Simprints after her PhD in nanoscience at the University of Cambridge. Working with organisations such as UNICEF, Simprints uses a fingerprint-sensing device to link patients to online medical records, and the non-profit company delivers better medical care to an estimated 90,000 people in South Asia and Africa.

Also shortlisted were British entrepreneur Samantha Payne for her Open Bionics project, which is 3D-printing bionic limbs for children; Lifebit, an operating system for genomics developed by Maria Chatzou, from Spain; Kristina Tsvetanova, a Bulgarian entrepreneur based in Vienna, whose company BLITAB Technology is making the first tactile tablet for blind and visually impaired people; and Tespack, co-founded by Caritta Seppa and Yesika Aguilera, who are Finnish and British respectively. Based in Helsinki, Tespack aims to make everyone 'energy independent' via wearable technology that uses solar power to charge your phone or tablet in minutes rather than hours.

"On average, half of us will run out of battery once a day," says Caritta, "and this is just in the city." For people in isolated areas or, say, the military "on rescue missions, access to energy becomes vital". Tespack has clients ranging from Vodafone to the United Nations, and even


Yesika Aguilera

CARITTA SEPPA AND YESIKA AGUILERA AIM TO MAKE EVERYONE 'ENERGY INDEPENDENT' VIA WEARABLE TECHNOLOGY THAT USES SOLAR POWER

the Austrian Space Forum, with which they are "testing and developing mobile energy solutions for a Mars mission".

Over in Canada, Sara Seager discovered the thrill of exploring other worlds early in life – one of her earliest childhood memories is of viewing the moon through a telescope with her father. Now she is an astrophysicist and planetary scientist at Massachusetts Institute of Technology (MIT), where she's leading the search for another Earth, using the Transiting Exoplanet Survey Satellite (TESS) to seek similar planets around the universe. The satellite will monitor more than 200,000 stars for temporary losses of brightness caused by an orbiting planet obscuring their light.

"A lot of people, including myself, want to find signs of life on another world by way of gases that don't belong: signature gases, we call them," she explains. "That's the point of finding nearby planets. The larger application is to be able to understand planets better: why is our solar system so rare, how do planets form and evolve, are planets out there like our planet, and what does that tell us about our own Earth?"


Gemma Milne

GEORGE GOTTLIEB

Professor Seager is one of many women whose work has uncovered the universe's secrets. Northern Irish astronomer Jocelyn Bell Burnell discovered radio pulsars in the 1960s, for instance, and Margaret Hamilton has gained belated credit as the computer scientist who developed the software – in fact, she even coined the phrase 'software engineer' – that guided NASA's Apollo missions and put men on the moon. When Barack Obama granted Hamilton the Presidential Medal of Freedom – the USA's highest civilian honour – in 2016, it confirmed the belated respect she is now accorded.

And in that example – no women have set foot on the moon, but a woman's ingenuity put men there – we have an indication of the difficulties women can face in gaining the status their talents deserve. There remains much to be done but many women, and men, are intent on bringing about change. Yesika Aguilera of Tespack feels that "in order to make a change and see a change, we need to be the change. We need to push for equality and avoid any battle of the sexes, and rather build a community where talent gets rewarded regardless of gender, sex, background, etc."

Julia MacMillan is doing her best to bring this change about and make tech more welcoming for women. Kaggle is a platform for data science competitions, and Julia set up a regular 'Women in Kaggle' meeting in London for data scientists to discuss their work.

"I had seen a need within the tech community for women to have a space where they weren't in the minority," she says. "It's in no way anti-guys, it's just a little haven where they could go and be in the majority and exchange skills and knowledge. People loved it and it took off."

Members include Gemma Milne, aged 26, a writer who is well-placed to survey attitudes across the industries she covers. Gemma is co-founder of Science Disrupt, which records podcasts, writes editorials and runs events with the aim of changing science's culture. She notes that in biology, women are well represented at junior levels, but this does not extend to proportionate representation in leadership positions.


Sara Seager

NASA/BILL INGALLS

REGIONAL AVERAGES FOR THE SHARE OF FEMALE RESEARCHERS IN SCIENCE:

- 40 per cent for Arab States
- 40 per cent for Central and Eastern Europe
- 47 per cent for Central Asia
- 23 per cent for East Asia and the Pacific
- 45 per cent for Latin America and the Caribbean
- 32 per cent for North America and Western Europe
- 19 per cent for South and West Asia
- 30 per cent for Sub-Saharan Africa

Source: http://uis.unesco.org/sites/default/files/documents/fs43-women-in-science-2017-en.pdf

"We still have a problem when it comes to who are the leaders of departments, or who are the speakers at conferences," she says, mentioning a forthcoming conference in Austria on cell migration. "It's all about biology and they don't have one woman speaker, and there's talk of boycotting it. This is the one area in science where there are plenty of women and you don't have any!

"Without making a sweeping statement, I think women are more encouraged to do subjects like biology than maths, physics or chemistry, because it's seen as being more about people."

Taking the USA as an example, the 'Science and Engineering Degree Completion by Gender' report released in April 2017 by the National Student Clearinghouse Research Center illustrates the situation at PhD level. The report breaks the degrees down into eight fields: engineering, computer science, Earth/atmospheric/ocean →

sciences, physical sciences, maths, biological and agricultural sciences, social sciences and psychology. The number of PhDs in scientific disciplines awarded to American students leapt by 50 per cent between 2006 and 2016, but the proportion of women gaining those degrees increased only by one or two percentage points, and across the board there was an average 40:60 imbalance towards men.

Biological and agricultural sciences were indeed one of the few areas where women are in a majority, receiving 51.6 per cent of PhDs; another is social sciences and psychology.

Elsewhere in the world the statistics reinforce the idea that progress is being made at undergraduate level. In 2015, Australia reached gender parity in the natural and physical sciences, when 50.1 per cent of undergraduates were women. And in 2014-15, women made up 46.7 per cent of science undergraduates in India.

