

A MONTHLY MAGAZINE ON KNOWLEDGE AND DEVELOPMENT BY THE
MOHAMMED BIN RASHID AL MAKTOUM KNOWLEDGE FOUNDATION



OCTOBER 2017
ISSUE 34

**Factories
Of The
Future**

UAE prepares
for the Fourth
Industrial Revolution

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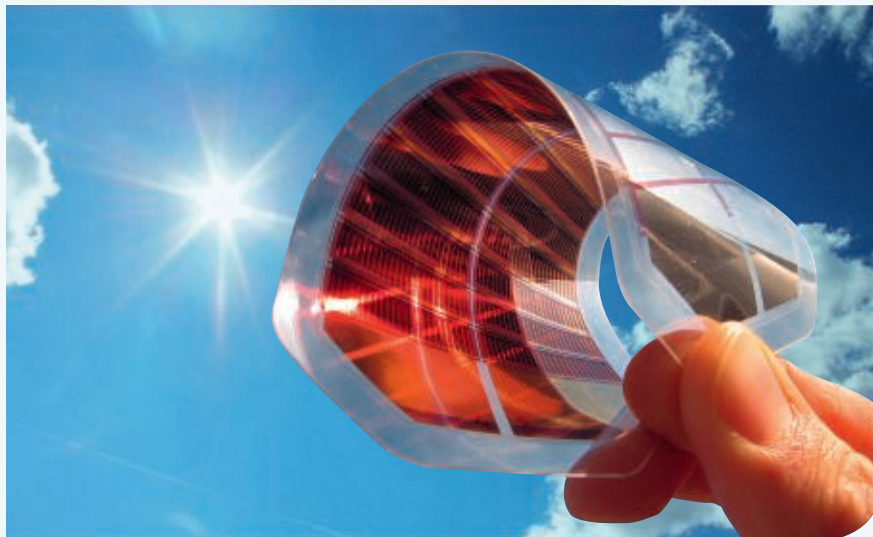
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THE ECO-FRIENDLY
PRIUS

THE WORLD'S LEADING HYBRID
THAT FUELED THE
HYBRID MOVEMENT



The Toyota Prius is a pioneer in sustainable mobility, and has led the hybrid revolution over the last 20 years. It drives further than conventional vehicles on a litre of fuel (26 km). The Prius' eco-friendly technology also helps reduce CO₂ emissions by 1 tonne a year. So, it's hardly surprising that it continues to lead environmentally-friendly change without compromising on style and comfort.

#TheFutureisNOW



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CHAIRMAN

HE Jamal Bin Huwaireb

EDITORIAL BOARD

Saif Al Mansoori

Khalid Wazani

Eyad Al Jurdy

Mohammed Bin Rashid
Al Maktoum Knowledge
Foundation
T: +971 4 423 3444
F: +971 4 368 7777
PO Box 214444, Dubai
United Arab Emirates
www.mbrf.ae
flashes@mbrf.ae



A Motivate Connect Publication

Media One Tower,
Dubai Media City
PO Box 2331, Dubai, UAE
T: +971 4 427 3000
F: +971 4 428 02261
motivatepublishing.com
connect@motivate.ae

PUBLISHER

Chris Capstick
chris@motivate.ae

GROUP EDITOR - CONNECT

Guido Duken

PROJECTS MANAGER

Ingrid Valles

SENIOR ART DIRECTOR

Tarak Parekh

DESIGNER

Sanil Kumar

CONTRIBUTOR

Robert Anderson

GENERAL MANAGER - PRODUCTION

Sunil Kumar



FOREWORD

Dear readers,

According to economist and bestselling author Jeremy Rifkin, who is an advisor to both the People's Republic of China and the European Union, we are heading towards a post-capitalist society. This 'New World Order' will be driven by the Internet of Things (IoT) that will enable people to evolve from consumers to prosumers, who produce and share the things they need in an economy that is defined by collaboration as opposed to competition.

Rifkin labels this transition into the digital age as the Third Industrial Revolution. It is being made possible by converging factors such as renewable energy, the IoT, and decentralised communication through the internet. It is Rifkin's contention that the GDP of countries that rely on centralized telecommunications, fossil fuel, nuclear power and internal-combustion transportation peaked 10 to 15 years ago. In other words, either innovate or stagnate.

Whether Rifkin's economic view is correct remains to be seen. However, the articles in this issue of *Flashes* leave little doubt how fast technology is moving. Nanotechnology is set to have a huge impact on renewable energy by breaking through cost and efficiency barriers. 3D bioprinting and gene editing are still in their nascent stages, but are already

impacting the health sector. Additive manufacturing, utilising 3D printing, is changing the ways things are made. Artificial intelligence, in the form of machine learning, is all around us.

All of this has been made possible by the invention of the humble transistor in 1947. The prototype was as big as a hand, as was the first integrated circuit in 1958. But things evolved rapidly. In 1971 the average microprocessor had 2,300 transistors, today it has 1,300,000,000. In 1984 the first mobile phone was released. In 1990 there were 12.5 million mobile phone users globally. By 2010, there were four billion. In 1990 there were also just 2.8 million internet users, which grew to 3.6 billion last year.

Rifkin believes we are still transitioning into the Third Industrial Revolution. Professor Klaus Schwab, Founder and Executive Chairman of the World Economic Forum, is convinced that we are at the beginning of The Fourth Industrial Revolution. Regardless of whom you believe, it is clear new technologies are fusing the physical, digital and biological worlds, impacting all disciplines, economies and industries.

Jamal Bin Huwaireb

CEO of Mohammed bin Rashid
Al Maktoum Knowledge Foundation



Unique Youth Centre Inaugurated

projects. It also includes office areas for youth, volunteering and training opportunities, a cafe, and a theatre for youth events. A collaborative brainstorming lab is also in the pipeline for brainstorming sessions that would lead to innovative ideas.

His Highness Sheikh Mohammed bin Rashid Al Maktoum and His Highness Sheikh Mohamed bin Zayed Al Nahyan have called for replicating this centre's model throughout the country. The aim is to develop various forums for the youth that enable them to serve the country, build their futures, and create innovations and projects that will shape the country's future.

His Highness Sheikh Mohammed bin Rashid said, "We want to prepare the younger generation to lead the process of development. The youth of the UAE deserve the best and we expect the best from them. This is why we have faith in their abilities to create a better future for our country."

His Highness Sheikh Mohamed bin Zayed hailed the youth centre as an exceptional addition and represents an environment that encourages innovations. He stressed that investing in the youth is essential for the development of the country.

HH Sheikh Mohammed bin Rashid Al Maktoum and HH Sheikh Mohamed bin Zayed Al Nahyan toured the centre accompanied by Minister of State for Youth Affairs Shamma bint Sohail Faris Al Mazrui, who supervised the centre's development, in cooperation with the country's other youth centres.

Vice President and Prime Minister of the UAE and Ruler of Dubai His Highness Sheikh Mohammed bin Rashid Al Maktoum, together with Abu Dhabi Crown Prince and Deputy Supreme Commander of the UAE Armed Forces His Highness Sheikh Mohamed bin Zayed Al Nahyan, inaugurated a unique youth centre that offers all-inclusive services for young people below the age of 30.

The centre comprises areas for journalists, entrepreneurs, researchers, programmers and gamers, and has an annual calendar of events and programmes. Youths below the age of 30 designed the centre. It includes meeting rooms, areas allocated for youth projects, a library, a theatre, a workshop, and a studio for creative productions.

Located in Emirates Towers, the centre will provide classes and workshops, besides hosting entrepreneurial

E-Learning Project Launched



His Highness Sheikh Mohammed bin Rashid Al Maktoum, Vice President, Prime Minister and Ruler of Dubai, launched the Mohammed bin Rashid Arabic E-Learning Project on September 18, which includes a Translation Challenge that aims to translate 11 million words and the terminology of math and science into Arabic.

The Translation Challenge calls on all Arabs to help translate 5,000 videos and 11 million words of world-class math and science material to Arabic, to be available online for free, for over 50 million Arab students from kindergarten to grade 12. The content is to be sourced and localised

in accordance with the highest international standards and curricula.

The Mohammed bin Rashid Arabic E-Learning Project is part of Mohammed bin Rashid Al Maktoum Global Initiatives (MBRGI). It is an online initiative that seeks to lay the foundation of a new knowledge base, and to establish the future of science and math excellence among Arab students.

During the launch, HH Sheikh Mohammed said, “Providing high quality education in science and math to all Arab students is integral to rebooting our civilizational development. E-Learning is the fastest way to bridge the educational gap in the Arab world.”

“We have challenged all Arabs to help translate 11 million words in order to produce 5,000 educational videos in one year; we urge anyone interested to participate in this important ongoing cultural project,” Sheikh Mohammed added.

His Highness elaborated, “Our goal is to provide high standard academic material in science and maths to all Arab students; this project is the first step in a long journey to improve education in the Arab world, and make it accessible to millions of Arab students. Translation is the foundation of a cultural renaissance, and opens the doors to intellectual enlightenment.”

“The reality of the education system in the Arab world may be disappointing, however today we light a candle of hope. I believe in the unbound potential of Arab students when they have access to the necessary resources, tools and material to excel,” Sheikh Mohammed said. †

World's Largest CSP Project

His Highness Sheikh Mohammed bin Rashid Al Maktoum, Vice President and Prime Minister of the UAE and Ruler of Dubai, announced the largest single-site Concentrated Solar Power (CSP) project in the world, which will be built at a total cost of AED14.2 billion.

The CSP project, which represents the fourth phase of the Mohammed bin Rashid Al Maktoum Solar Park, will generate 700MW of clean energy to support Dubai's electricity grid. The project is considered an integral part of the emirate's Clean Energy Strategy 2050.

His Highness Sheikh Mohammed highlighted the UAE's model for sustaining a green economy based on environmental sustainability and clean energy.

“We have made steady progress in realising the goals of Dubai Clean Energy Strategy 2050 that was launched as part of our objective to transform Dubai into a global clean energy and green economy hub. The carbon footprint of Dubai will be the lowest in the world by 2030,” said Sheikh Mohammed. “We are proud that by demonstrating their capabilities, our local talent have proved that they are ready to assume responsibility,” he added. †





Mohammed bin Rashid Al Maktoum Knowledge Award Board of Trustees Begins Evaluating Candidates

The Board of Trustees of the Mohammed bin Rashid Al Maktoum Knowledge Award (MBRKA) held its first meeting following the closing of the application period for the Award, in the lead-up to the second round of qualifications.

The meeting was held on September 10 at the Dubai headquarters of the Mohammed bin Rashid Al Maktoum Knowledge Foundation (MBRF) – the institution organising the Award – under the patronage of MBRF Chairman His Highness Sheikh Ahmed bin Mohammed bin Rashid Al Maktoum, who is also the MBRKA's Chairman of the Board of Trustees.

The Foundation's CEO, His Excellency Jamal bin Huwaireb, presided over the meeting, where the Board examined the entries of candidates – both individuals and organisations – who made it to the second round

of selections after the Committee of Advisors shortlisted them from the applications submitted via the Award's website over a period of four months. The Board also discussed preparations and procedures for the upcoming second phase of the Award.

Members of the Board present at the meeting were: Dr Ali Ahmed Al Ghafl, Vice Dean for Social Sciences at the College of Humanities and Social Sciences, UAE University; Nick Rawlins, Professor of Behavioural Neuroscience at the University of Oxford; and Alexander J.B. Zehnder, Visiting Professor and Member of the Board of Trustees of Nanyang Technological University (NTU), Singapore.

“The Mohammed bin Rashid Al Maktoum Knowledge Award has spearheaded the efforts to spread knowledge across the UAE and the Arab world,” said HE Jamal bin



Huwaireb, noting that this year the Award was open for nominations for the very first time. “Our region needs to build on this opportunity and continue its efforts to shed light on major contributions and achievements that serve to produce and spread knowledge.”

HE bin Huwaireb explained that the Board will begin shortlisting the most successful entries and then present the list to MBRKA's Chairman of the Board to approve by October 2017. “This is an international award,” he stressed, pointing out that the Award's Board of Trustees “can count representatives from prestigious international knowledge institutions among its members – institutions such as UAE University, the University of Oxford, Nanyang Technological University (NTU) Singapore and National Geographic.”

Dr Ali Al Ghafla lauded the Award as a platform to recognise and reward contributions by thought-leaders – be they individuals or organisations – who have devoted time and effort to create knowledge and positively affect people's lives.

Prof. Nick Rawlins, for his part, underlined the importance of an Award like the Mohammed bin Rashid Al Maktoum Knowledge Award, seeing as it honours individuals and organisations for making contributions to the knowledge industries and helps create a global network of

knowledge professionals, pioneers and enthusiasts. Rawlins went on to commend the progress recorded in the knowledge and education sectors across the Arab world.

“The Committee of Advisors was extremely impressed with the high quality of the nominations,” said Dr. Wes Harry, Member of the Award's Committee of Advisors. “The Advisors spent two days selecting the very best of the potential MBR Knowledge Award winners. It proved to be a very difficult task to select only a few of the nominations for the Trustees to consider as potential MBRKA laureates. We look forward to many more nominations of the same high quality next year, even if it makes our mandate a lot more demanding.”

The Mohammed Bin Rashid Knowledge Award honours success in several knowledge-related categories, including development, innovation, leadership and creativity, the development of educational institutions, scientific research, communication technology, literature, publishing and printing, paper and electronic documentation, and many other sectors identified by the MBRKA Board of Trustees.

The Mohammed bin Rashid Al Maktoum Knowledge Foundation will announce the winners during the Knowledge Summit 2017, set to be held in Dubai this November. †

MBRF Launches “Bil Arabi” Programme on Al Oula Radio

The Mohammed bin Rashid Al Maktoum Knowledge Foundation (MBRF) launched a new programme as part of the “Bil Arabi” (In Arabic) initiative, in co-operation with Al Oula Radio in Dubai, as a follow up to the success of the Bil Arabi initiative.

Bil Arabi targets children and families, with the aim of improving their awareness about the importance of the Arabic language and encouraging them to use it daily. It also aims to promote the Bil Arabi initiative and its other knowledge-based projects.

HE Jamal bin Huwaireb, CEO of MBRF, stressed that the programme is a follow-up to the success and unexpected popularity of the Bil Arabi initiative and its various organised events during the past four years.

He added that the initiative reaching a billion people around the world in 2017, through its channels on social media websites such as Twitter, Facebook, Instagram and Snapchat, reflecting the stature of Arabic among children who

can speak the language. The Bil Arabi programme started on 16th September on Al Oula Radio. It runs every Saturday from 4 to 5pm, and includes various topics, such as a “say and do not say” segment, a segment to discuss various stories and books, a segment for scientific experiments demonstrated by children, an audience interaction segment, an “express in Arabic” segment, and a segment about the beauty and strength of the Arabic language.

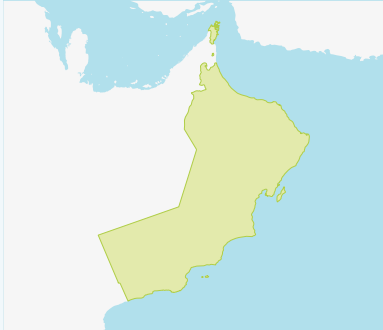
Bil Arabi began as an idea proposed by a group of university students to the Mohammed bin Rashid Al Maktoum Foundation, which later adopted the initiative to be carried out on a yearly basis, and to coincide with the UN Arabic Language Day on December 18. The initiative encourages social media users in the Arab world to exclusively use the Arabic language on their Facebook, Twitter, and Instagram accounts for the entire day.

“Bil Arabi” reflects the Foundation's vested interest in adopting innovative



ideas that contribute to the dissemination of knowledge and that cement the role and status of the Arabic language and encourages the younger generations to preserve it. †

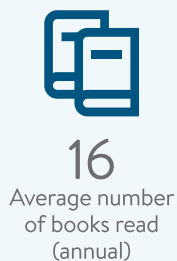




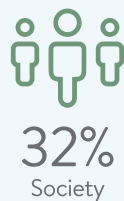
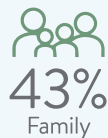
Reading Rank Overall: 12th
Total Reading Time Per Year: 35 hours
2016 Sample Size: 2005
Number of Arab Countries Sampled: 22

The Arab Reading Index (ARI) was first released in 2016 and aims to provide an objective assessment of the state of reading in the Arab region

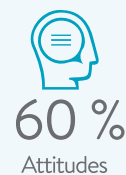
under the wider vision of the Arab Knowledge Index. As reading is the basic tool in knowledge acquisition, exchange, and dissemination this assessment is of primary importance. The Arab Reading Index focuses mainly on reading within the more general knowledge development concept, emphasising the role of reading as a tool for enlightenment and empowerment.



Reading matter sourced from



Made up of



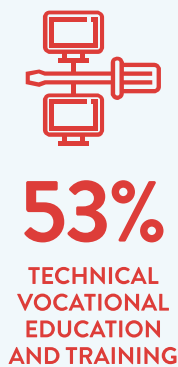
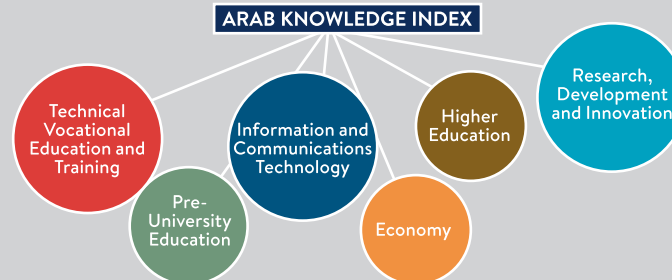
The Arab Reading Index is done in partnership by the Mohammed bin Rashid Al Maktoum Knowledge Foundation (MBRF) and the United Nations Development Programme (UNDP).

Source: www.knowledge4all.com

Number of Arab Countries
Sampled: 22

The Index, which was initially launched at 2015's Knowledge Summit, monitors the status of knowledge in 22 Arab countries to help decision makers, experts and researchers to implement development policies and identify knowledge gaps.

THE SIX MAIN SECTORAL INDICES OF THE ARAB KNOWLEDGE INDEX



Main pillars

5%

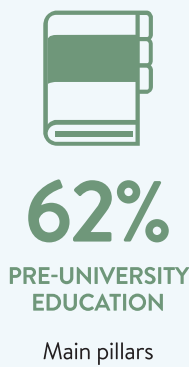
Education and Training

57%

Organisational Framework

79%

Development context



Main pillars

43%

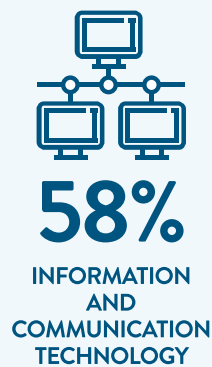
Enabling environments

78%

Knowledge capital

61%

General developmental context



Main pillars

60%

Technological capabilities

55%

Enabling environment



64%

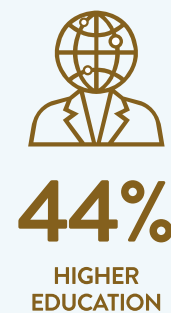
Organisational performance and human resources

53%

Competitiveness and creative development of the economic structure

48%

Economy-related information technology



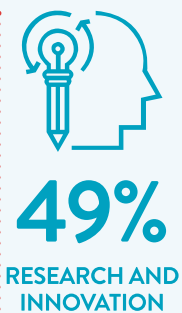
Main pillars

63%

Higher education inputs

33%

Higher education outputs



Main pillars

43%

Innovation

44%

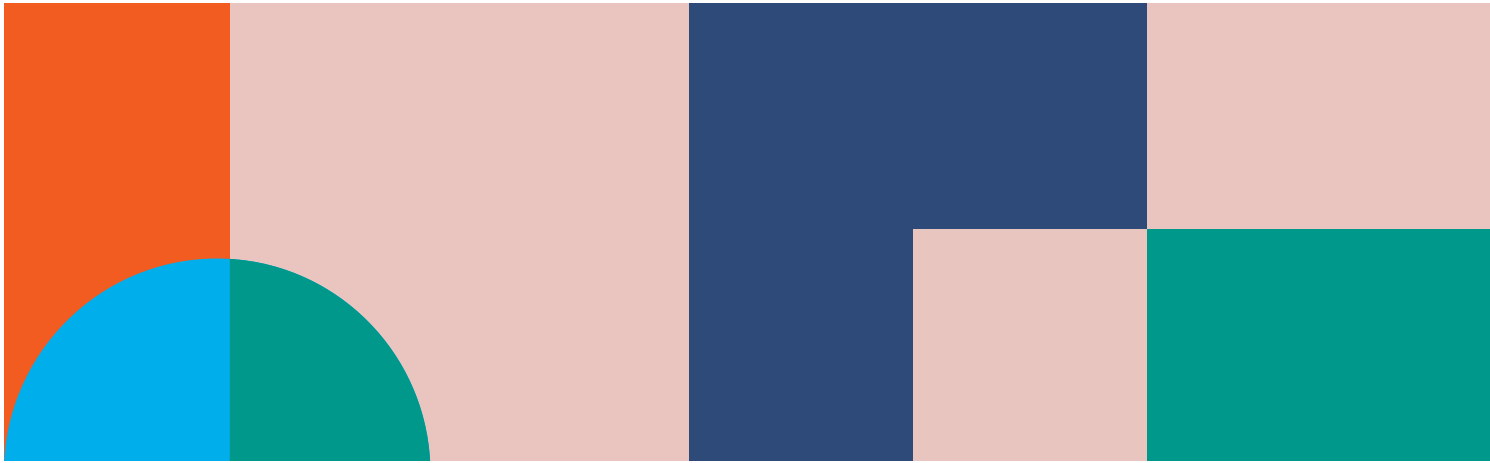
Research and development

62%

Enabling environment and infrastructure

The Arab Knowledge Index is a joint initiative between the Mohammed bin Rashid Al Maktoum Knowledge Foundation (MBRF) and the United Nations Development Programme (UNDP).

Source: www.knowledge4all.com



NOT TOY

Ayah Bdeir's startup littleBits is democratizing hardware and

Just one week after New York City-based startup littleBits' latest product – the R2D2 Droid Inventor Kit – was launched on August 31, it was the number one seller on Amazon in *Star Wars* toys and also featured highly in Walmart's predicted top 25 toys for the holidays.

In an incredibly competitive market this kind of straight-to-the-top success is a rare accomplishment. Yet Ayah Bdeir, the thirty-something Founder and CEO of littleBits, takes the success in her stride. Since the inception of littleBits in 2011, Bdeir has shouldered the meteoric rise of her first company calmly, keeping her feet on the ground and her vision in focus.

EMPOWERED CREATIVITY

Bdeir's mission is to "put the power of electronics in the hands of everyone, and to break down complex technologies so that anyone can build, prototype and invent."

The product Bdeir invented is a platform of easy-to-use electronic building blocks that empower the user to create anything, from interactive machines to home devices without the need for soldering, complicated wiring or tricky programming. Instead, the littleBits components snap together with a patented magnetic system.

The library has over 70 modules and it continues to expand, with every module

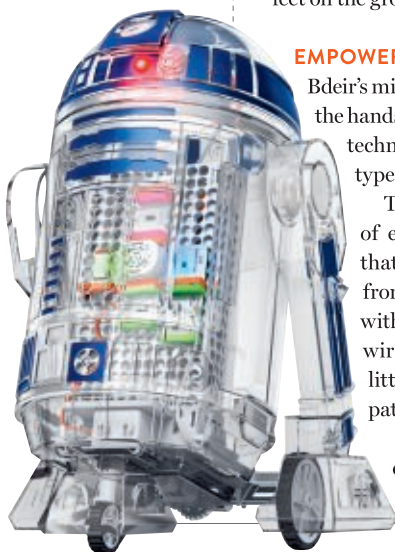
working with every other, thus allowing for millions of possible combinations. Children, designers, artists, engineers, scientists – anyone at all – can experiment with open-source access to designs and in no time at all snap together some littleBits to make anything they want: a dimmer light and alarm, a remote-controlled lobster or a confetti canon... whatever the imagination wishes.

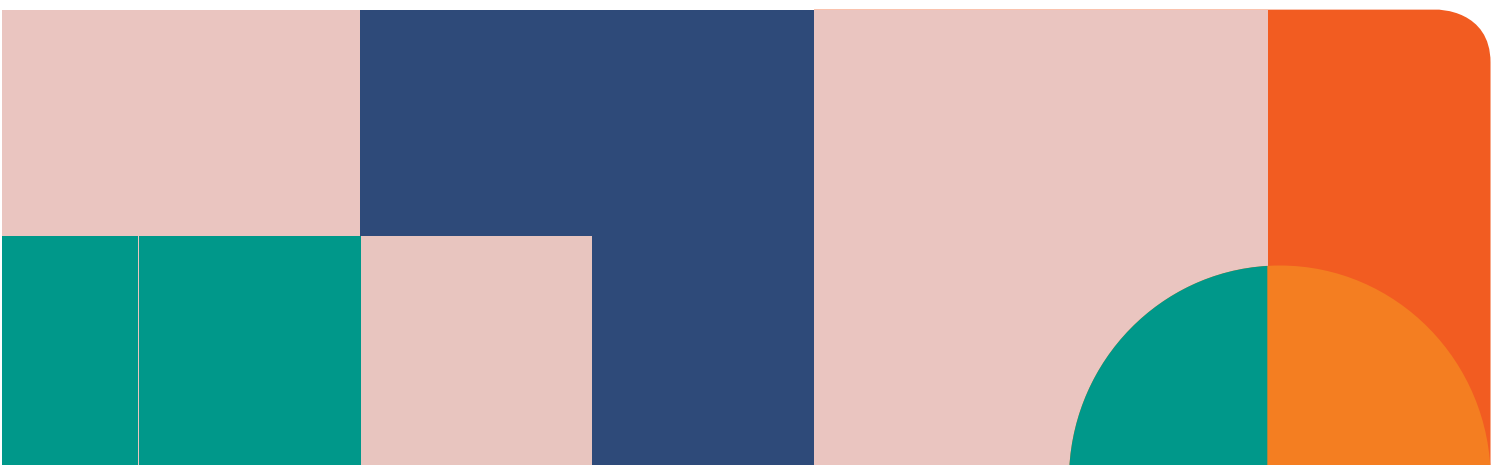
The company's website states: "At littleBits, we are on a mission to democratize hardware by empowering everyone to create inventions, large and small, with our platform of easy-to-use electronic building blocks."

Blocks are a fundamental feature in Bdeir's inspiration and success. She is a big fan of the concrete block due to the fact that soon after its invention in 1868, it became the most ubiquitous and efficient construction unit in the world. Infrastructure and engineering entered a new phase with skyscrapers and bridges soon rising high above our cities.

Bdeir would like to apply that same proliferation and freedom to construct to electronics, helping us to understand the increasingly connected and electronic world around us and our place in it. Speaking to *Flashes* Bdeir says, "We are continuing a global inventor movement that empowers young people to participate in a story that inspires them to be creators, not just consumers of technology."

With reference to the instant hit Droid Inventor Kit Bdeir adds, "We've created a gender-inclusive product





BUT TOOL

helping people understand a world where electronics proliferate.

that celebrates kids' own self-expression and ingenuity, while showcasing the same characteristics of imagination, grit and invention that are embodied in the *Star Wars* franchise."

NOT A TOY

While Bdeir is naturally thrilled to be enjoying great success in the toy sector, she is careful with her choice

of words and defines littleBits not as a toy, but rather as a tool. With respect to relatable products on the market, she resists the interpretation that littleBits is the 'LEGO for the iPad generation'.

This is by no means because she doesn't respect the LEGO product – Bdeir is a very vocal admirer of the company that has made some 400 billion 'automatic binding bricks' to date – but because she says, "LEGO



Left: Ayah Bdeir gave a popular TED Talk called 'Building blocks that blink, beep and teach'.



Above: Children build a city using their imagination and littleBits components.

Right: Bdeir started littleBits in 2011. The company now has \$60 million in funding.



considers themselves a toy. I consider them as much more but they position themselves as a toy. We consider ourselves as a tool. It's a tool for education, for understanding the world, and it's a tool for invention. Entertainment and play is part of it but it's not the whole thing."

In her popular TED Talk, 'Building blocks that blink, beep and teach', Bdeir cited the impact of LEGO in 1947 saying that when it became a global household product, people didn't have, "to be an engineer to make beautiful houses, beautiful bridges, beautiful buildings. LEGO made it accessible. LEGO has essentially taken the concrete block, the building block of the world, and made it into the building block of our imagination."

Now, Bdeir is doing the same with electronics, essentially democratizing the access to the engineering

and hardware development of electronic devices. Considering that the use of electronic devices in developed societies is over 11 hours a day, it can only be a positive thing that with littleBits more people can understand how they work and even make their own.

In a recent Inc. Founders Forum interview Bdeir says, "I believe it's become a form of illiteracy for us not to understand what the world is made of. It's important for us to be able to know how the lights come on in the bedroom, how your coffee maker is functioning or why an iPhone is such a big deal... otherwise we become sort of passengers in our own life and we are just consumers purchasing what companies say we should."

Bdeir is charming, eloquent and earnest in her desire to put the power of electronics in the hands of people everywhere, enabling anyone to become an inventor. "Electronics have a lot of power beyond you just consuming them and using them and we want to enable anyone to use that power to bring their creativity to life," she says.

"Just like software used to be something that only large companies could do many decades ago," Bdeir continues, "software got democratized and now anybody with a laptop and a few days can write their own programme or make their own website. 3D printing is the same thing – manufacturing used to be just experts, now anybody can desktop 3D print at home. Hardware should follow the same path and that is what we are doing."

With her formidable work ethic and passionate energy at the helm, littleBits has raised around \$60 million total capital, is working with over 3,500 schools, and is in approximately 130 countries. The success of the company can be viewed in a wider context as being part of the growing 'maker movement'





even though she employed 45 employees with offices on Union Square in Manhattan. Bdeir, an MIT graduate, is grateful she and her company could stay

and says, "There was a period when I genuinely did think I was not going to be able to stay, but I would do anything in my power to stay... I'm in love with New York and I wouldn't have the company be anywhere else."

Bdeir wrote about this period on Medium saying, "The issue is personal for me. My family and I are refugees many times over. My parents are both from Syria and moved to Lebanon as kids. They then fled Beirut to Montreal when the war broke out."

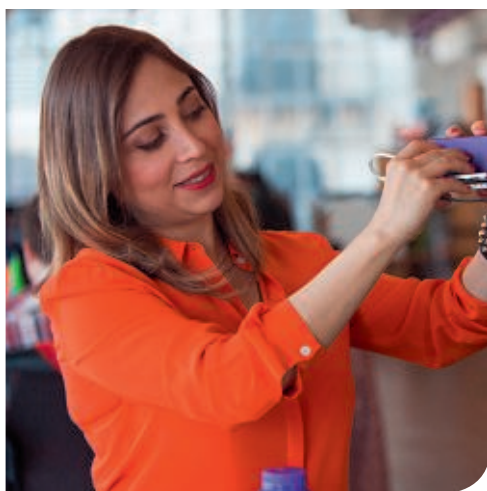
Bdeir goes on to explain that one of the reasons littleBits is so successful is thanks to employees that are immigrants and that about one fifth of the staffers are from outside the USA. In characteristically bold and fearless fashion, Bdeir responded to the widely criticized and internationally condemned on-again-off-again travel blockade with a unifying act of protest.

LittleBits bought a large scale digital advertisement on Times Square that beamed out the words: "We Invent the World We Want to Live In" followed by the translation in Arabic in order to diffuse the notion of Arabic being foreign or threatening by using it to communicate a positive message.

In final reflection Bdeir says, "I really relish moments in my life when I am disconnected but I do think there are a lot of opportunities to bring the best of the digital world and embed them in the physical world. The ability to understand your space and how you occupy it better, the ability to interact with the machines around you as opposed to just consuming them. We want to encourage a world of creators, of inventors, of contributors, because this world that we live in, this interactive world, is ours. So... start inventing." ↑

Above left and right: LittleBits is working with more than 3,500 schools and is present in around 130 countries.