But if figures from a separate American study conducted at MIT in 2014 remain broadly accurate four years on, they back up Gemma Milne's comments about women's representation at senior levels. According to the *Proceedings of the National Academy of Sciences* article authored by biology graduate Jason Sheltzer and software engineer Joan Smith, only 36 per cent of assistant professors and 18 per cent of full professors are women. In laboratories run by female professors, women formed 53 per cent of graduate students and 46 per cent of postdocs; but in labs run by men, those figures were 47 per cent and 36 per cent respectively. The gender differences were heightened in 'elite' labs. Those run by male

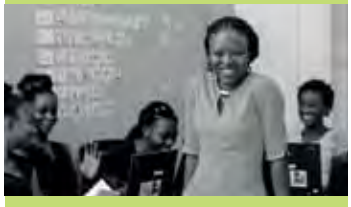
THREE TO WATCH

PERU: MARIANA COSTA

Peruvian social entrepreneur Mariana Costa is co-founder and CEO of Laboratoria, which has trained more than 400 young South American women in coding since it began in 2014, with a job placement rate of 77 per cent. She noticed a need for developers while working in software development. Barack Obama praised her social enterprise as "wonderful" when speaking at Stanford University, and Mark Zuckerberg mentioned her in a speech to the APEC summit in Lima. *laboratoria.la*

IRELAND: RHONA TOGHER

Sound Bounce is described as the world's first smart-material hearing protection that works to absorb damaging sounds. The product is inserted into the cups of of a pair of ear defenders, and it provides eight times more protection than foam inserts. The material reacts to variations in acoustic levels, harnessing sound energy and becoming increasingly absorbent in loud environments. *soundbounce.co*



GHANA: REGINA HONU

After years as the only female IT specialist at a bank in Accra, Regina Honu left to launch Soronko Solutions, a software development company. Honu is one of Africa's foremost women in tech, and is using her status to break down gender stereotypes. "As an African woman, the role is you go to school, you get a job, you marry," she said. Her 'Tech Needs Girls' initiative sees her visit places like Nima, a slum in Accra, to teach girls coding. *soronkosolutions.com*

Caritta Seppa

Nobel laureates, for instance, had a ratio of two male grad students to one female, and this ratio was three-to-one among postdoc students. Such imbalances were not evident in labs run by elite women scientists.

"What we found is that these labs really function as a gateway to the professoriate," Sheltzer explained. "So we think the fact that they're not hiring very many women is important for understanding why there are still so few female faculty members."

Meanwhile a 2017 UNESCO Institute for Statistics report puts this in a global context, showing that worldwide women represent 28.8 per cent of scientists involved in research and development (see panel on previous page for a regional breakdown).

It's clear that brilliant women are continuing to enter the realms of science and tech and changing the world for the better, whether by widening access to healthcare or understanding our planet's place in the universe. The challenge now is to change the culture at senior levels so that they can go as far as their talents deserve. ■

womeninkaggle.co.uk
tespack.com
gemmamilne.co.uk
saraseager.com
womenwhotech.com

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FUTURE

April 1, 2068.

Odgers Berndtson's HQ based in Neo-London has been charged with finding a new 'Amflee' for global social media brand Eyeball, as it looks to expand its number of users from five billion to around seven billion

In case you are wondering, the term CEO went out decades ago as the push for a more gender-enriched, fluid persona for these top roles became essential. Hence Amflees, which are extraordinary individuals, using male and female characteristics in perfect balance. And they are very, very good at what they do. They are also in short supply, so the hunt is on...

Amflees lead in an age when early 21st-century concerns such as disability or disease are now problems of the past. Everything coalesced following the great uprising of 2052 when across the planet a wave of protests – both physical and virtual – led to the introduction of new techniques and radical programmes to eradicate these areas. Amflees are race-agnostic and lead while most other people, living to at least 175, spend a greater proportion of their time pursuing intricate leisure pursuits – when they're not using Eyeball, that is. →

PERFECT

ALAMY

Eyeball has publicly declared that its goal of ensuring every man, women and child on the planet has an account is now within sight. With traditional 'governments' a thing of the past and social media behaviours genetically programmed into every newborn child, the power of Eyeball is vast.

Eyeball, along with arch rivals Googlebaba and Amazon's interplanetary hyper-drone-based service Amaworld, has over the past two decades revolutionised just about everything that happens on Earth – and beyond. These mega-organisations control it all.

'Work' and 'workplace' have also morphed beyond anything we might have expected 50 years ago. Almost everybody is 'uni-employed': that is, they work for themselves and offer their services to organisations at rates determined by mutual consent. These 'jobs' are open to anyone, anywhere on the planet, because most of the tasks required can be conducted from home, or in a personal, VR-infused 'workspace'. All manufacturing and distribution of products is now carried out locally by intelligent machines that never need servicing: they do it themselves. Their lifespan is measured in centuries, not decades.

The calibre of each individual applying for a uni-job is measured by his or her 'cellmetrics', a deep view of their genetic make-up, at a cellular level. Unlike 20th-century methods such as psychometric testing, it is completely flawless. Odgers pioneered cellmetrics, one of the key testing methodologies, some 30 years ago.

So what sort of Amflee can take on this prime role at Eyeball? Might it be a 'REHAB' instead of an Amflee? The acronym REHAB – which stands for Radically Enhanced Human Activated Being – was introduced around 2060 to describe the now indistinguishable difference between a robot (such a quaint term) and a human.

It took a while. Earlier REHAB models from around 2038-40 were deemed entirely inadequate when it came to necessary top-level requirements such as long-term (50-years-plus) strategic thinking, compassion, quick-wittedness and appropriate dress code. They might move like humans and have a human appearance, but it didn't take long before it was evident that they were simply poorly programmed machines that could never successfully chair a tough intercontinental – or interplanetary – meeting.