Left: Bdeir demonstrates how to build an electronic bubble-blowing machine with littleBits.



and the resurgence of manufacturing in the USA.

Responding to how littleBits fits in with this, Bdeir says, "The maker movement has always been here, it just didn't have that exact name. It was called DIY. Actually, it was normal life... if your car broke you fixed it and if your phone broke you opened it up. But the world went in a new direction of complete, finished, black box products so much that the maker movement had to come back and offer an alternative to this."

THE VALUE OF IMMIGRANTS

While littleBits can be seen as an exemplary contributing player in the rejuvenation of domestic manufacturing in the USA, the recent political instability resulting from President Trump's executive order temporarily banning immigrants from seven predominantly Muslim nations, gave Bdeir serious cause for concern about the future of her company and indeed whether it would remain US-based.

As a Canadian citizen that grew up in Lebanon, Bdeir had to endure a period of uncertainty where she was unsure if she could stay in the USA or not,

NANOTECHNOLOGY ON THE MOVE

Nanoscience and nanotechnology is impacting every sphere of life, but it is in the energy sector that numerous breakthroughs are being made.

Nanotechnology, which has often been over-hyped or misunderstood, is making its impact felt in various spheres such as information technology, homeland security, medicine, transportation, energy, food safety, and environmental science. In simple terms, nanotechnology is science, engineering, and technology conducted at the nanoscale, which is about 1 to 100 nanometers (one nanometer is a billionth of a metre).

The ideas and concepts behind nanoscience and nanotechnology started with a talk entitled “There’s Plenty of Room at the Bottom” by physicist Richard Feynman at an American Physical Society meeting at the California Institute of Technology (CalTech) on December 29, 1959, long before the term nanotechnology was used. In his talk, Feynman described a process in which scientists would be able to manipulate and control individual atoms and molecules. Over a decade later, in his explorations of ultra-precision machining, Professor Norio Taniguchi coined the term nanotechnology. It wasn’t until 1981, with the development of the scanning tunneling microscope that could “see” individual atoms, that modern nanotechnology began.

Today, after more than 20 years of basic nanoscience research and more than 15 years of focused R&D,

applications of nanotechnology are delivering in both expected and unexpected ways on nanotechnology’s promise to benefit society.

THE BENEFITS OF NANOTECHNOLOGY

Many benefits of nanotechnology depend on the fact that it is possible to tailor the structures of materials at extremely small scales to achieve specific properties, thus greatly extending the materials science toolkit. Using nanotechnology, materials can effectively be made stronger, lighter, more durable, more reactive, more sieve-like, or better electrical conductors, among many other traits.

This is of particular relevance to the energy sector where most important processes happen at the nanoscale. In solar cells, for instance, photons can free electrons from a material, which can then flow as an electric current; the chemical reactions inside a battery or fuel cell release electrons, which then move through an external circuit; or the role of catalysts in numerous chemical reactions. These are just a few examples where nanoscale engineering can significantly improve the efficiency of the underlying processes. >



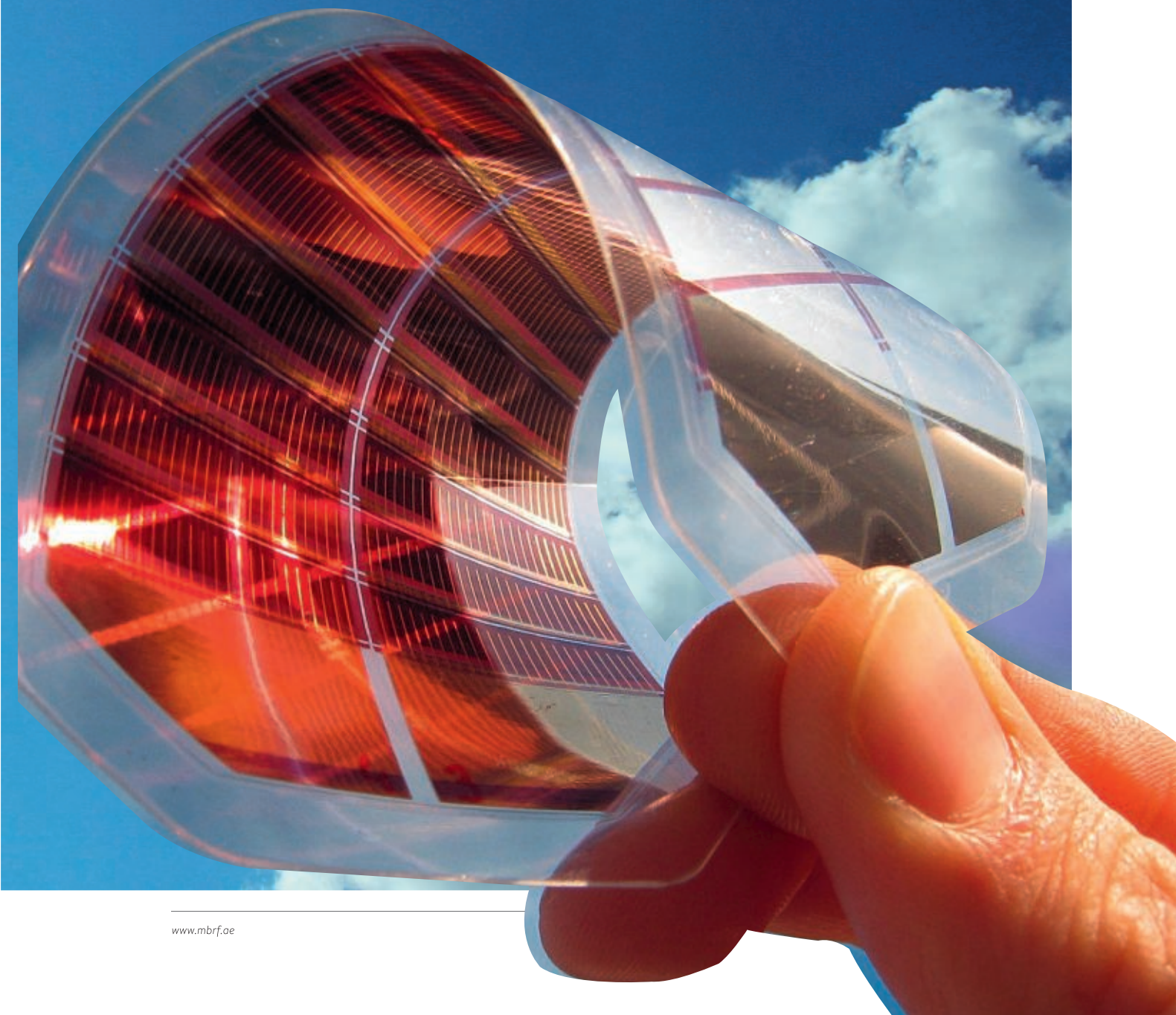
6 MILLION

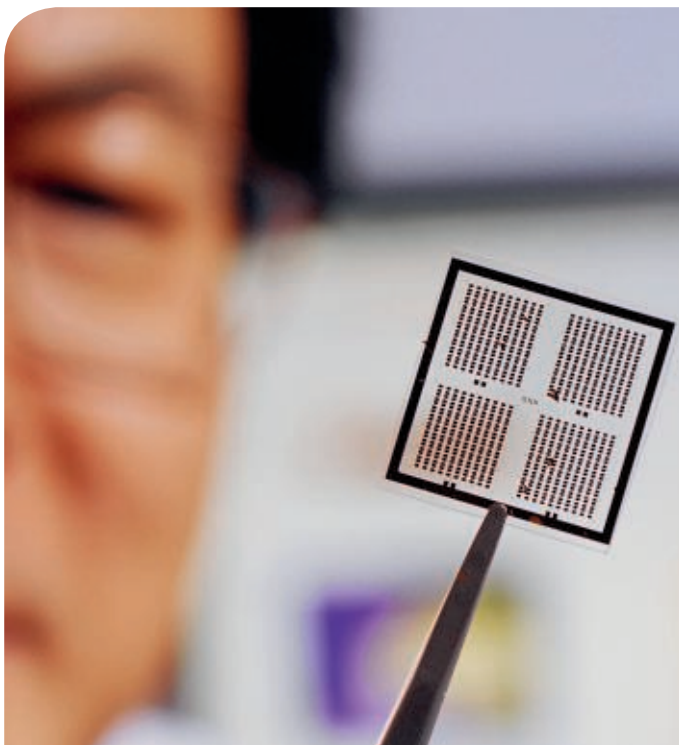
The estimated number of nanotechnology workers needed worldwide by 2020



2 MILLION

The number of those jobs expected to be in the US.





Above: Nanosheets use piezoelectric techniques to extract energy from motion.

Last April, for example, scientists at the Ludwig Maximilian University of Munich announced the creation of iron-nickel oxide nanoparticles that can increase the efficiency of hydrogen production by a factor 10. Nanotechnology is also being explored in the oil and gas industry, where it can help increase the durability of drilling equipment.

A FORCE IN RENEWABLE ENERGY

The greatest impact of energy-related nanotechnologies, however, is likely to be in the renewable energy space, where nanotech could prove key in breaking through cost and efficiency barriers. One of the biggest drawbacks with modern solar power devices is their efficiency: even the most advanced devices only absorb a fraction of the incoming solar radiation, and only a fraction of that radiation is converted into electricity (the rest is mostly lost as heat and reflected light).

Most solar power generators in use today are solar cells, which use long, thin crystals of silicon to convert sunlight into an electric potential. These can absorb a maximum of about 48 per cent of incoming solar radiation, about half of which can be converted into electricity.

A 2008 study from Stanford University showed that solar cells composed of silicon 'nanowires' and 'nanocones' can absorb approximately 90 per cent of incoming solar radiation (at certain angles of incidence) – almost twice the amount that can be absorbed by traditional thin-film solar cells.

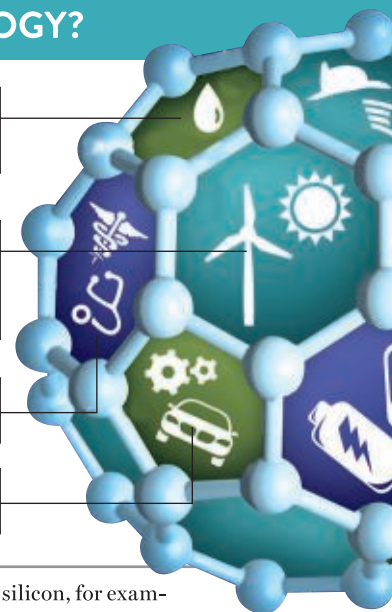
WHAT'S THE BIG DEAL ABOUT NANOTECHNOLOGY?

Clear environment through new water purification methods and by removing pollutants from groundwater and soil.

Energy innovations, like more efficient solar panels, stronger lighter weight wind turbines, lighter car parts and improved fuel efficiency.

Better detection and treatment of cancer and other medical conditions.

Automotive innovations thanks to smart tires, anti-fog window coatings and stronger car parts.



Adding nano needles to black silicon, for example, not only enables the making of solar cells that can absorb more sunlight from a wider range of angles than traditional ones, it also avoids the need for an anti-reflection coating, thus saving costs. A new class of nanomaterial (quantum dots) could also allow solar cells to be deposited as a solution, like printing ink onto paper or painting a wall. While efficiency levels are not yet competitive (9% vs 22% for black silicon), the technology could theoretically reach 45% conversion efficiency – and spraying solar cells would be both faster and cheaper than building them from silicon.

Wind power is also benefitting. An epoxy containing carbon nanotubes is being used to make windmill blades that are longer, stronger, and lighter-weight than other blades to increase the amount of electricity that windmills can generate.

ENERGY STORAGE

A main problem of renewable energy is that it is intermittent, which makes energy storage a vital component. Nanotechnology is already being used to develop many new kinds of batteries that are quicker-charging, more efficient, lighter weight, have a higher power density, and hold electrical charge longer.

Nanowires, a thousand times thinner than a human hair, pose a great possibility for future batteries. But they've always broken down when recharging. However, researchers at the University of California Irvine have discovered that gold nanowires in a gel electrolyte avoid that fate. In fact these batteries were tested by

Incredibly small scale, generally between one and 100 nanometers. The nanoscale is so tiny that a sheet of paper is about 100,000 nanometers thick. Nanotechnology could bring about the next wave of information in science and engineering – the possibilities are endless



Defense innovations, like enhanced sensors for chemical and biological weapons and high performance materials for personal and vehicular defense.

Improved everyday items, like fabrics that can better resist staining and enhanced sports equipment.

Electronics that are faster, smaller, more portable and can store larger amounts of energy and information.

recharging them over 200,000 times in three months and showed no degradation at all.

Yi Cui, a materials scientist at Stanford University, is marrying battery chemistry with nanotechnology. He is building intricately structured battery electrodes that can soak up and release charge-carrying ions in greater quantities, and faster, than standard electrodes can, without producing troublesome side reactions. His company, Amprius, already supplies phone batteries with silicon electrodes that store 10 per cent more energy than the best conventional lithium-ion batteries on the market. Another prototype beats standard batteries by 40 per cent, and even better ones are in the works. So far, the company does not make batteries for electric vehicles (EVs), but if the technologies Cui is exploring live up to their promise, the company could one day supply car batteries able to store up to 10 times more energy than today's top performers. That could give modest-priced EVs the same range as gas-powered models – a revolutionary advance that could help nations power their vehicle fleets with electricity provided by solar and wind power, dramatically reducing carbon emissions.

Nanotechnology is also making an impact on conventional energy. It is improving the efficiency of fuel production from raw petroleum materials through better catalysis. Nanotechnology is also enabling reduced fuel consumption in vehicles and power plants through higher-efficiency combustion and decreased friction.

Researchers are also developing wires containing carbon nanotubes that will have much lower resistance than the high-tension wires currently used in the



electric grid, thus reducing transmission power loss.

In the area of energy harvesting, researchers are developing thin-film solar electric panels that can be fitted onto computer cases and flexible piezoelectric nanowires woven into clothing to generate usable energy on the go from light, friction, and/or body heat to power mobile electronic devices.

For example, researchers at Vanderbilt University have built a system that uses piezoelectric techniques for extracting energy from motion by harvesting electricity from human motion. The researcher's system uses sheets of black phosphorous that are only a few atoms thick. Bending or pressing the black phosphorous nanosheets produces a small electrical current that can be harvested and stored in a battery.

Similarly, various nanoscience-based options are being pursued to convert waste heat in computers, automobiles, homes and power plants to usable electrical power.

In addition to those noted above, nanotechnology is enabling more efficient lighting systems; lighter and stronger vehicle chassis materials for the transportation sector; lower energy consumption in advanced electronics; and light-responsive smart coatings for glass.

From the above it is clear that nanotechnology will have a huge impact on our future. In 1997, around 13,000 nanoscience-related papers were published worldwide. By 2016, the number had risen to more than 154,000, according to a report released at the 7th International Conference on Nanoscience and Technology in September this year. This exponential growth bodes well for the world's energy future.

Above: The new generation of solar cells is stronger, lighter and more reactive thanks to nanotechnology.

THE YEAR OF ZAYED

Next year the UAE will be celebrating the legacy of the late Sheikh Zayed bin Sultan Al Nahyan, who laid the foundations that the UAE's success is built on.

Sheikh Zayed bin Sultan Al Nahyan, who died in 2004, would have turned 100 next year, which is why his son, His Highness Sheikh Khalifa bin Zayed Al Nahyan, the President of the UAE, has declared that 2018 will be the 'Year of Zayed'. The announcement was made on August 6, the day Sheikh Zayed assumed leadership in Abu Dhabi in 1966.

As a result, next year will be dedicated to highlighting the role of the late leader in establishing the UAE federation, as well as his local, regional and international achievements. In this context The Year of Zayed is focused on achieving several objectives.

The first of these is paying homage to the vital role Sheikh Zayed played in establishing the UAE and consolidating its foundations of modern development. There will also be an emphasis on the nation's local, regional and global achievements, which continue to form the basis of the country's progress.

The Year of Zayed is also focused on sharing Sheikh Zayed's values and principles, with organisers hoping the celebration will strengthen his stature as a symbol of patriotism and love for the nation.

HH Sheikh Khalifa touched on these points when he announced The Year of Zayed. "On this day, August 6, a new era dawned upon us all when the late Sheikh Zayed assumed command of the Abu Dhabi government, and began the march towards unity, prosperity and societal development."

"The Year of Zayed is a great national occasion where we will proudly share memories of the life of the founding father, Sheikh Zayed bin Sultan Al Nahyan, and his gift to us of deeply-rooted values, principles and traditions that have become part of our Emirati identity."

The President has urged all residents of the UAE to uphold the "noble values instilled in them by the late Sheikh Zayed", including those of wisdom, respect, determination, loyalty, a sense of belonging to the nation, and a willingness to make sacrifices at whatever cost.

His Highness Sheikh Mohammed bin Rashid Al Maktoum, Vice President and Prime Minister of the UAE and Ruler of Dubai, said: "We celebrate the centennial anniversary of the birth of one of the greatest and most noble men who dedicated his life for the present and future of the nation."

"We are inspired by the Zayed school of leadership and management. With the founding blocks of the Union State placed by the late Sheikh Zayed, from which we are all reaping the benefits, we will continue this path and look forward with optimism to the future."

Many volumes have been written about the contribution of Sheikh Zayed towards creating the prosperous, innovative country that the UAE is today. However, there were two important days on the UAE calendar in August that give a snapshot of his legacy. >







Above: HE Shamma Al Mazrui is the minister of State for Youth Affairs.

Right: Around 20.5 per cent of the UAE's budget is earmarked on the education sector.

FOCUS ON YOUTH

On August 12 International Youth Day was celebrated around the world. The UAE recognizes the day as an opportunity to focus on the central role of youth in the development of the country. As Sheikh Zayed said: "Future generations will be living in a world that is very different from that to which we are accustomed. It is essential that we prepare ourselves and our children for that new world." As a result the country's wise leadership has always aimed to unlock the potential of young Emiratis by encouraging community participation and the pursuit of leadership roles through different national and regional endeavours.

His Highness Sheikh Mohammed bin Rashid Al Maktoum summed up this focus: "The UAE is a success story, whose champions are the youth. They are in the driver's seat when it comes to development, in both the government and private sectors. They are the UAE's most valuable asset."

The UAE government therefore has a strong focus on preparing the youth for the future. HE Shamma Al Mazrui was appointed as the Minister of State for Youth Affairs in 2016 and she heads the Emirates Youth Council that represents the youth ideas, aspirations and solutions before the government.

The UAE is also investing heavily in future generations. Of the UAE's \$13.3bn budget for 2017 about 20.5



per cent is earmarked for the education sector. This is very much in line with Sheikh Zayed's philosophy that: "The real asset of any advanced nation is its people, especially the educated ones, and the prosperity and success of the people are measured by the standard of their education."

Driven by a robust and diversified economy, as well as visionary leadership known for their extensive humanitarian work overseas, the United Arab Emirates has developed a global reputation for encouraging a "can-do" attitude among its residents respectful of religious and cultural diversity. This is underlined by the 2017 Asda'a Burson-Marsteller Youth Survey, which held face-to-face interviews with 3,500 youth in 16 countries. It found that the UAE was a role model for the region and the country that the Arab youth would most like to live in.



THE ROLE OF WOMEN

On August 28, the UAE celebrated its third annual Emirati Women's Day. Sheikh Zayed had put women at the centre of his plan to develop the nation many years ago. "The woman is half of the society, any country which pursues development should not leave her in poverty or illiteracy. I am on the woman's side," he said.

As a result the Constitution of the UAE guarantees equal rights for both men and women. Women enjoy the same legal status, claim to titles, access to education, the right to practice professions, and the right to inherit property as men. Women are also guaranteed the same access to employment, health and family welfare facilities. Women's empowerment is also a key target in the UAE's national strategy, which is to be achieved by 2021.

The success of Emirati women speaks for itself. More women than men complete their secondary education and go on to enrol at universities. Women's literacy has reached 91 per cent, with data showing that Emirati women account for 71.6 per cent of "students in government tertiary-level institutions" and 50.1 per cent of "students in private higher education".

Emirati women are also a force in the engineering and technology sectors. The UAE has the most number of female employees working in the space industry in the world, at 40 per cent, compared to international entities that have an average of 12 per cent female staff, according to UAE Space Agency officials. That figure is set for further growth. At more than 50 per cent, the representation of Emirati women in STEM programmes at UAE universities already exceeds international averages.



Within the business sector, the UAE possesses the largest number of businesswomen in the region where entrepreneurship is becoming increasingly popular. Almost 23,000 Emirati businesswomen run projects worth over AED50 billion, and occupy 15 per cent of the positions in the boards of chambers of commerce and industry nationwide.

A total of 18 Emirati women made it into *Forbes'* "Top 100 Most Powerful Arab Businesswomen" list this year – the highest of any country in the region. The strides made by these women fall perfectly in line with the UAE's aspirations to become a country within the top 25 in the world with respect to gender equality.

It is clear that women's empowerment in the UAE is no longer just a term or a theoretical concept, but a reality. This is borne out by the diversity of contributions by Emirati women to the UAE's growth, which is evident across the spectrum of nation-building – from aviation, military, police, science and technology, environmental sciences, the government sector to banking and entrepreneurship. Emirati women have been equal stakeholders in making the UAE reach the enviable position it is in today on the global stage.

According to the Global Gender Gap Report published by the World Economic Forum in 2013, UAE led the MENA region with the narrowest gender gap and according to the Social Progress Index 2015 report, UAE ranks first among 132 countries in the 'women treated with respect' indicator.

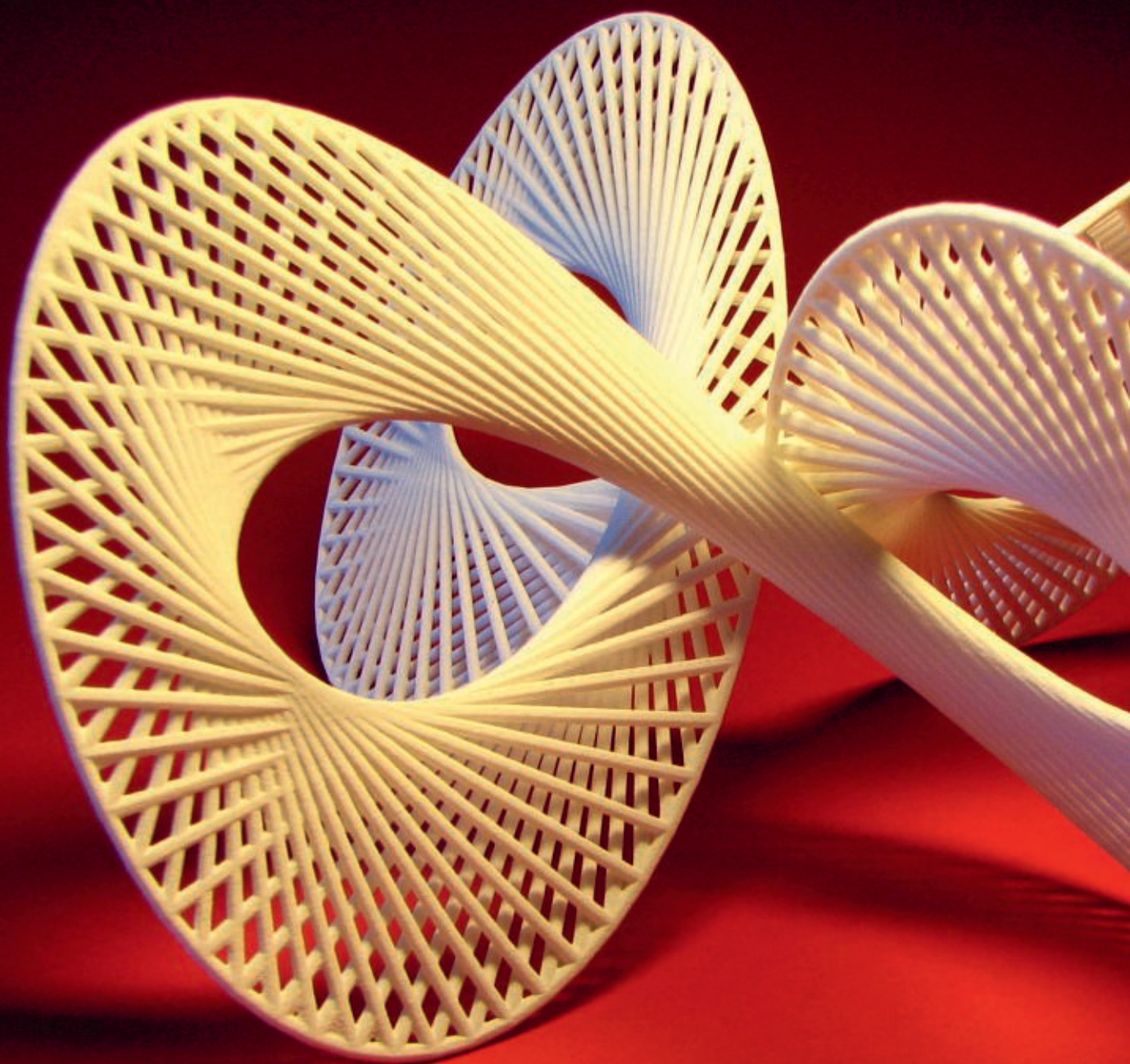
The important role that the youth and women play in the UAE's success and the government's focus on its citizens is very much born out of the Sheikh Zayed School of Thought.

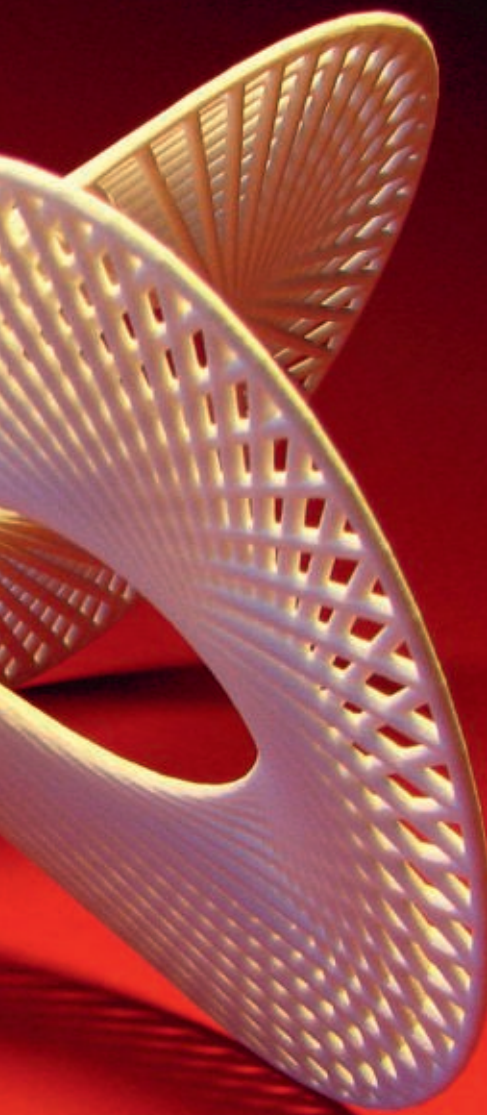
"Wealth is not money. Wealth lies in men. This is where true power lies, the power we value. This is what has convinced us to direct all our resources to building the individual, and to using the wealth which God has provided us in the service of the nation."†

Above: At more than 50 per cent the representation of Emirati women in STEM programmes already exceeds international averages.

Above centre: The UAE has a strong focus on preparing the youth for the future.

EXPLORE





FACTORIES OF THE FUTURE

The advent of additive manufacturing marks a radical change in the production landscape.

Steam powered the first machines that mechanized some of the work our ancestors did. Next came electricity, the assembly line and the birth of mass production. The third era of industry came about with the advent of computers and automation where machines began replacing human workers on assembly lines. Now we are entering Industry 4.0, in which computers and automation will come together in an entirely new way, with robotics connected remotely to computer systems equipped with machine learning algorithms that can control the robotics with very little input from human operators.

These envisaged 'smart factories' seamlessly combine technologies such as the internet of things (IoT), cloud computing, advanced robotics, real-time analytics, and machine learning around a versatile additive manufacturing hub, and enable the production of customised products at mass scales, cheaply and quickly.

ADDITIVE MANUFACTURING IS HERE

General Electric recently announced a radical departure from the way it has traditionally manufactured things. Its aviation division, the world's largest supplier of jet engines, is producing a fuel nozzle for a new aircraft engine by printing the part with lasers rather than casting and welding the metal. The technique, known as additive manufacturing (because it builds an object by adding ultrathin layers of material one by one), is transforming how GE designs and makes many of the complex parts that go into everything from gas turbines to ultrasound machines.

GE chose the additive process for manufacturing the nozzles because it uses less material than conventional techniques. That reduces GE's production costs and, because it makes the parts lighter, yields significant fuel savings for airlines. Conventional techniques would require welding about 20 small pieces together, a labour intensive process in which a high percentage of the material ends up being scrapped. Instead, the part is built from a bed of cobalt-chromium powder. A computer-controlled laser shoots pinpoint beams onto the bed to melt the metal alloy in the desired areas, creating 20-micrometre-thick layers one by one. The process is a faster way to make complex shapes as the machines can run around the clock.

GE isn't the only player in the aviation sector to make use of additive manufacturing. For example, the Airbus A350 contains more than 1,000 3D printed flight parts. By doing this, aircraft parts weigh 30 to 55 per cent less, while reducing raw material used up to 90 per cent, an important advantage in such a competitive sector.

German automaker Daimler AG is experimenting with 3D printed plastic spare parts for Mercedes-Benz trucks, no matter how old the model. By consigning these replacement parts to on-demand production, the company not only decreases inventory but it's also able to retire a large number of moulds and related equipment, thereby cutting costs.

Toy company Mattel is working on a \$300 microwave-sized 3D printer called the Thing-Maker, which lets kids create their own toys through a companion app. >

EXPLORE



3RD INDUSTRIAL REVOLUTION

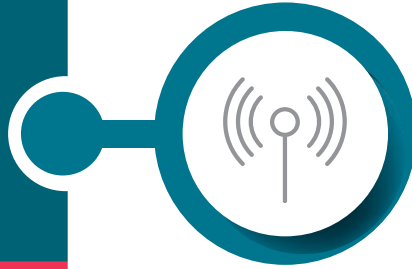
Combining IT and electronics allows for further automation of the production process



1ST INDUSTRIAL REVOLUTION

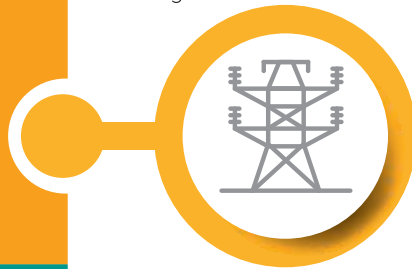
Introduction of mechanical production facilities supported by water and steam power

Right: Adidas's automated Speedfactory manufactures custom running shoes with 3D printed soles.



4TH INDUSTRIAL REVOLUTION

Combining IT and the connected enterprise leads to the 4th Industrial Revolution. Production facilities are connected with the internet of things.



2ND INDUSTRIAL REVOLUTION

Mass production fuels the 2nd Industrial Revolution with the help of electrical power

Industrial tech giants HP and Siemens recently partnered to develop an Additive Manufacturing (AM) software module. The new software module will allow customers to develop and manage parts in a single software environment for their 3D printing projects, avoiding data conversions and third-party tools.

CUSTOMISATION ON DEMAND

Additive manufacturing is also gathering momentum in a variety of consumer product sectors. In April this year, the German company Adidas partnered with Silicon Valley-based startup Carbon and unveiled the Futurecraft 4D, a running shoe with a 3D printed sole. At the launch, the sportswear manufacturer said it planned on selling 5,000 pairs by winter, which would scale up to more than 100,000 pairs by the end of 2018. The brand's official spokesperson said that the future aim is to provide each athlete with bespoke performance products tailored to their individual physiological data and needs on demand.