> One of Odgers Berndtson's specialisms lies in recruiting top-notch Extinct Biologists

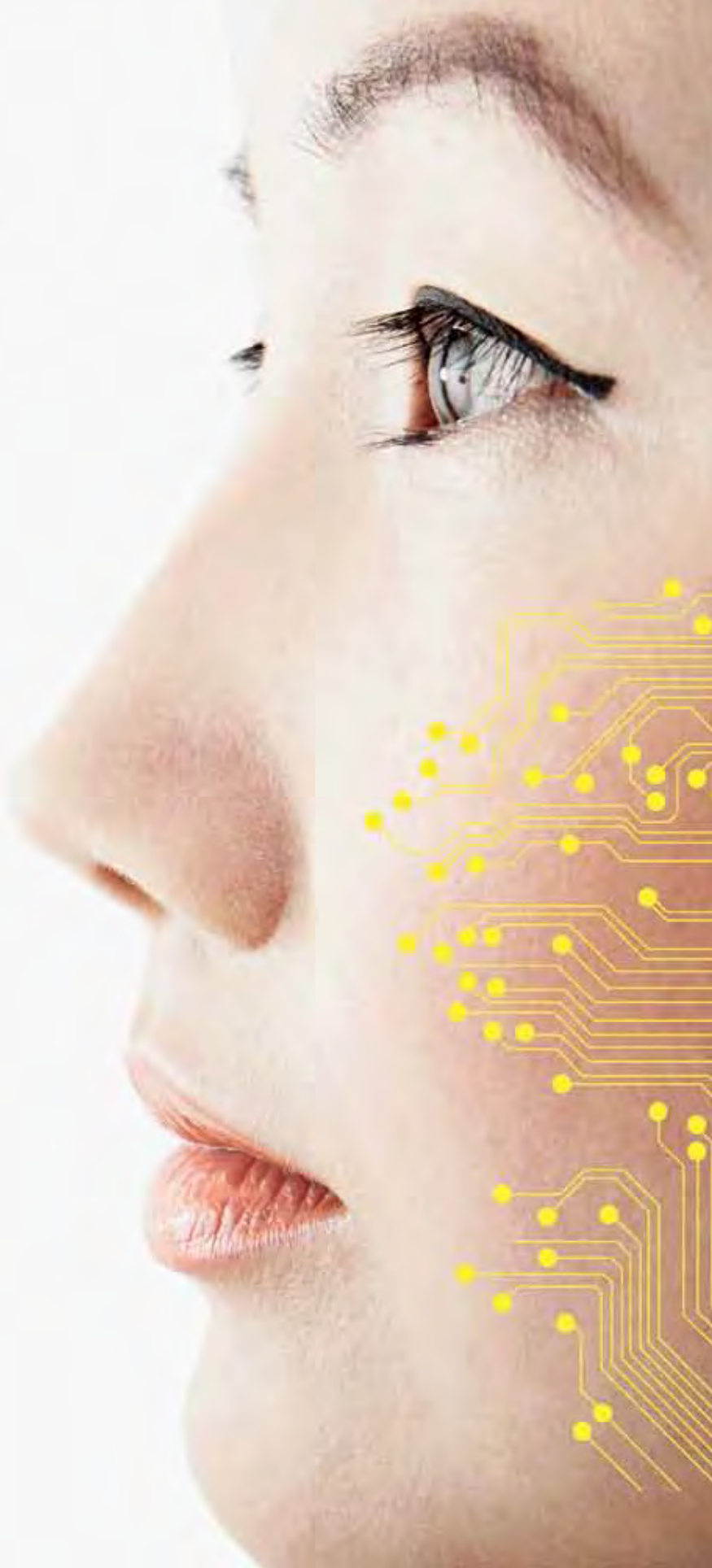
They also failed every VR- and AI-based technique for determining a range of capabilities. By using cellmetrics and other tools, Odgers Berndtson has also pioneered an entirely new way of determining whether or not a REHAB or an Amflee brings the right synchronisation of characteristics for a particular top-level position. These measurement tools have been deployed across the globe – not only for placing Amflees but also for use in multiple learning laboratories and 'job' roles.

One of Odgers Berndtson's specialisms lies in recruiting top-notch Extinct Biologists, who have the enviable task of recreating everything from (docile) dinosaurs to woolly mammoths for use in vast 'theme parks' that can be physically or virtually visited at any time. Other disciplines that Odgers is now feted for include finding top talent in areas as diverse as urban agriculturalists, 5-D printing generals, avatar compliance officers and many more.

The term 'C-suite', like so many other antiquated management constructs, became obsolete around 2035 when 'boards' and 'boardrooms' morphed into the virtual world where everything happens using the latest augmented reality programming. Boards never 'meet' and are fluid. Members are drawn from Odgers' global 'spidrax' based on their cellmetrics, to deliberate upon a specific agenda item only – the approach to accelerating transcendental success.

So the hunt is on for Eyeball's next Amflee. Odgers HQ in Neo-London has been a hive of activity as the search enters its critical stage, with a shortlist of 200 now preparing themselves for cellmetric testing and the thought of winning the ultimate prize. ■

This is a work of fiction. Any resemblance to living humans or other machines is entirely coincidental.



THE WAR FOR DIGITAL TALENT

New research conducted by Forrester and Odgers Berndtson reveals that a company's future revenue will depend on it harnessing technology – and having the talent to manage it, says

NIGEL FENWICK

The digital industrial revolution is accelerating, forever changing industries and the relationship between consumers and producers. But beyond the hype, real changes in some companies are already paying dividends for progressive CEOs and digital-savvy executive teams. That's the conclusion from the latest joint research study between Forrester and Odgers Berndtson on digital transformation. The research highlights the key differences between companies just beginning their digital journey and more advanced digital leaders, drawing important conclusions for how you can shape your company's digital future.

To highlight differences between the more advanced companies and those following behind, Forrester created three levels of digital business maturity – beginner, intermediate and advanced (see table opposite) – by analysing five competencies of business leadership:

1. **Strategy:** The ways executives accelerate revenue and optimise operations.
2. **Structure:** The ways business leaders organise teams.
3. **Culture:** The cultures that work best in a digitally enabled world.
4. **Talent:** The skills and capabilities companies need to bring on to their teams.
5. **Technology:** The technologies companies need to master.

Digital Beginner
Disrupt Experiences
Establishing new digital capabilities as part of the existing business, investments to improve customer experiences and operational efficiency dominate the digital portfolio. Digital initiatives in early-stage companies are most often driven by a C-level executive below the CEO.