The brand kept the focus on athletes, but if you read between the lines you'd see the next big move coming: the age of mass customisation. Adidas – which offers customisation of its shoes through its Mi Adidas ("my Adidas") online platform – built its first automated manufacturing facility called Speedfactory in Germany in 2015. Since the successful launch of the Futurecraft 4D, the factory in the Bavarian town of Ansbach began large-scale production. The company plans to open additional Speedfactories in Western countries, including one in Atlanta, USA later this year. While Adidas will continue to make the vast majority of its shoes via the Asian contractors in its base supply chain, it wants the Speedfactories to be able to produce an estimated one million custom-designed pairs of shoes





annually to meet the high-priced demand for customised products in Western countries.

With Speedfactories, Adidas intends on drastically slashing down the time between custom orders and delivery. Initial figures suggest customer deliveries could be done within four to five business days. This system also allows Adidas to keep tabs on its customers' creations. If certain designs or features continue to show up at a high-enough rate, the company can then incorporate them into standard shoes in the base supply chain. Personalised orders thus offer insight into customers' desires.

Adidas's biggest competitor, Nike, also offers customisation through its NikeiD programme wherein customised shoes can be ordered via its website. However, according to Nike Chief Operating Officer Eric Sprunk, the American sports apparel brand is moving towards an era where its customers can walk into a Nike store and have a 3D-printed shoe made within a matter of hours.

A NEW ERA

It is clear this new-age manufacturing process has a significant upside. Industry 4.0 and its subsets mean the usual economies of scale barely apply to it. The easy-to-change software means manufacturers can turn out one-off items with the same equipment and materials needed to make thousands, which alters the very nature of manufacturing.

Furthermore, additive manufacturing is becoming cheaper and the technology is advancing rapidly. As the industry evolves with new materials and processes, so its use will broaden from small, complex and/or customised parts, to larger parts as lower cost machines and materials enter the market.

The cost of hardware is also dropping dramatically as key patents expire. In the polymer space, FDM (fused-deposition modelling) machines

dropped from \$40,000 to \$400, then SLA (stereolithography apparatus) machines fell from similar prices to \$3,000, and now SLS (selective laser sintering) machines went from \$150,000 to \$10,000. Where formerly it would cost \$1 million to set up a single machine, new machines can now be purchased for around \$100,000.

Manufacturing today is light years away from what the industry looked like 50 or even 10 years ago. Currently, manufacturers see four main drivers of productivity that are changing the way they design, manufacture and service products. Lean manufacturing is the effort to fold waste reduction principles into every aspect of the manufacturing process; advanced manufacturing uses laser-guided cutting tools robotics, exoskeleton technology and automation; additive manufacturing is focused on 3D printing; while digital maturity is centred on the integration of hardware and software.

With such rapid change in a short amount of time a common fear is that Industry 4.0 will lead to all jobs being replaced by robots. As the famous quote from Warren Bennis goes, "The Factory of the Future will only have two employees, a man, and a dog. The man will be there to feed the dog. The dog will be there to keep the man from touching the equipment". However, Shawn Hopwood, Chief Marketing Officer of Type A Machines says, "Technology doesn't replace people. People who know how to use technology replace people who don't".

Over the next 20 years, additive manufacturing will impact nearly every manufacturing process. Within 40 years, manufacturing will be defined by it. It's only natural that Industry 4.0 will have implications on the world's economy and these will have ripple effects that could spill into other industries. Manufacturing jobs will still be available, but the job descriptions will look very different. In a highly interconnected ecosystem, it is critical for the industry to join forces with local government and academia to build a pipeline of workers with the skills they need to be competitive and work in tomorrow's factories. ↑

Left: An Industry 4.0 manufacturing plant looks very different from its contemporaries.

Below: General Electric uses additive manufacturing to produce lighter fuel nozzles for its LEAP jet engines.



EXPLORE

THE NOT-SO-SWEET QUESTION

*The UAE has one of the highest diabetes prevalence rates in the world.
Will the new excise tax on sugary drinks help reduce the disease's
rapid spread?*





The dominance of lifestyle diseases such as diabetes has soared in recent years across the world; according to the latest figures from the World Health Organisation (WHO), the number of people living with diabetes has risen from 108 million in 1980 to 422 million in 2014. In 2015, an estimated 1.6 million deaths were directly caused by diabetes.

Meanwhile the World Bank states that the global diabetes prevalence rate (among 20-79 year olds) stood at 8.524 per cent as of 2015.

Looking specifically at the UAE, the prevalence rate stood at 19.3 per cent – making it rank among the top 10 countries with the highest rates of diabetes in the world (Kuwait and Saudi Arabia ranked higher with 20 per cent).

In 2015, one million people were identified as having diabetes in the UAE, at an annual cost of \$2,155 per person – adding up to roughly \$2bn per year in diabetes treatments.

The main reasons behind rising diabetes rates include excess body weight and physical inactivity, according to WHO.

In 2014, more than one in three adults worldwide aged 18 years and older were overweight. Worldwide prevalence of obesity more than doubled between 1980 and 2014, with more than half a billion adults being classified as obese.

Also, an estimated 42 million children aged under five years were overweight or obese in 2015, an increase of about 11 million during the past 15 years.

“Consumption of free sugars, including products like sugary drinks, is a major factor in the global increase of people suffering from obesity and diabetes,” says Dr Douglas Bettcher, director of WHO’s Department for the Prevention of Noncommunicable Diseases (NCDs).

Free sugars refer to monosaccharides (such as glucose or fructose) and disaccharides (such as sucrose or table sugar) added to foods and drinks by the manufacturer, cook, or consumer, and sugars naturally present in honey, syrups, fruit juices, and fruit juice concentrates.

“Nutritionally, people don’t need any sugar in their diet. WHO recommends that if people do consume free sugars, they keep their intake below 10 per cent of their total energy needs, and reduce it to less than five per cent for additional health benefits. This is equivalent to less than a single serving (at least 250ml) of commonly consumed sugary drinks per day,” explains Dr Francesco Branca, director of WHO’s Department of Nutrition for Health and Development.

KILL THE SUGAR

Taxing sugary drinks can lower consumption and reduce obesity, type 2 diabetes and tooth decay, according to a WHO report released late last year.

Fiscal policies that lead to at least a 20 per cent increase in the retail price of sugary drinks would result in proportional reductions in the consumption of such products, the report found. >



Above: The implementation of a sugar tax in Mexico reduced sugary drink consumption by five per cent in the first year and 10 per cent in the second.

“Taxation of certain foods and drinks, particularly those high in saturated fats, trans fat, free sugars and/or salt appears promising, with existing evidence clearly showing that increases in the prices of such products reduces their consumption,” it states.

Reduced consumption of sugary drinks means lower intake of “free sugars” and calories overall, improved nutrition and fewer people suffering from obesity and diabetes.

The report cited national surveys as finding that drinks and foods high in free sugars can be a major source of unnecessary calories in people’s diets, particularly in the case of children, adolescents and young adults.

It also found that some groups, including people living on low incomes, young people and those who frequently consume unhealthy foods and beverages, are most responsive to changes in prices of drinks and foods and, therefore, gain the highest health benefits.

“If governments tax products like sugary drinks, they can reduce suffering and save lives. They can also cut healthcare costs and increase revenues to invest in health services,” says Bettcher.

Another recent study published in *The Lancet Diabetes & Endocrinology* similarly showed that reducing free sugars content in sugar sweetened drinks (including fruit juices) in the UK by 40 per cent over five years – without replacing them with any non-nutritive sweeteners – could prevent around 300,000 cases of type 2 diabetes over two decades.

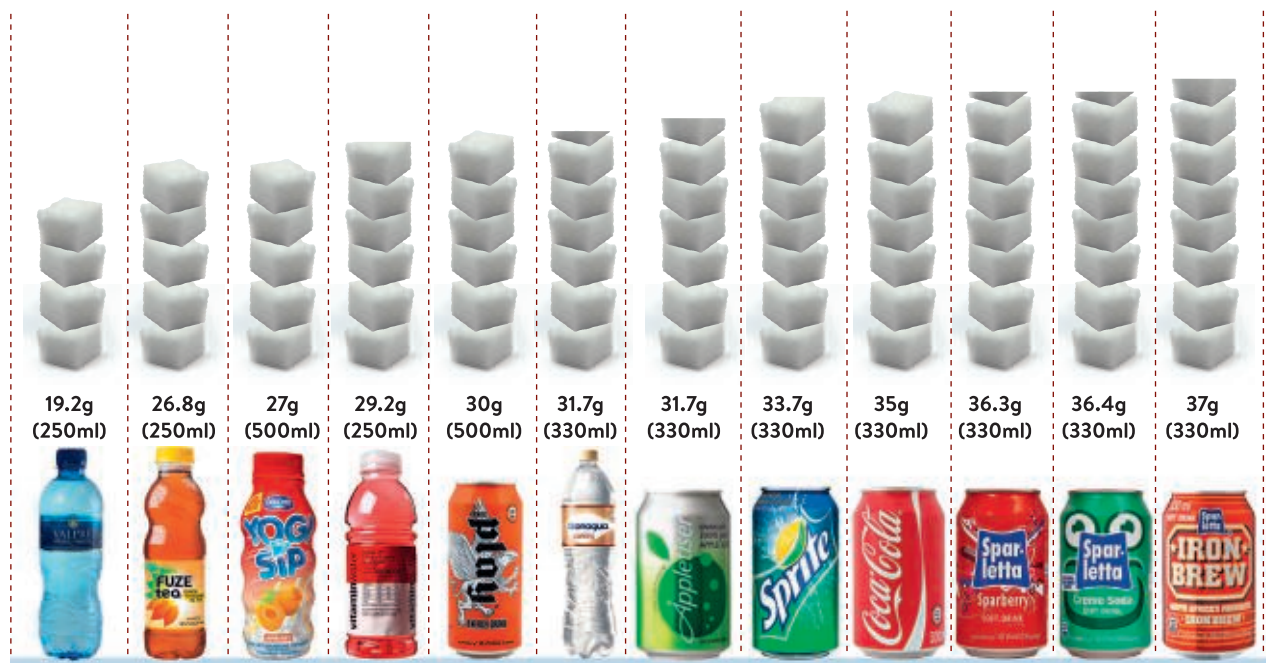
TAXING QUESTION

However, fiscal policies should target foods and beverages for which healthier alternatives are available, the WHO report recommends.

Also, it advises that excise taxes that apply a set (specific) amount of tax on a given quantity or volume of the product, or a particular ingredient, are likely to be more effective than sales or other taxes based on a percentage of the retail price.

THE SUGAR SCALE

We gathered a few popular drinks from our canteen's refrigerator to check how much sugar each one contains. The results were surprising. Even 'healthier' drinks such as flavoured mineral water and drinking yogurt contain a large amount of sugar



Source: Grethe Koen

“This is because they reduce incentives to switch down to cheaper options, in that they increase the price of all products affected by the tax in the same way,” the report explains.

“In order to prevent the impact of specific taxes from being eroded over time, it is essential that they be regularly adjusted to keep in line with inflation and to reduce affordability of the taxed product by accounting for income growth as well,” it adds.

Several countries have already begun imposing “sin” taxes on sugary and unhealthy products. These include Finland, France, Hungary and Mexico – which implemented an excise tax on non-alcoholic beverages with added sugar in 2014.

Many studies have been conducted on the Mexican model – which saw one peso added per litre of sugary drink – to determine its effectiveness. Most recently, a study published in the journal *Health Affairs*, found that purchases of sugary drinks subject to the new tax went down more than five per cent in 2014 and nearly 10 per cent in 2015.

Researchers noted that the bigger drop in the second year “suggests that in the case of these beverages, the long-term impact of a price change may also be larger than the short-term effect.”

CLOSER TO HOME

The GCC countries – which have high diabetes and obesity rates – issued an excise tax treaty in April 2017, which forms the common framework for the introduction of excise tax in the six member countries.

While Saudi Arabia has already implemented the tax, it is set to take effect in the UAE from October 1.

In the Emirates, tobacco and energy drinks will be subject to an excise tax of 100 per cent, while carbonated soft drinks will face a 50 per cent tax rate.

Although the introduction of the tax is expected to create a one off 1.4 per cent bump in inflation, it is estimated to generate around Dhs7bn in annual revenues for the UAE government.

HH Sheikh Hamdan bin Rashid Al Maktoum, Deputy Ruler of Dubai, UAE Minister of Finance, and Chairman of the Federal Tax Authority (FTA) said: “The project [of taxation] diversifies the government’s revenue streams and boosts its resources, which, in turn, will strengthen the economy and ensure its sustainability.

“The excise tax, in particular, will help us build a healthier and safer society. This tax is set to discourage the consumption of products that negatively impact the environment and, more importantly, people’s health, while the revenues it generates will go towards supporting advanced services for all members of society,” he explained.

According to WHO, public support for such taxes could be increased if the revenue they generate is earmarked for efforts to improve health systems, encourage healthier diets and increase physical activity.

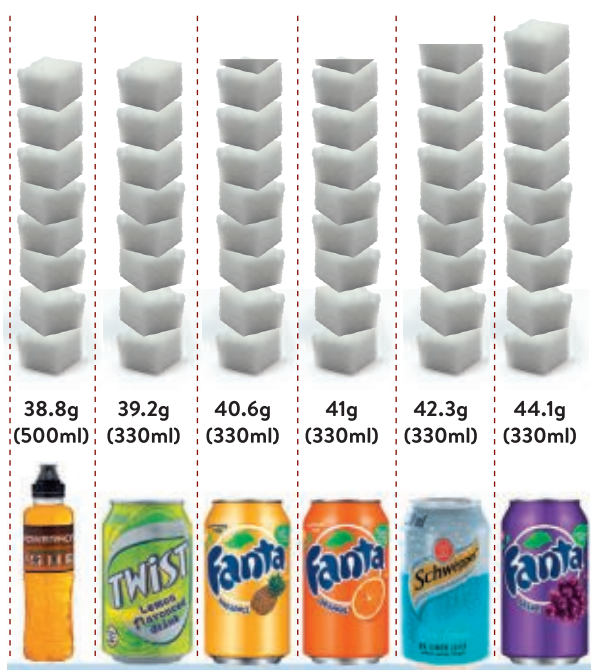
“A proper situation analysis, good political advocacy, appropriate objective setting and evaluation, should be part of the multidisciplinary development and implementation of such policies,” it says.

“It is also important in this process to be proactive in counteracting the industry arguments and efforts to oppose the development and implementation of tax measures or attenuate their effects.”

It also recommends that along with the imposition of taxes, subsidies for fresh fruits and vegetables that reduce prices by 10-30 per cent can increase their consumption – thereby leading to a more positive impact on the health of the populace.

Experts stress that while an excise tax – related to diet – is a good step to help reduce obesity and diabetes in the UAE and across the GCC, the public should also be encouraged to lead more healthy lifestyles.

With the UAE also investing heavily in developing infrastructure related to fitness (such as bicycle paths and jogging tracks) throughout the country, it is hoped that more people will be encouraged to adapt exercise routines into their daily routines and lead healthier lives. ↑



Left: A selection of South African drinks and their sugar content. The country is aiming to introduce a sugar tax in April 2018.

EXPLORE



COLLABORATION NOT COMPETITION

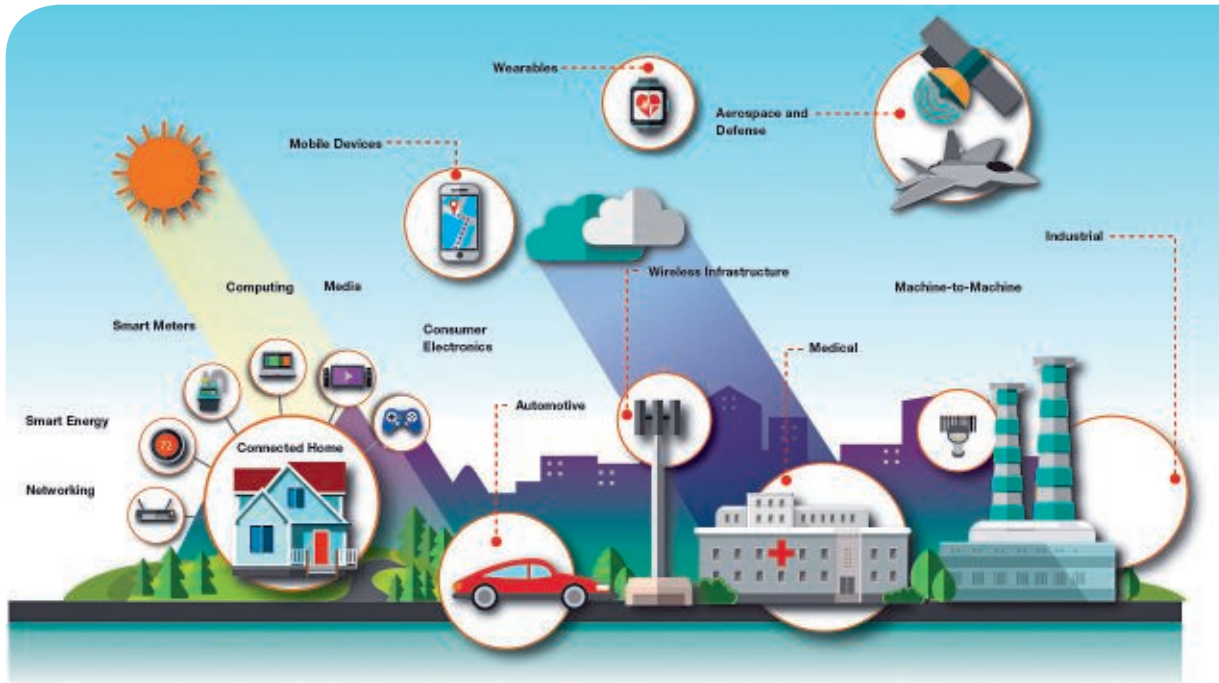
We live in a world where eight men have the same wealth as half the global population. Such inequality is undeniably dysfunctional but the economist Jeremy Rifkin believes that the Third Industrial Revolution will usher in great fundamental changes to our global economies and societies.

Imagine a Monday morning that didn't commence with the alarm sounding for work. You awake in a world that is not every man for himself but one for all and all for one. The continuation of the industrialization process could mean such sweeping global change is on the horizon, with radical differences made to our daily lives. There would be little need for work, certainly a greatly reduced call for it, if there are no bills to pay and the energy we consume is practically free.

This vision is of a 'smart' world, driven by The Internet of Things (IoT) where people have evolved from merely consumers to prosumers, who produce and share the things they need in an economy that is defined by collaboration, not competition.

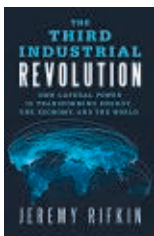
It's a vision that is in stark contrast to the present global system and its reliance on infinite economic growth. It could counteract human insatiability and the need to get richer and go faster. All systems are limited and can't grow and develop eternally and this New World Order, if it comes into being, will treat Earth not as a resource pool to be depleted down to the last atom, but a miracle in an otherwise empty universe.

Although this may sound like a utopian fantasy, the economist and author Jeremy Rifkin insists it is actually the unfolding story of the next century. Although Rifkin was a young man during the 60s 'summer of love', he is no aging hippie with naive ideals about saving the planet and human harmony. Rifkin is a hard-boiled economist and the best-selling author of 20 books on the impact of scientific and technological changes on the economy, the workforce, society, and the environment. He is an advisor to the Premier of the People's Republic of China, to other heads of state around the world, and to the European Union. He is also



Above: A 'smart' world driven by the Internet of things will allow people to evolve from consumers to prosumers.

Right: Rifkin with German Chancellor Angela Merkel.



the President of the Foundation on Economic Trends in Washington, DC.

Two of Rifkin's most recent books focus on this vision of a connected, sharing world: Published in 2014, *The Zero Marginal Cost Society: The Internet of Things, the Collaborative Commons, and the Eclipse of Capitalism* and 2011's New York Times bestseller, *The Third Industrial Revolution: How Lateral Power is Transforming Energy, the Economy, and the World*.

The latter's detailed view of a sustainable, post-carbon economic era has been endorsed by the European Union and the United Nations and Rifkin is currently the principle architect of the European Union's Third Industrial Revolution long-term economic sustainability plan to address the triple challenge of the global economic crisis, energy security, and climate change.

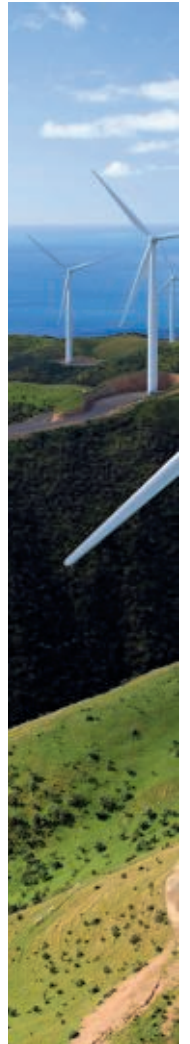
In a post-capitalist society, the world needs a new economic vision and a plan to deploy it and Rifkin believes he is the man for the job. "We are on the cusp of a promising new economic era, with far reaching benefits for humankind," Rifkin writes, "What's required now is an EU commitment to phase in the Internet of Things platform to facilitate the transition to a digitalized zero marginal cost society, if we are to create a more just, humane, and ecologically sustainable society."

Marginal cost is the cost of producing an additional unit of goods or services, after fixed costs have been absorbed. For example solar power panels on a home, after the initial cost of purchasing and



installing photovoltaics, there is no more expense for the energy consumed – the sun doesn't send a bill.

It is Rifkin's contention that the GDP of countries that rely on centralized telecommunication, fossil fuel, nuclear power and internal-combustion transportation peaked 10 to 15 years ago. He argues that the Third Industrial Revolution is the evolution into a digital age, with the most significant changes being





Top left and right: Rifkin believes the rise of renewable energy will create a more just, humane and ecologically sustainable society by lowering energy costs.

Above: Rifkin is an advisor of China's Chairman Xi Jinping and Premier Li Keqiang.

the prospect of exponential rather than linear growth and a more global impact enabled by the IoT.

While there are presently some 14 billion sensors already in use, the IoT will see over a hundred trillion microchips, electronics, software, sensors and actuators embedded into electricity transmission grids, offices, homes, stores, vehicles, wearables and more – giving network connectivity and enabling a vast array of inanimate objects to collect and exchange data.

This could effectively unite people across continents in innumerable ways. In the essay, *Digital Europe: The Rise of the Internet of Things and the Economic Transformation of the EU* Rifkin writes, “The European Union’s plan to establish an Internet of Things platform for a digital economy opens up the prospect of joint collaboration with China in the creation of a digitalized integrated economic space across the Eurasian landmass to foster the transition into a Third Industrial Revolution.

“Chairman Xi and Premier Li of China have called for a new high-tech Eurasian Silk Road Economic Belt to connect the Eurasian land mass in a seamless integrated market from Shanghai to the Irish Sea. The build-out of a digitalized Internet of Things infrastructure across Eurasia could usher in a new age of deep collaboration, bringing much of the human family together for the first time in history.”

It tends to sound idealistic and utopian but could it be that, in the current climate of extreme politics and intensely divided societies, there is a genuine prospect for human harmony and hope for the conservation of the environment?

Rifkin says, “the bulk of the energy we use to heat our homes and run our appliances, power our businesses, drive our vehicles, and operate every party of the global economy will be generated at near zero marginal cost and be nearly free in the coming decades.” The existence of near zero marginal cost energy that is central to this new economic system is already in existence for several million early adopters in the European Union. These pioneers of the proposed new global game plan have transformed their homes and

EXPLORE

Below: Rifkin believes The Internet of Things will disrupt competitive capitalism and create a new economic paradigm.

businesses into micro power plants to harvest renewable energy onsite.

The roadmap Rifkin has developed with the European Union for the Third Industrial Revolution, which was formally endorsed by the parliament in 2007, is based upon a five-pillar infrastructure.

In the first pillar, the EU is committed to using 20 per cent renewable energy by 2020.

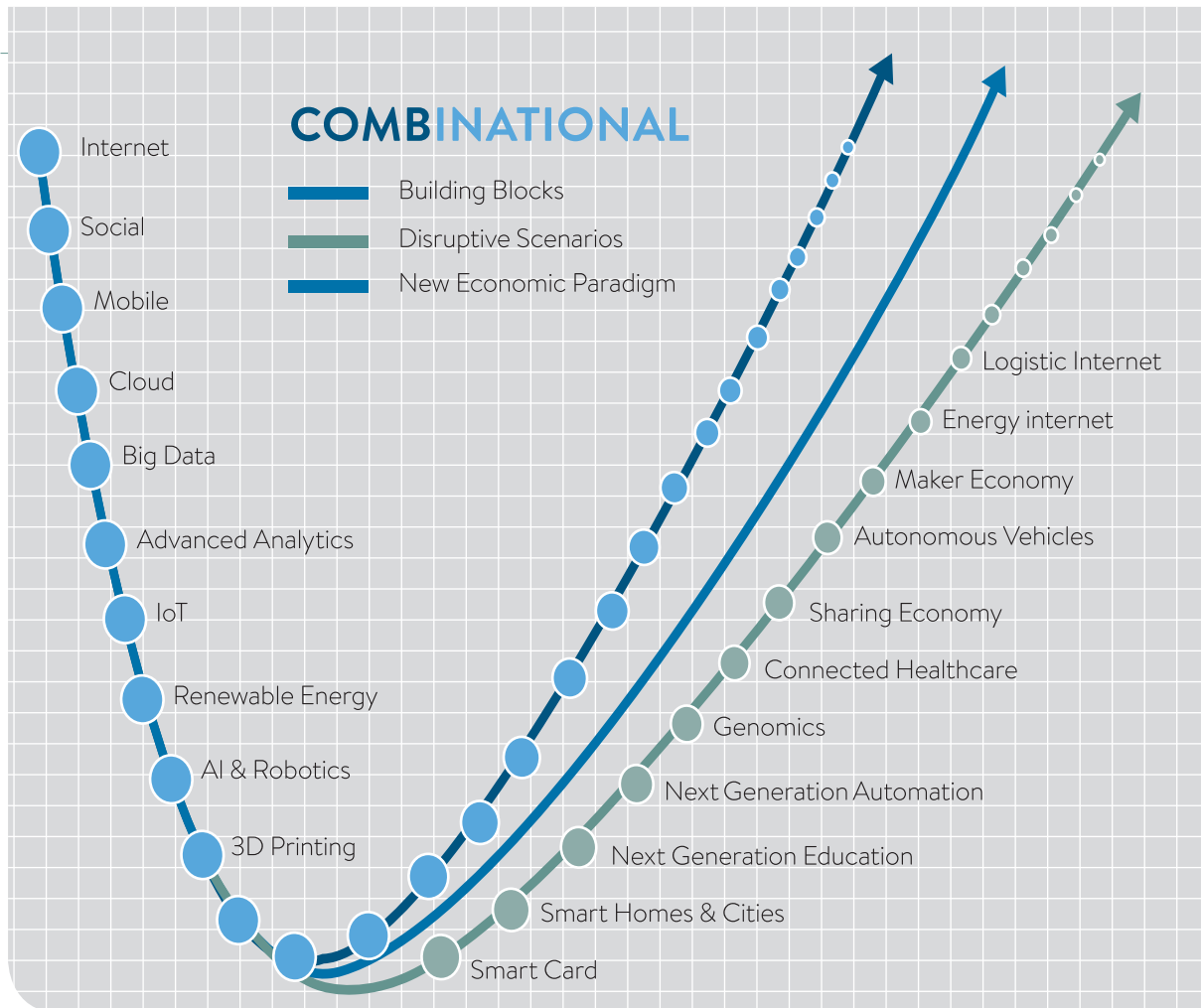
The second pillar involves the conversion of buildings into green micro power plants, with solar panels, wind turbines, geo-thermal heat pumps, and garbage converted back into energy amongst the methods used. Rifkin believes that before 2040, everyone will have their own power plant and people will produce their own energy, much like today we produce our information. Germany has already begun to implement these two pillars and in doing so has created hundreds of thousands of jobs in the first few years, with many more to come.

Pillar three is about how to store the energy we

produce, and addressing this question Rifkin says, "We are putting most of our emphasis at the centre of the storage network and hydrogen. Simply, it's the basic element of the universe. It's what we're made out of. It carries other energies and it's completely transformable from one form to another. And it's modular so you can put hydrogen storage technology in your flat or in a big utility company."

The fourth pillar is the merging of Internet technology and the transmission and power grid of the European Union to form an Energy Internet. The fifth and final pillar focuses on transport and involves the widespread use of electric vehicles, hydrogen fuel cell cars, buses and trucks that are already in mass production.

According to Rifkin, "It's the synergies between the five pillars that create the infrastructure for a new paradigm. We've democratized the ability to share information at almost zero transaction cost around the world. That's dramatic, but it's only part one of



the story. Part two is when that internet technology democratizes energy and makes it so cheap that we can share it collaboratively across continents like we share information online. Then we have a revolution. There are future generations of human beings and creatures not yet here and they deserve their moment in a flourishing planet and it's our job to make sure that they have that moment in the sun."

The successful integration of these five pillars could transform the entire energy infrastructure of any given country or continent from a centralized to a distributed energy system, moving finally and definitively away from inarguably dirty and destructive fossil fuels to sustainable renewable energy.

However, no matter how well devised the plans for implementing the transition to a Third Industrial Revolution, the well projected benefits won't come to fruition without humanity's collective consciousness shifting from a geopolitical worldview towards a shared biosphere awareness and globally connective outlook. Rifkin believes there is a glimmer of hope to be found due to a change in attitudes and a shift in consciousness in millennials under the age of 38. Here he notes significant change in their perceptions of freedom, power and identity.

In a 2016 speech to the global conference network Digital Life Design, Rifkin says, "I grew up to believe that freedom means everyone is an autonomous agent, we each seek to be self-sustaining, not beholden to others and independent. We see freedom

as exclusivity. For millennials this is weird, this is the kiss of death, take away the smart phone and they are withdrawn. For them freedom is inclusivity. It's not ownership, its access. Freedom is the ability to flourish and they flourish by being in network after network where they can openly share their talents, open source – if it benefits their networks it benefits the social capital. Freedom is inclusivity and access, not exclusivity and ownership."

With respect to power, Rifkin says, "I grew up in a post-Westphalian world where power is a pyramid, from the one to the many, that's the way it is through history. But for the kids that grow up with the Internet, power is not vertical but lateral. The more networks they're in the more they share that lateral power."