Digital Intermediate
Disrupt Businesses
Intermediate-maturity companies fundamentally shift in their business model as they learn to harness digital capabilities in support of improved customer outcomes. But leaders in these companies still have obstacles to overcome, especially cultural. The CEO must be on board to truly move digital at this level.

Digital Advanced
Disrupt Markets
Advanced companies press the boundaries of the possible to find new ways of delivering customer value and drive new revenue models. Advanced companies are natural business predators, buying weaker competitors and startups with bright ideas. The CEO is squarely behind digital at this level.

ALAMY

Crucially, advanced companies report significantly higher revenue growth rates on average than their less mature counterparts. The simple reality for many companies is that customer value, and therefore revenue, is now intrinsically bound up with the digital experiences a firm creates alongside physical products and services. Whether it's companies like Schindler creating new 'Port' technology to optimise the flow of people in buildings, or LG creating a range of smart appliances connected to a consumer's mobile phone, leading companies understand their future success lies in harnessing the power of digital to deliver new sources of customer value.

In examining the differences between digital beginners, intermediates and the more advanced firms, the research identifies how leaders in these companies vary their approach to the five core competencies of business (see box).

Across the advanced digital companies, 90 per cent report having the right people to define their digital strategy compared to just 19 per cent or companies beginning their digital journey. And when it comes to having the necessary people and skills to execute the strategy, just seven per cent of beginners say they have what it takes, compared to 91 per cent of the advanced companies.

The stark contrast between these numbers highlights the enormous lead advanced companies have in the war for digital talent. A firm's ability to drive new revenue from digital investments will be intrinsically bound to their ability to attract and retain the top talent. To help succeed, Forrester recommends you:

Fix your culture. Even if you attract great talent, without a culture that nurtures their creativity, you'll quickly lose them. Yet better culture remains the number-one barrier to successful digital transformation. To help fix your culture, change employee metrics and rewards to focus more on customer outcomes and innovation.

Shift the focus of digital customer experience from bolt-on to transformation
To win in the future, where great experiences are now table-stakes, you must refocus your customer experience strategy on transforming the relationship with the customer through digital.

Embed design thinking and journey mapping
Design thinking teaches your employees to have greater empathy for the customer and to design new ways to create customer value.

Nurture your most creative employees
While your company needs to retain creative innovators, these individuals are not necessarily your best employees at managing tasks. If your company's success metrics reward task completion, you may be unintentionally managing your most creative employees out of the organisation. Make sure your culture and performance metrics support and even reward creative experimentation. ■

Nigel Fenwick is Vice President and Principal Analyst, Forrester. To read the full report go to: odgersberndtson.com/insights

FIVE COMPETENCIES FOR DIGITAL SUCCESS

1. Communicate a clear vision and strategy. Help employees understand how the company will be different as a digital business.
2. Design the right organisation and governance. Prioritise agility and customer outcomes over operational efficiency.
3. Nurture an outside-in culture. Digital transformation demands a customer-obsessed culture that supports continuous innovation.
4. Attract and retain top talent. Embed new digital skills, such as design thinking and journey mapping, into your organisation.
5. Invest in flexible and advanced technology architectures designed to continuously evolve. Learn to rapidly adapt the business to use emerging technology in the service of customers.

Have a heart

While leaders remain transfixed by technological imperatives, something more fundamental is being neglected – compassion – as JACQUELINE FOLEY explains

ALAMY

We are living in a time of technological chaos – or at least it feels that way. Bombarded by digital communications and more information than we can absorb, as well as the fear of constant change and an uncertain future, we have a lot on our minds. Studies show this is making us stressed and distracted, and perhaps a little less human. I would argue that it's making us a lot less compassionate.

So why should we care about being more caring? Well, in addition to the fact that neuroscience illustrates we feel happier when we show compassion towards others, we also know that there is a proven correlation between expressing empathy and improved results. According to a study published by the Centre for Creative Leadership, it seems that managers who genuinely seek to understand their employees and their perspectives are rated by their bosses as being better performers.

We also know that being a successful leader in today's global, technology-driven economy requires collaboration and building consensus among groups with many different perspectives and values. And what better way to engage others than by showing them you care about them? Caring builds trust, and trust builds loyalty and commitment. And who doesn't want to work for a company that makes them feel valued as a person?

Author, speaker and leadership expert Simon Sinek is preaching this message around the world. He believes that empathy – the ability to recognise and share others' feelings – is the most important instrument in a leader's toolbox today. According to Sinek, you can start with these three simple words: "Is everything OK?"

And this is the good news – empathy and compassion are available to us all. With some practice and a little more mindfulness, we can become better at putting ourselves in the shoes of others, sending a ripple effect of caring throughout our organisations. In essence, we can be the change we want to see in our workplaces. ■

Jacqueline Foley is Chief Marketing Officer for Odgers Berndtson in Canada

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Construction

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DRONES OVER WORKING HEAD

With long-standing resistance to change and low productivity, the construction industry needs to urgently adopt new technologies – and employ visionary leaders – as JONATHAN ARNOLD explains →

A recent survey by Balfour Beatty – one of the world's leading construction groups – titled 'Innovation 50: A Digital Future for the Infrastructure Industry' opened with the following, dramatic statement:

"The construction site of 2050 will be human-free. Robots will work in teams to build complex structures using dynamic new materials. Elements of the build will self-assemble. Drones flying overhead will scan the site constantly, inspecting the work and using the data collected to predict and solve problems before they arise, sending instructions to robotic cranes and diggers and automated builders with no need for human involvement. The role of the human overseer will be to remotely manage multiple projects simultaneously, accessing 3D and 4D visuals and data from the on-site machines, ensuring the build is proceeding to specification. The very few people accessing the site itself will wear robotically enhanced exoskeletons and will use neural-control technology to move and control machinery and other robots on site."

Construction revolution

Fanciful? Perhaps. But many of the industry's leading figures believe the construction sector has remained stubbornly resistant to change for decades, if not centuries, and that, like it or not, radical change is coming. With the advent of these revolutionary new technologies the entire industry is set for a major shake-up that will impact upon everything from productivity to talent to on-site construction methods.

Indeed, the World Economic Forum is clear on what these changes will mean for the industry: "Wherever the new technologies have properly permeated this fragmented industry, the outlook is an almost 20 per cent reduction in total life cycle costs of a project, as well as substantial improvements in completion time, quality and safety."

Mark Reynolds, CEO of Mace, the $2.5bn international consultancy and construction business headquartered in the UK, is unequivocal about why action is needed now: "We are quite simply not keeping up with the pace of technological change. Advancements in robotics and automated manufacturing, data analytics and virtual reality are radically transforming the sector and, indeed, the whole economy. Yet all is not lost.

"The fourth industrial revolution – or Industry 4.0 – could improve productivity levels in construction, increase the number of highly skilled jobs and transform the way that [the UK] delivers some of the biggest and most complex infrastructure projects of the future. New and evolutionary infrastructure projects are vital to creating a favourable environment for investment, so important particularly in times of political and economic uncertainty. New construction technologies may also contribute to solving the housing crisis, which is arguably the single biggest social policy challenge facing [the UK]."

Rise of the robots

Some enlightened players in the wider industry are already grasping the technology nettle. Last year, John Deere, the US equipment manufacturing giant, partnered with drone technology start-up Kespry, in a deal that will involve John Deere's sales teams selling drones and related services to the construction industry. One of the ways drones can help construction workers is by flying over their construction sites while taking pictures. These pictures can help construction workers keep tabs on their productivity, track their materials and monitor how their projects are coming together.

Hugo Blasutta, President and CEO of WSP Canada, part of the global entity that employees 36,000 people in 40 countries worldwide and provides management and consultancy services to the built and natural environment, believes AI is going to be the "big disruptor" and that it will "affect the entire architecture, engineering and construction (AEC) sector".

He explains: "A lot of work is going on concerning field assembly through robotics and AI. If I break down our business and take a typical project in a typical engineering firm, around 80 per cent of the work tends to be fairly repetitive and around 20 per cent is unique and where you really want to apply your creative skills. What ends up happening in the average firm is that they spend 80 per cent of their time on the repetitive work, because they don't have the AI in place or processes in place, →

SHUTTERSTOCK/ALAMY

Construction

"A lot of work is going on concerning field assembly through robotics and AI"

and then run out of time to work on the creative part. What we're doing and where AI will help is to flip that around so that we are spending 20 per cent of our time on the repetitive work and then use AI in the creative side of the business."

AI will, he adds, allow for more "iterations of creative designs" so that what the client sees is more options, fully thought through, to select from. It's 'value added' in a way not seen before. Adds Blasutta: "Deploying AI on the creative side will enable us to test different options much faster and deeper with more meaningful analysis."

Imaginative solutions

David Cox, Managing Director for Middle East and South Asia at Mott MacDonald, the global engineering, management and development consulting firm, reckons that the pace of the construction industry's digital adoption is increasing exponentially and "technology will ensure that we adapt even faster in the future".

He explains: "The period between industrial revolutions is contracting, so we must be prepared not only for the ongoing digital revolution but the machine one that will follow. We are already adopting technology to enhance our long-term and imaginative solutions and service offerings to our clients through the application of Building Information Modelling (BIM), generative design, and design for manufacture and assembly (DFMA). And we are exploring the application of machine learning and artificial intelligence."

Fergal Whyte, a Director at Arup Group responsible for infrastructure in east Asia, adds: "We see going digital as a way of optimising the engineering process to make better decisions and deliver better outcomes for our clients. We are driving this based on three pillars: automating tasks that are by nature repetitive, harnessing data and enabling uniform data exchange, and developing software products and platforms that support this way of working.

"For example, our structural teams are already using an in-house developed tool for parametric modelling where certain parameters are safeguarded in a design while others are allowed to vary. This leads to a final scheme that adheres to the most valued principles with the highest levels of structural efficiency and safety. Engineers are responsible for defining the logic and leave the tedious, repetitive work to computers. Design automation not only empowers engineers to work in a much more

> Engineers will have more time to enjoy being engineers

efficient and interesting way but also provide higher quality of work – engineers can evaluate many more options before they settle on one; and if anything changes, they can make the update very quickly. It will free engineers to be more creative and think at a strategic level. Engineers will have more time to enjoy being engineers."

For Richard Beard, Managing Director, Middle East and Asia at Ramboll, a leading engineering, design and consultancy company, "the world of virtual design and engineering is a fast-growing field" and that "we have seen rapid developments in recent years". He adds: "Using parametric models augmented by advanced digital simulation and algorithms, we can now embed design principles and intelligence into BIM tools and other advanced software to develop customised solutions for design and also for future management of the buildings. By incorporating digital design into the way we design buildings of the future, we have the ability to create highly innovative solutions while maintaining an incredible level of control in terms of precision, performance and quality."

The war for talent

All of this activity will be count for little if the *desire* to change isn't there – and that means having the right talent in place. Says Mace's Reynolds: "It is therefore crucial that the construction industry works to attract, retrain and up-skill the current and future construction workforce in order to fill the jobs created by advanced technology. To avoid a cliff edge this training must start now, not in five or 10 years' time." Hugo Healing, who heads up the Real Estate and Built Environment Practice at Odgers Berndtson in London, adds: "Increasingly, automated construction sites will force businesses across the supply chain to re-evaluate the skills they deploy, and where their key people will be able to leverage greatest effect on a project or task. As 'conventional' trades are replaced, the challenge for the industry will be in thinking creatively about how it sources its talent and then how it incentivises those with these new skills to join an industry sector that may appear at first sight a little late to the party. Those businesses that can anticipate, adapt and then innovate faster than the competition are most likely to win the war for talent. Our experience of progress in other sectors shows that the construction industry is playing catch-up."

Blasutta echoes this point by citing Bill Gates's much-quoted observation: "We always overestimate the change that will occur in the next two years and underestimate the change that will occur in the next 10. Don't let yourself be lulled into inaction."