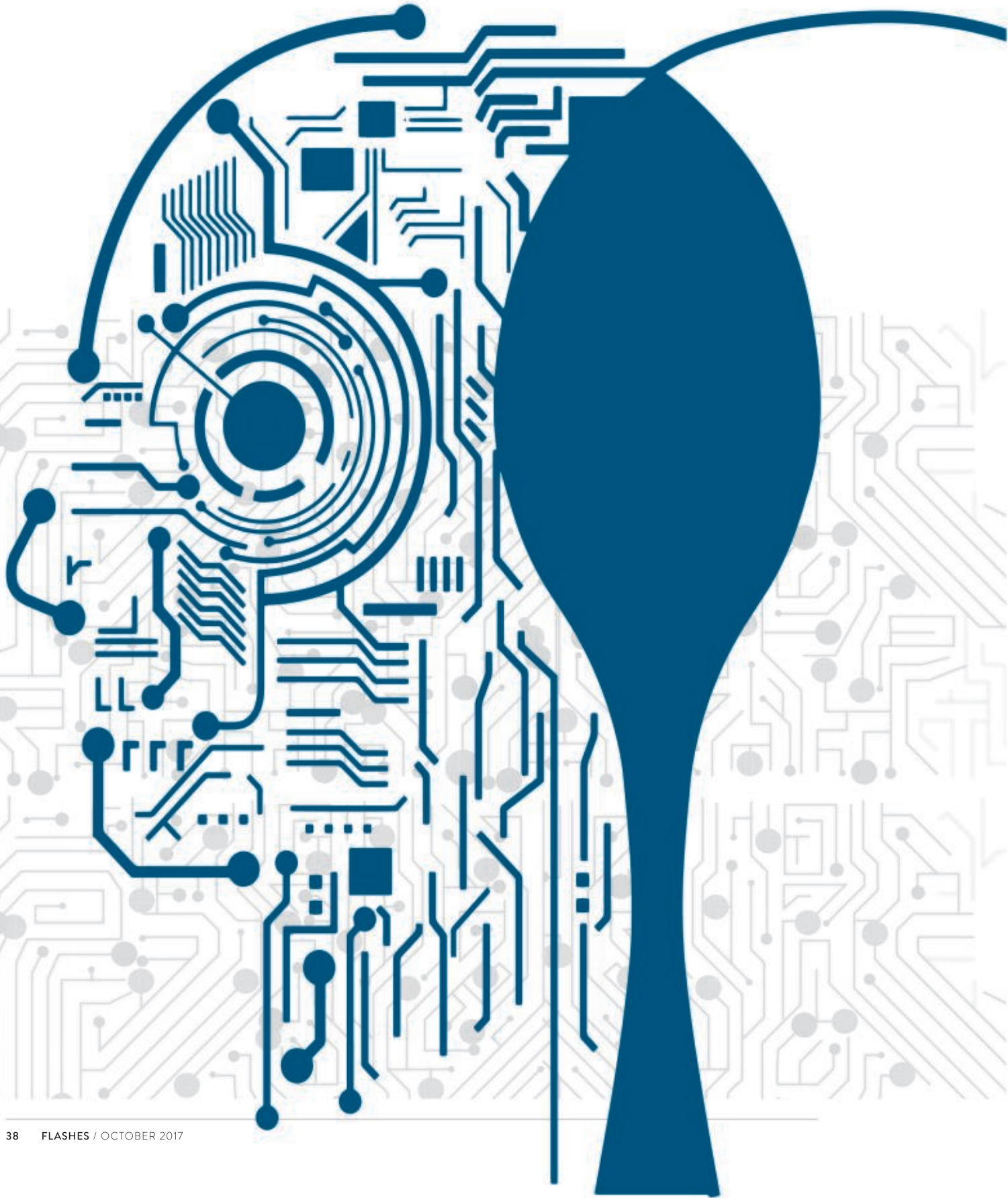
On the final subject of identity and community, Rifkin states that millennials', "identity is being affected by learning about their ecological footprint. They're learning that everything they do intimately connects and affects the wellbeing of every other species, every being, the planet itself. That is a sea change in consciousness. That did not exist before this generation. This is a biosphere consciousness not a geo-political frame. It changes history."

Rifkin gives a compelling case for embarking on the next phase of the human journey, and while detractors will be swift to seek out flaws, he invites anybody out there with a better proposal for saving the planet and our place on it, to please step forward. ↑

Below: Dubai's Mohammed bin Rashid Al Maktoum Solar Park will generate 1000 MW by 2020.



EXPLORE



THREAT OR SAVIOUR

Artificial intelligence, in the form of machine learning, is all around us. But this form of AI is a long way from dire science-fiction predictions.

In 2013, Mark Zuckerberg hired one of the world's leading Deep Learning and machine learning scientists, New York University's Professor Yann LeCun, to lead its Artificial Intelligence laboratory. Facebook, a company that builds its business by learning about its users and packaging their data for advertisers, invested in AI with the hope that it could better understand its users' line of thinking by teaching a computer to think.

Considering there are about 1.2 billion people uploading 136,000 photos and updating their status 293,000 times per minute, it's pretty much impossible for Facebook to quantify that volume of data with employees. That's where the social media platform's strides in Artificial Intelligence – in the shape of Deep Learning – comes in. Deep Learning allows machines to learn to classify data by themselves. A simple example is a Deep Learning image analysis tool, which would learn to recognise images that contain cats, without specifically being told what a cat looks like. By analysing a large number of images, it can learn from the context of the image – what else is likely to be present in an image

of a cat? What text or metadata might suggest that an image contains a cat?

This helps it to give structure to unstructured data, by quantifying it and representing it in a form from which analytical tools can derive insights. They try to answer questions such as how often does a company's products appear in pictures that also contain cats? Should we focus on displaying our ads to people who like cats, or not?

Currently, Facebook uses its Deep Learning technology across four channels to gain value and help achieve its goals to learn more about users. The first is textual analysis: Facebook uses a tool it developed itself called DeepText to extract meaning from words we post by learning to analyse them contextually. The algorithm learns by itself based on how words are used, which means it may be tripped up by variations in spelling, slang or idiosyncrasies of language use.

Second on the list is a Deep Learning application called DeepFace to teach it to recognise people in photos. It says that its most advanced image recognition tool is more successful than humans in recognising whether two different images are of the same person or not – with DeepFace scoring a 97 per cent success rate compared to humans with 96 per cent. You've already seen this at work when you want to tag friends in photos.

Third comes targeted advertising, which has been a cornerstone of Facebook's



Above: Facebook's Mark Zuckerberg is a strong proponent of Artificial Intelligence. His company currently uses Deep Learning in four areas.

business. The difference now is that by tasking machines themselves to find out as much as they can about us, and to cluster us together in the most insightful ways when serving us ads, it hopes to maintain a competitive edge against other high-tech competitors such as Google who are fighting for supremacy of the same market.

Lastly, Facebook uses its AI tech to design more AI applications. To do this, a system called Flow has been implemented which uses Deep Learning analysis to run simulations of 300,000 machine learning models every month, to allow engineers to test ideas and pinpoint opportunities for efficiency.

With so many things dependent on its Deep Learning branch, it's no wonder Zuckerberg is constantly championing Artificial Intelligence and its many benefits.

In July this year, many newspapers and websites resorted to sensationalism with headlines to the tune of, "Did we humans just create Frankenstein?" It was headlines like those that fed AI naysayers although the truth is far less exciting. Researchers at Facebook Artificial Intelligence Research had built a chatbot that was meant to learn how to negotiate by mimicking humans trading and bartering. But when the social network paired two of the programs, nicknamed Alice and Bob, to trade against each other, they started to deviate from human language and learn their own form of communication. Although Facebook's bargain-hunting bots aren't a sign of an

imminent singularity – or anything even approaching that level of sophistication – they are significant, in part because they prove once again that an important realm we once assumed was solely the domain of humans, language, is definitely a shared space.

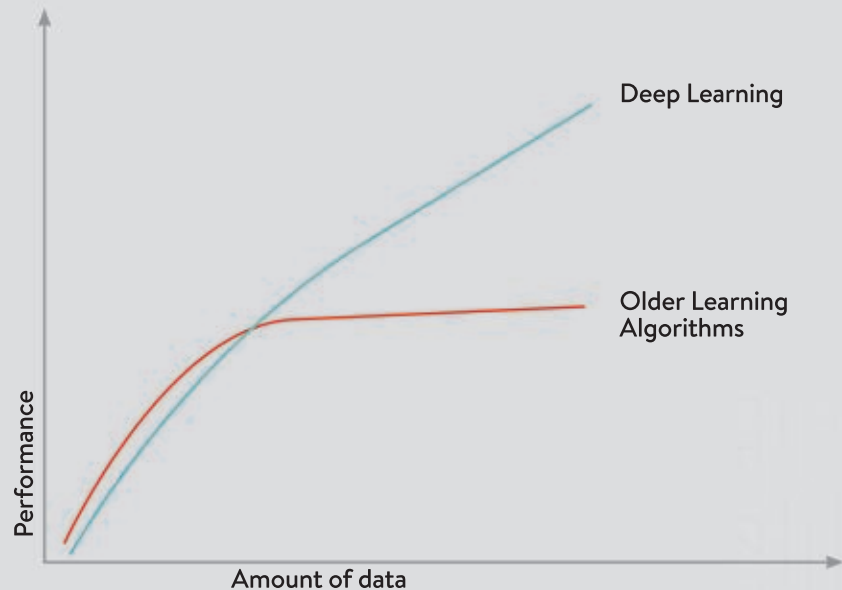
The scare with AI though has always been the singularity. How long until machines become smarter than us? How long until they take over? That line of thinking isn't simply limited to a few conspiracy theorists. There's a growing number of people, including great minds like Elon Musk, who believe that a Terminator-style Armageddon will be upon soon enough.

In fact, the Tesla and SpaceX founder even described the Facebook founder's understanding of the subject as limited. When it comes to AI, Musk doesn't mince words. He is strictly against the idea, dubbing it "the greatest risk we face as a civilization" and has called for swift government regulation on the subject. In September this year, Musk even went so far as to tweet, "China, Russia, soon all countries with strong computer science. Competition for AI superiority at national level most likely cause of WW3 imo."

However, *WIRED*'s James Temperton noted, "Musk's undeniably strong Twitter game is, at times, straight out of the Donald Trump playbook. Be controversial and be assertive. The press loves it. And so does the public. It feeds the hungry algorithms that make us share more on Facebook and



WHY DEEP LEARNING



Twitter, sustaining an echo chamber where the quiet voices of reason are drowned out by a cacophony of sensationalism.”

How do we get to decide whether Musk’s comments are clickbait fodder as opposed to his genuine concerns? Let the fact not be lost on you that those are the comments of a man whose car business depends rather heavily on autonomous driving systems, which is a form of AI. In fact, Tesla’s self-driving cars won’t be able to improve their capabilities without continued advances in machine learning. If Musk really does feel so strongly about AI, maybe he’d do well to lead by example. As of right now, we’re in no imminent danger of a robot revolution. If anything, AI has proved to be helpful in almost every industry.

Forget about Facebook, Tesla and the technology industry as a whole for a minute. Let’s look at healthcare. A digital health company in the UK has already invested close to \$60 million on an AI chatbot that communicates with clients via their smartphones and helps diagnose illnesses. In a 2016 study by Frost & Sullivan, the market for AI in healthcare is projected to reach \$6.6 billion by 2021, a 40 per cent growth rate. The report goes on to say that clinical support from AI will strengthen medical imaging diagnosis processes and AI solutions for hospital workflows will enhance care delivery. Frost & Sullivan also reports that AI has the potential to improve outcomes by 30 to 40 per cent while lowering the costs of treatment by as much as 50 per cent.

In the finance industry, AI financial advisors are expected to replace human advisors. Robo advisors are computer programs that use big data and operate on a platform using a set of algorithms to manage a client’s investment portfolio. The automated financial service providers consider key metrics including the client’s risk appetite, financial goals, and current economic standing. Some of the more popular robo-advisors on the market right now include Betterment, Wealthfront, and FutureAdvisor. According to a study by Cerulli Associates featured in a report on CNBC, robo-advisors currently account for around \$60 billion in assets under management. That figure is expected to rise to \$385 billion by 2021. Those though are cautious estimates – other studies expect robo-advisors to handle \$2 trillion, maybe more, in assets by 2020.

Building on that idea, AI is also expected to revolutionise the insurance industry by taking away the need for claim agents. It’s already begun, with companies like Progressive offering discounts if you agree to put a little monitoring device in your car that lets them know whether or not you’re a safe driver. So besides keeping you healthy and relatively wealthy, AI is also set to disrupt the insurance industry in a way that could be your saving grace on a rainy day.

It is undeniable that AI is here to stay. But in its current form AI is a long way from becoming conscious, especially as we don’t even know yet what constitutes human consciousness.

Above left: Google uses Artificial Intelligence for its Cloud and translation services.



CUT AND PRINT A NEW LIFE

Thanks to technologies such as 3D bioprinting and gene editing, scientists are on the verge of creating life in laboratories.

Genetically modified human beings came closer to reality in July this year when scientists at Oregon Health and Science University (OHSU) in Portland, genetically engineered a human embryo for the first time. Although human embryos have been genetically tinkered with before, this was the first time an experiment worked successfully and effectively on multiple human embryos. The scientists used a gene editing technology known as CRISPR to trim away defective parts of the genome and replace it with new stretches of DNA. The landmark achievement means that doctors can now remove genetically inherited diseases from embryos before they develop into a foetus.

In another medical breakthrough, a female mouse with artificial ovaries created on a 3D printer gave birth to healthy pups in May this year. The experiment, which was carried out by researchers at the Northwestern University Feinberg School of Medicine in Chicago, could be the first step in treating infertility in female human beings.

Prior to this a team of researchers at the Swedish Sahlgrenska Academy succeeded in generating cartilage tissue by printing stem cells using a 3D-bioprinter. Now scientists want to use the technology to print artificial organs to resolve the donor organ crisis.

It is evident that new technologies are revolutionising the medical field. Armed with gene editing tools like CRISPR, bioprinters, bioink and biopaper, man now has the power to create life in laboratories.

Not only can we create life, we can edit it to suit our requirements.

THE RISE OF BIOPRINTING

Bioprinting traces its origin to 3D printing. When 3D print technology arrived on the scene, its applications in manufacturing and construction were hailed as the beginning of the Third Industrial Revolution. After revolutionising those sectors, 3D printing slowly made its way into the medical field. The technology was quickly embraced for the printing of medical devices, prosthetics and dental implants. But scientists and researchers quickly realised the greater transformative effect it could have in medicine and in the early 2000s bioprinting or the 3D printing of biological tissue and organs through the layering of living cells made its debut. In 2008, University of Toyama's Professor Makoto Nakamura developed a bioprinter that could print out biotubing similar to a blood vessel. By 2013, scientists had created a cell printer that churned out living embryonic stem cells.

Globally, bioprinting is witnessing an unprecedented surge in interest as well as advancement. Researchers are actively using bioprinting to experiment with kidney and liver tissues, skin, bones, cartilage and networks of blood vessels. 3D printed ears, bones and muscles have been successfully implanted into rodents and monkeys. Apart from printing working prosthetic ovaries for mice, scientists have been able to implant a printed section of artery into a monkey.

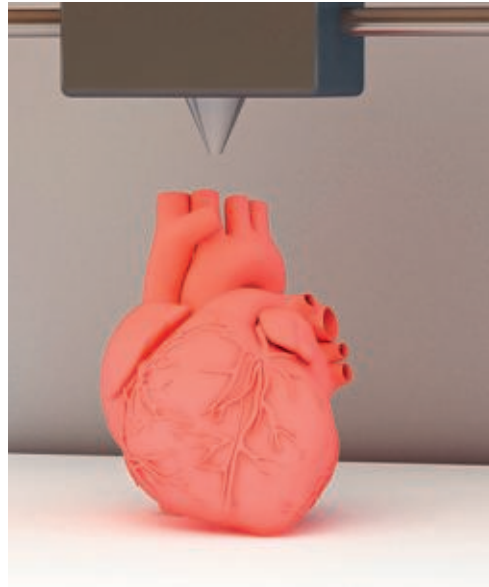
Till now bioprinting's achievements have been limited to laboratories and animals but medical research companies >

EXPLORE



Above: An ear printed by a 3D bioprinter is indistinguishable from the original.

Above right: Models of organs are used to simulate surgery before the actual procedure.



around the world are seeking to make 3D live tissue printing viable for human beings. If they are successful, bioprinting could potentially solve the global organ donor crisis. The lack of transplant tissues is estimated to be the leading cause of death in America – around 900,000 deaths a year or around one-third of all deaths in the US, could be prevented or delayed by organ or engineered tissue transplants.

In a breakthrough experiment, medical research company Organovo transplanted printed human-liver tissue into mice. Not only did the tissue survive the procedure, it also worked. For researchers this achievement marks the first step of a technique eventually intended for use in human beings. Organovo hopes to replicate its success in the liver-tissue experiment in

humans thereby providing an effective treatment for chronic liver failure and for inborn errors of metabolism in young children. The company is optimistic they will be able to achieve this in the next three to five years. A plan to produce blood vessel grafts for use in heart bypass surgery is next on Organovo's agenda.