BIM and Big Data

Blasutta adds: "That's where our industry is today. We may be overestimating the amount of change over the next two years but underestimating over the next 10. Indeed, over the next 10 to 15 years there will be much more activity around the digital and AI component of engineering, which in turn has a big impact on our human capital and staffing models. BIM tools are a big part of it, too, as is Big Data – not just collecting it, but structuring it in a way that we can slice and dice, getting away from notional ideas of 'I think this works well', but instead having the data to say categorically 'this works, and this doesn't'."

Alasdair Spink, Head of Odgers Berndtson's Industrial Practice, Asia Pacific, says: "Although driverless construction vehicles and self-building bricks won't be with us for some time, technology already exists now that could transform safety and delivery, and reduce cost in construction. The tipping point will come when the industry develops leaders who can integrate technology into delivery within the financial constraints of highly competitive tenders or when a demand for technology comes from those procuring construction services."

As one industry commentator put it: "AI's potential can best be described as 'limitless'. The technology is still very much in the early stages of development, and just how it will progress in the coming years is really anybody's guess." ■

THE APPLICATION OF SCIENCE

Chief Scientific Officers play a crucial role in the development of some of the most significant medical and pharmaceutical breakthroughs, as DAVID CRAIK explains

In a world faced with increasingly complex environmental, health, societal and economic challenges, the need to fully exploit scientific breakthroughs for the benefit of all is crucial.

The Chief Scientific Officer (CSO) plays a large part in harnessing and developing that potential within a range of organisations, from life sciences and pharmaceutical firms to research groups.

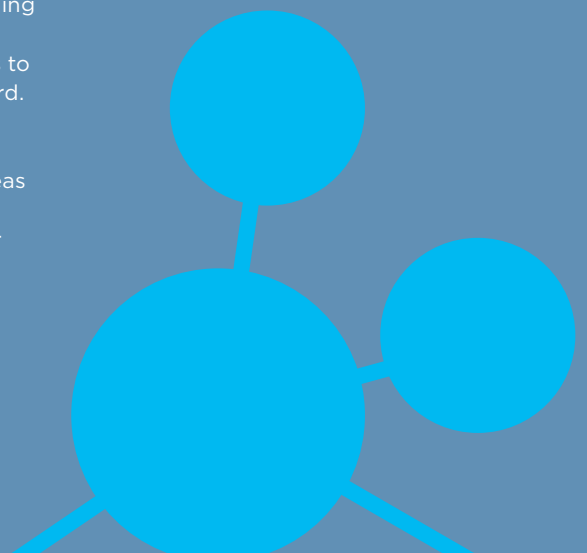
But what exactly is their role, how is it evolving and what skills do you need to ensure success?

Research excellence

Dr Marie Dziadek, CSO at the Sydney-based Garvan Institute of Medical Research, which undertakes breakthrough medical research, says her role takes on many facets. "It includes operationalising our executive director's vision for the Institute. I work closely with him to develop strategies and policies to ensure that we meet and maintain excellence in our research performance. I support scientists to perform at their absolute best, including skills and leadership training programmes for our younger researchers," she states. "We want our scientists maintaining a high level of integrity to produce research outcomes to the highest possible standard. An important part of that is adhering to a strict code of conduct and ethics in all areas of research activity."

Dziadek says that another focus is facilitating and managing the Institute's strategic initiatives and collaborations with various community, academic and industry organisations and groups. "I'm charged with ensuring that all parties are benefiting from these partnerships. We need to effectively translate our research findings into clinical practice," she says.

Dr Derek Craston, CSO at UK-based life sciences research and analysis firm LGC Science & Technology, recognises the diversity of Dziadek's role.



"Like other CSOs, I wear a number of hats. First, I have functional responsibility for a business unit that undertakes contract research services such as product authenticity in the food sector. Second, I have cross-organisational responsibility for reporting scientific outputs to our board and for connecting our scientific community across our multiple functional units and global sites," he explains. "By doing so I aim to ensure we share collective knowledge for the benefit of all of our operations and that we are drawing in scientific information from the external world that will help inform our future plans. My aim is to assist the company in remaining nimble and responsive to scientific developments that might impact us and our customers."

He sees that role evolving as LGC grows. "As we acquire more operations and invest in further capability and infrastructure, the complexity of scientific diversity and internal communications increases. Also, like most organisations, we recognise the importance of effectively tapping into the global science base to look for our next generation of products," he explains. "This means building a mix of strategic relationships with universities with acknowledged strength in our scientific fields, as well as a wider process for trawling for innovations emanating from both small companies and from the university science base."

Scientifically sound

This focus on strategy appears to have been crucial in the recent appointment of Ronald Plasterk, molecular geneticist and former Dutch Minister of the Interior, at Dutch healthcare technology group myTomorrows.

His primary role is to focus on creating academic partnerships to support the group's aim to facilitate early access to pre-approval medicines for patients with unmet medical needs.

"I work closely with academic medical centres to discuss our strategies and what we can offer patients. I also ensure that, because we are dealing with non-registered drugs, everything we do – from how we treat our data to the →

financial and marketing decisions we make – are all scientifically sound. The numbers and results must be correct; if they are not, we will lose trust with our partners," Plasterk states. "As such, your science credentials are going to be crucial in this role. You will not know everything. There will be areas of medicine and language that you are not familiar with, so you need to keep asking questions to ensure that you completely understand what your team of scientists are telling you."

Michael Roberts, founder and CSO of Synpromics, a developer of synthetic gene promoters, also believes that having a strategic mind is important. "I define which direction our research and development should be taking," he states. "I guide our scientists and, as such, looking outwards to see what the medical industry is focusing on or developing is vital. I network and keep up with the latest literature, and ask if there are any shortfalls our technology or internal research can address."

> "Your science credentials are going to be crucial in this role. You will not know everything... keep asking questions"

GOVERNMENT CHIEF SCIENTIFIC ADVISERS (CSA)

They are tasked with using their and the science community's knowledge to help in policy areas such as trade deals for emerging technologies, how to prevent and tackle animal diseases, environmental pollution and future energy capacity. They need to reach out to scientists in their field to keep abreast of the latest research, thinking and discoveries.

They also need to be able to communicate often-complex science topics in plain language to Government ministers and the media.

They need to be good at horizon scanning and to see what is coming next in the science field.

They need to be able to answer real-world questions that matter to the Government, such as the growth and spread of artificial intelligence and nanotechnology. For this you need to be able to talk to a broad range of experts, such as 23- or 24-year-old coders and gamers – not just the usual medical professionals.

An outstanding CSA needs to be an eminent scientist who has the respect and recognition of the science community. They need to be not just an expert in their own field, but also to have sufficient all-round knowledge in all areas of science.

Plasterk says soft skills are important when dealing with partners. "We are an innovative company and as such there is some scepticism around what we offer. It is therefore vital that as CSO I listen to our partners and their concerns, and help overcome them."

Dziadek identifies very similar skill sets every CSO needs to be armed with. She explains that the Garvan Institute has six different research divisions including bone biology, cancer and genomics. As such, knowledge across all research areas is crucial. "You need to have awareness of technology developments, applications of technology, understanding of intellectual property, and commercialisation," she states. "You also need good communication skills."

LGC's Cranston agrees on both points. "You need to know enough about all of the many areas you operate in to understand the issues and the significance of specific developments that might impact the business," he says. "You also need to be able to communicate across a diversity of scientific understanding, from those with a rich knowledge in their areas of expertise through to those with little or no technical background. Being able to describe difficult concepts in simple, easily understood terms is a really important part of the role."

For Roberts, having a strong business sense is another necessity. "You need to ensure that you deliver to your customers' or clients' timelines and deadlines," he states. "You must, like any business, meet their expectations." ■

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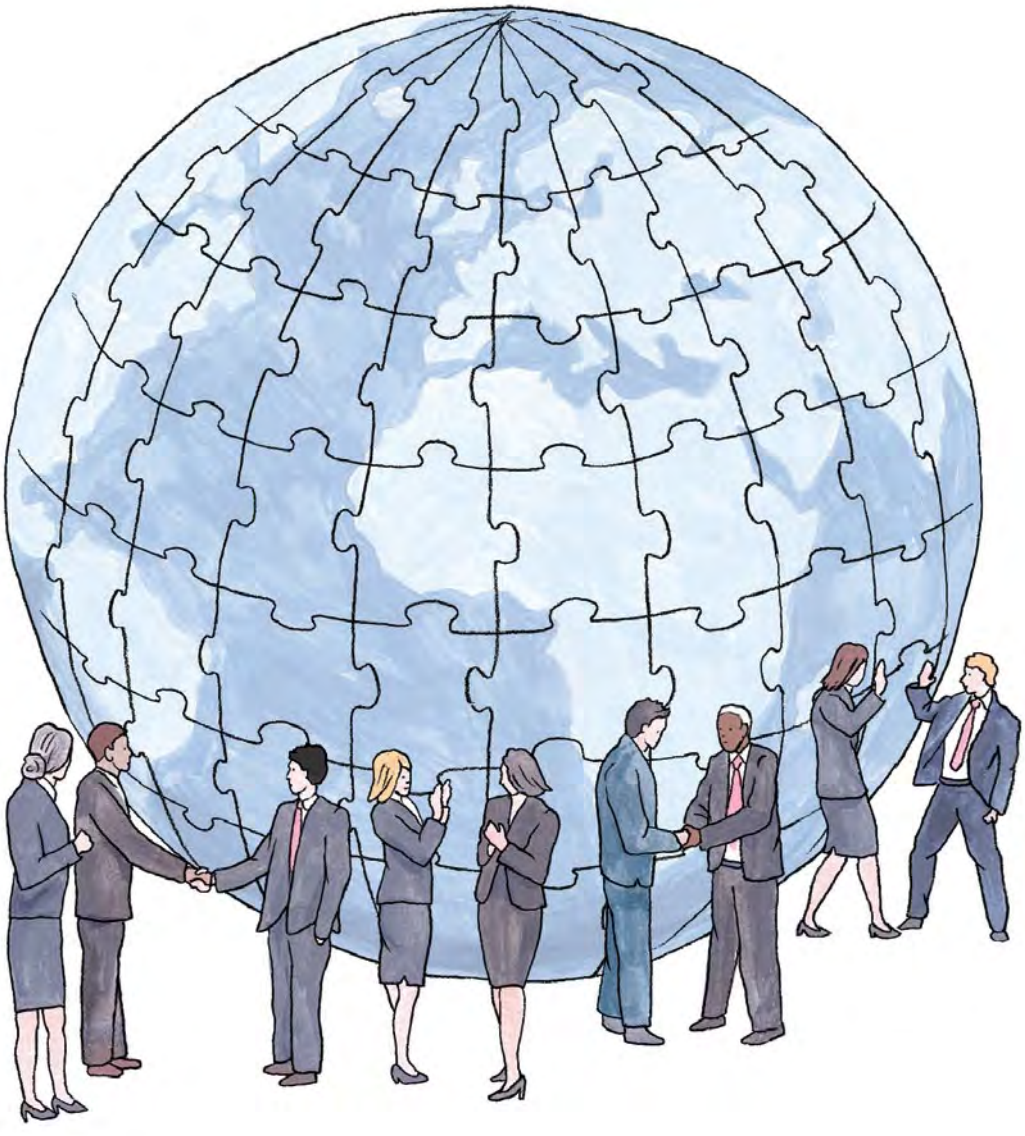

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Need to know

DONALD H TAYLOR on why today's training department is no longer fit for purpose

In the Renaissance period knowledge may have been power, but today things are very different. Where once information was laboriously conveyed in person or via the written word, it now flies around the world almost instantaneously.

The impact of this for the knowledge economy is vast. According to intellectual capital merchant bank Ocean Tomo, in 1975 intangible assets accounted for just 17 per cent of the market value of the S&P 500. By 2015 that figure had risen to 87 per cent. These intangible assets are made up of brand equity, intellectual property and so on, but the largest single component for more enterprises is human capital – the people of an organisation, what they know and what they can do.

Before the internet, these people came into the workplace with smarts and knowledge, and kept up to date through an annual schedule of training courses. That pedestrian approach won't cut it today. With so much information available for free, whatever is unique to organisations needs to be shared rapidly internally, allowing employees to make best use of it as a differentiator before competitor organisations catch up.

This imperative for speed is at odds with the traditional training department's usual approach: first, create a beautiful, information-heavy course for delivery. Next, schedule attendance, and test on completion. Moving this model from the classroom to online does not make learning sufficiently faster, nor more effective. The result: training departments are struggling to adjust in a world of digitised information.

There is an answer. Training departments must accept that their role has changed – from instructors of information to curators of content and facilitators of conversations around it. This enables people to learn fast from the vast amount of content that already exists in organisations, rather than waiting for someone else to turn it into a course first. It is also the only way organisations can compete in a world where knowledge is no longer power. ■

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ALAMY

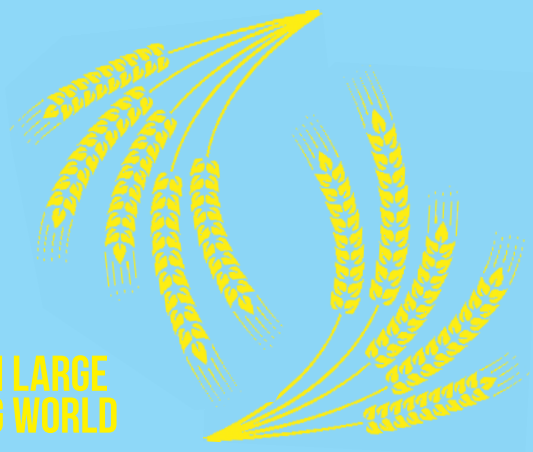
Donald H Taylor is the author of *Learning Technologies in the Workplace*, published by Kogan Page in 2017. He is Chairman of the Learning and Performance Conference and the Learning and Performance Institute and is editor of *Inside Learning Technologies* magazine

500 MILLION

SMALL-SCALE FARMS PRODUCE MORE THAN

80%

OF THE FOOD CONSUMED IN LARGE PARTS OF THE DEVELOPING WORLD



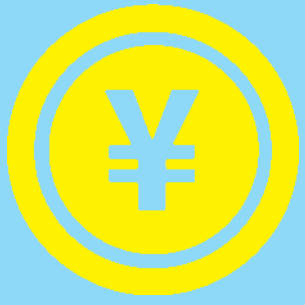
WORLDWIDE, WOMEN REPRESENT

28.8%

OF SCIENTISTS INVOLVED IN RESEARCH AND DEVELOPMENT

71%

OF CHINA'S 234 MILLION UNBANKED ADULTS LIVE IN RURAL AREAS



THE ESTIMATED NUMBER OF UNDERNOURISHED PEOPLE INCREASED FROM 777 MILLION IN 2015 TO

815 MILLION

IN 2016, AFFECTING APPROXIMATELY

11%

OF THE GLOBAL POPULATION

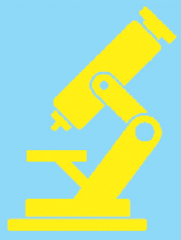
IT'S A FACT!

STATISTICS ABOUT SCIENCE AND TECH DRAWN FROM THIS ISSUE OF *OBSERVE*

BY 2020 THERE WILL BE

50 BILLION

MORE DIGITAL DEVICES ON THE INTERNET OF THINGS



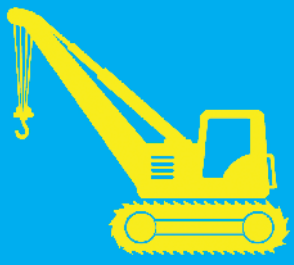
47%

OF THE SCIENCE RESEARCHERS IN CENTRAL ASIA ARE FEMALE, THE LARGEST PROPORTION GLOBALLY

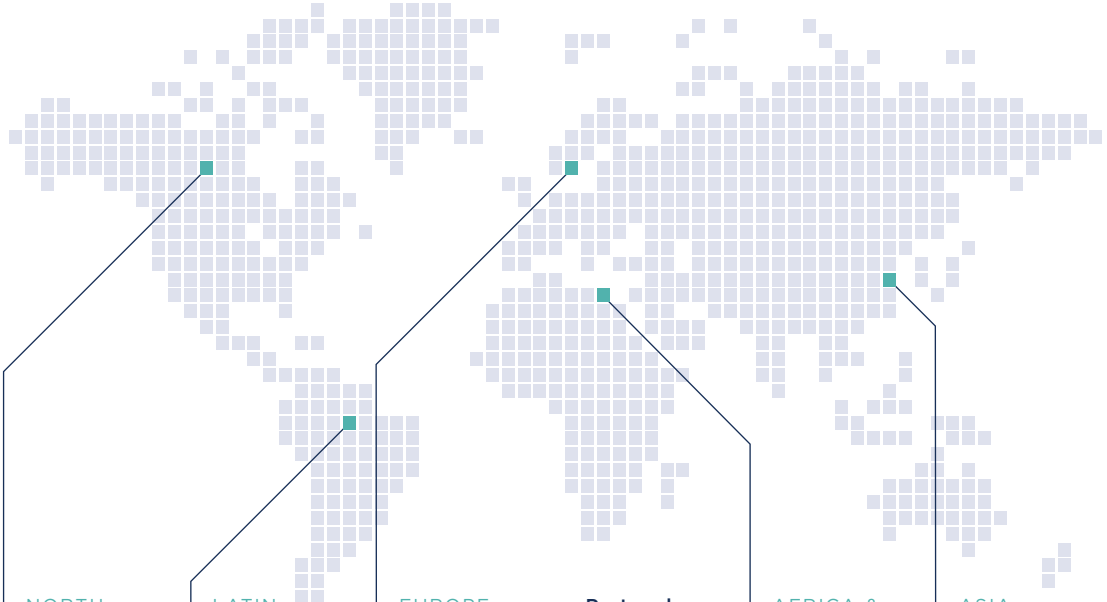
AS MANY AS

600,000

CONSTRUCTION-SECTOR JOBS [IN THE UK] COULD BE REPLACED BY TECHNOLOGY IN THE NEXT TWO DECADES



Offices worldwide



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