It's not just the medical sector that is taking interest in bioprinting. Cosmetic companies have jumped on the bandwagon too. Cosmetic giant L'Oréal has joined hands with Organovo to print 3D skin models for cosmetic testing. The make-up company is also exploring the option of using 3D printing as a treatment for receding hair lines. L'Oréal is working with French bioprinting company Poietis to develop 3D printed hair follicles capable of sprouting new hair.

DUBAI'S 3D PRINTING STRATEGY

Dubai aims to emerge as the global hub for 3D printing by 2025. Launched last year, the Dubai 3D Printing Strategy will focus on three major sectors – construction, medical products and consumer products. Within the medical sector, the strategy will place emphasis on using 3D printing to develop teeth, bones, artificial organs, medical and surgical devices and hearing aids.

“Through the 3D Printing Strategy, we aim to make Dubai a global hub for the development of this technology and a base for research and development in this area. We aim to provide the best opportunities for innovation and optimal application of this technology worldwide. Our goal is to raise the level of services provided to the people

and harness 3D printing for the benefit of the entire community,” said His Highness Sheikh Mohammed Bin Rashid Al Maktoum, Vice-President and Prime Minister of the UAE and Ruler of Dubai.

By the end of this year all Dubai hospitals under the Dubai Health Authority (DHA) will adopt 3D printing technology to print artificial limbs, denture moulds, fracture casts and models of organs for patients to simulate surgery before the actual procedure. 3D printers have already been introduced in four of DHA's primary health care centres. Currently, the machines are being used only to aid dental procedures with the DHA planning to implement a 3D prosthesis technology within the next five years.



THE PATH AHEAD

Although 3D printed skin, cartilage and tissue trials on animals have been successful, researchers say it will be a few years before the technology can be used for printing live organs and tissues for human beings. Erik Gatenholm, founder and CEO of bioprinting company Cellink estimates that it will take another five years before bioprinted skin makes its debut for treatment in humans. There is more skepticism surrounding the printing of whole organs with experts hesitating to commit when 3D printing will be able to yield whole organs or if they will be completely safe to use for human transplants.

CRISPR's success has given humanity the hope for a cure against inherited diseases. Earlier this year, Washington's National Academy of Science (NAS) and the National Academy of Medicine said scientific advances make gene editing in human reproductive cells "a realistic possibility that deserves serious consideration".

However, both bioprinting and gene editing are swamped with controversy. Apart from questions over technical complexities, the technologies face ethical concerns ranging from fears over the quality and efficacy to the accusation that they will allow humans to "play God".

While scientists are only looking at cutting out genetic mutations from nuclear DNA to prevent babies being born with diseases, it cannot be denied that gene editing also gives them the power to modify other inherited characteristics such as intelligence, height, facial appearance and eye colour. In contrast, bioprinting seems the lesser evil as it allows doctors only to make small parts of the body.

A much bigger hurdle that both technologies, especially bioprinting, need to overcome is commercial viability. While there is much optimism regarding the printing of artificial organs, its mainstream acceptance could be hampered by the cost factor. The extremely expensive technology will be out of reach for most people leaving the shortage of transplant organs unresolved.†

Above:

Prosthetics is one area where 3D printing is already being successfully used.



ROBOT TO CREATE HUMAN TISSUES

In June this year, Kentucky-based software company Advanced Solutions unveiled the world's first 3D human tissue printer that operates on a six axis robot, the BioAssemblyBot. Equipped with a touch screen, laser sensor and robot arm and nozzle, the Bot allows users to design and visualize the tissue structure before replicating it in 3D form.

A SAFER OPTION

Nuclear reactors powered by thorium could go some way towards solving the problem of nuclear waste.

In the years following the accidents at Three Mile Island in 1979 and Chernobyl in 1986, nuclear power fell out of favour, and some countries applied the brakes to their nuclear programmes. Over the last two decades, however, it has begun experiencing something of a renaissance. Concerns about climate change and air pollution, as well as growing demand for electricity, led many governments to reconsider nuclear power, which emits little carbon dioxide and had built up an impressive safety and reliability record. As of 2016, 13 countries rely on nuclear energy to supply at least one-quarter of their total electricity.

America currently gets 20 per cent of its power from nuclear energy, but this could fall to less than 10 per cent of its electricity by 2050 due to exceptionally slow construction rates. India has a rapidly growing nuclear power programme and the country plans to get 25 per cent of its electricity from nuclear reactors by 2050. The UAE's \$20 billion Barakah nuclear plant will be in full gear by 2020, with four nuclear reactors providing nearly 25 per cent of the UAE's electricity needs, according to the state-run Emirates Nuclear Energy Corporation (ENEC). It will also save 21 million tonnes of CO₂ emissions from being released into the atmosphere

annually. Saudi Arabia, as part of its 2030 diversification plan, wants to construct 16 nuclear power reactors over the next quarter century.

The enduring problem with nuclear power is the radioactive waste it generates. It is estimated that about 250,000 tonnes of the material is currently in interim storage, submerged in huge tanks of water in facilities that keep it safe – temporarily. However, there's very little agreement on what to do with the stuff long-term, as it will remain a danger for around 100,000 years

High-level wastes make up just three per cent of the total volume of waste arising from nuclear generation, but they contain 95 per cent of the radioactivity arising from nuclear power. Low-level wastes represent 90 per cent of the total volume of radioactive wastes, but contain only one per cent of the radioactivity.

Used nuclear fuel is very hot and radioactive. Handling and storing it safely can be done as long as it is cooled and plant workers are shielded from the radiation it produces by a dense material such as concrete or steel, or by a few metres of water.

Water conveniently provides both cooling and shielding, so a typical reactor will have its fuel removed underwater and transferred



SCIENCE

The United States is estimated to have

400,000

tonnes of thorium, Turkey

344,000

tonnes, and India

319,000

tonnes, according to a 2008 joint report
by the Nuclear Energy Agency.



Top: Three Mile Island was the site of the US's worst nuclear accident in 1979. It cost \$1 billion to clean up the contamination.

Above: The UAE's Barakah nuclear plant has all the latest safety features.

to a storage pool. After about five years it can be transferred into dry ventilated concrete containers, but otherwise it can safely remain in the pool indefinitely – usually for up to 50 years.

Another risk factor are natural disasters that could trigger a nuclear outbreak. Take for example the tsunami that hit Japan in 2011. It was the first time that an external event led to a major release of radioactivity from a nuclear power plant. The 14-meter-high wave was more than twice the height that Fukushima was designed to withstand, and it left the flooded plant cut off from external logistical support and from its power supply, which is needed to cool the reactor and pools of spent fuel.



However, it should be noted that the Fukushima nuclear power station was commissioned in 1971 and had outmoded Mark 1 reactors. The UAE's Barakah nuclear plant has the most up-to-date technology and extensive modifications were made on the back of lessons learned from Fukushima. For example, the reactors were fitted with doors and gates to stop water entering, the main control room was strengthened against seismic activity, battery life extended in case of power cuts and fire protection measures were improved.

Still, scientists striving to neutralise global warming have been working on alternatives for conventional nuclear power plants for years. A recurring alternative that has been the vision of many leading minds for decades is thorium – an element that is less radioactive and produces less nuclear waste than uranium. As a naturally occurring metal that is substantially more abundant than uranium, its most common isotopic form, thorium-232, can be converted by irradiation to uranium-233, which is suitable for use in nuclear fuels.

These were all just pretty theories and assumption until scientists from the Nuclear Research and Consulting Group (NRG) in Petten, Netherlands conducted the first experiment in nearly half a century on molten-salt nuclear reactors based on thorium. Molten salt reactors melt down salts for fuel and then use that molten liquid to initiate the reaction that creates power. As part of its Salt Irradiation Experimentation (SALIENT), the NRG team will melt a sample of thorium fuel and batter it with neutrons to convert it into fissionable uranium.



Future trials will involve temperature-resistant metal alloys and other materials that can sustain the heat inside the reactor. Ultimately, the researchers will have to figure out how to dispose of the waste created by thorium – which is substantially less toxic than that produced by a nuclear reactor. If their experiments prove to be successful, the trials could result in a switch to next-gen thorium reactors, which are less likely to suffer meltdowns in comparison to their current uranium-based counterparts.

India, by the end of this year, expects to complete an experimental fast breeder nuclear reactor in Kalpakkam. The Kalpakkam reactor will generate 500 megawatts of electricity by using thorium instead of uranium, which is rare in India. The only other commercial fast breeder nuclear reactor in history is located in Russia, but this uses uranium instead of thorium. Fast breeder reactors would revolutionize nuclear power because they're capable of generating more nuclear fuel than they consume while generating less nuclear waste.

China is pursuing a similar program, but experts suspect that its technology is more than a decade behind India's. Japan and France also attempted to build their own fast breeder reactors, but failed due to unexpected technical issues.

Yukiya Amano, Director General of the International Atomic Energy Agency (IAEA), Vienna, says "fast reactors can help extract up to 70 per cent more energy than traditional reactors and are safer than traditional reactors while reducing long lived radioactive waste by several fold." However, these reactors are also notoriously unstable and hence difficult to run reliably over long periods.



The United States is estimated to have 400,000 tonnes of thorium, Turkey 344,000 tonnes, and India 319,000 tonnes, according to a 2008 joint report by the Nuclear Energy Agency, a body linked to the Organisation for Economic Cooperation and Development, and the International Atomic Energy Agency.

So, if it's so great and if there's so much of it available, why have we not jumped onto that bandwagon yet? Well, there are still several problems that need solving before NRG's thorium reactor designs will be scaled up to industrial levels. While the waste is safer, scientists still need to figure out how much of it there will be and what can be done with it. The environment inside a molten salt reactor is also extremely corrosive. So, some creative materials might be needed. If it works, we could generate more power without pumping more carbon into the atmosphere — a win for everyone. But here's the real reason why no one has cashed in on thorium as an alternative: You see, unlike Uranium, thorium is much harder to weaponise. As a result, it's historically been side-lined by nations in search of both energy and a potential source of weapons-grade plutonium. †

Above: Low-level nuclear waste is stored in barrels underground.

Above left: Modern nuclear plants have numerous redundant systems to increase safety.

EXPLORE

DISRUPTION ON A GRAND SCALE

The media industry has to adapt or die as the Digital Revolution disrupts traditional business models and consumer behaviour.





With the possible exception of music, the Digital Revolution has impacted media more than any other industry. It has turned it inside out and upside down, upended business models and restructured how we consume media. Where once there was simply television, radio, newspapers and magazines, now there is social media, video-on-demand, broadband TV and citizen journalism.

The rise of the internet has led to the elimination of traditional distribution barriers and the democratisation of content, just as the old gatekeepers of content have been replaced by a new world order. Where once the likes of *The New York Times*, *The Washington Post*, CNN and the BBC dominated, now there is Facebook, Twitter, YouTube and Netflix. The internet has enabled previously unheard of levels of global reach.

The majority of this change has been enabled by technology. The internet, of course, but also tablet computers and smartphones. The latter have become ubiquitous in most parts of the world, accounting for nearly 70 per cent of all media consumption in the US, according to a recent comScore report, and seven out of every 10 minutes spent on YouTube. By this time next year over a third of the world's population is projected to own a smartphone, an estimated total of almost 2.53 billion people.

The impact of this has been devastating for traditional print media, with publications shutting down, jobs being lost in their thousands, and companies being forced to diversify their offering across multiple platforms. Although a publisher's role has been enhanced by the use of video content, podcasts, mobile apps and rapid-fire breaking news, making those offerings financially viable has been another matter altogether. Even *The Guardian* with its 'digital first' focus is struggling to remove itself from debt, although it cut its losses by more than a third to \$60 million in the last financial year.

The reality is that advertising funds the majority of media, and brands have changed how and where they spend their money and engage with consumers, switching to more easily measured digital platforms. According to a new survey from the Pew Research Center, for example, two-thirds (67 per cent) of Americans now get at least some of their news on social media, with two-in-10 doing so often. "Since 2013, at least half of Twitter users have reported getting news on the site, but in 2017, with a president who frequently makes announcements on the platform, that share has increased to about three-quarters (74 per cent), up 15 percentage points from last year," said the report.

According to a World Association of Newspapers and News Publishers report, consumers also now spend 143 per cent more time consuming digital content, including news, compared with nine per cent less time reading print newspapers and 36 per cent less time on all other sources.

Digital media has given consumers unending choice. It has also allowed them to actively create their own content and to become publishers themselves, leading to the rise of social media influencers, citizen journalists, bloggers and YouTubers such as Saudi Arabia's Telfaz11. With an estimated 14 million Facebook users and, according to figures from Google, the highest YouTube watch time per capita in the world, Saudi Arabia has one of the most digitally engaged societies in the world.

"We are observing the rise of the new digital generation," says Joyce Baz, head of communications and a spokesperson for Google in the Middle East and North Africa. "Almost anyone can access news and media content now, and those born and raised in the era of the internet are taking matters into their own hands. Internet users are no longer passive observers, >

EXPLORE

NETFLIX'S ANNUAL REVENUE FROM 2002 TO 2016

(in million US dollars)

2002	150.8
2003	270.4
2004	500.6
2005	682.2
2006	996.7
2007	1,205.3
2008	1,364.7
2009	1,670.3
2010	2,162.6
2011	3,204.6
2012	3,609.3
2013	4,374.56
2014	5,504.66
2015	6,779.51
2016	8,830.67



they are active protagonists, who create and amplify stories and define how they want to consume content. Engagement is the new currency for this digital generation.

“One of the key drivers has been the explosion of distribution channels that allows content owners, publishers, advertisers, etc to reach larger audiences than ever and in many more ways. This means that media consumers have a nearly limitless amount of sources to choose from and a limitless amount of digital content to spend time with, whether that is on search, online video, mobile apps and so on. Also, with the explosion of devices, consumers are using multiple platforms for media consumption.”

Alex Jena, head of research and development at Dentsu Aegis MENA, adds: “The ongoing, mainstream access to fast internet connectivity (wifi everywhere, 3G, 4G in advanced markets) which has occurred at the same time as smartphones getting more advanced and coming down in price has opened up a host of new platforms that are accessible for all. The impact on media can be boiled down to: a) migration (traditional formats or touchpoints being replaced); and b) companionship (traditional formats or touchpoints being complemented).”

Online producers such as Telfaz11 are now making a living from YouTube, and it's easy to see why. Over a period of seven months last year they released 32 videos, with an average view count of 700,000 per episode and 20 million views in total. The numbers speak for themselves, as they do for social media influencers such as Dubai-based Huda Kattan and



her 21.5 million Instagram followers. Money follows the numbers.

“The digital revolution essentially boils down to the blurring of the physical, digital and biological worlds,” says Jena. “As a result, the media industry now has an even greater stake, with everything from machine learning to neuroscientists discussing the impact of technology on the brain now becoming matters of interest to brands, publishers and agencies alike. Large technology companies and consultancies are now rubbing shoulders with traditional agencies as a result, completely transforming the way media has traditionally operated.”

It is possible in some circumstances to overlay the effects of the digital revolution. Traditional TV, for example, continues to have the broadest reach, although the switch to social media and online streaming services such as Netflix and Amazon is accelerating. Whether it can continue as the last remaining mass medium only time will tell, but advertisers across industries and sectors are reinforcing their traditional TV spending, according to McKinsey & Company's *Global Media Report 2016*. Even the sale of physical books is increasing in countries such as the UK, while ebook sales are declining.

“TV remains the number one consumed media, even amongst younger audiences, but there are now competing options for long form media consumption



such as Shahid, Netflix, Starz, Apple TV,” says Jena. “Tech has allowed for things to be on-demand and for the region to keep pace with international content releases. As smartphones become more critical to working and leisure aspects of our lives, snacking on short form content media consumption constantly throughout the day has become more prevalent. Our audiences now lead fundamentally digitally lives.

“Being constantly connected and only a click away from a sporadic desire or answer to a question has empowered, for the first time, the audience to be completely in control of how, what, and when they consume media.”

It is unlikely that this digital revolution will cease anytime soon, or that the move towards digital channels will abate. Augmented reality, machine learning, voice activation, the Internet of Things, all will continue to impact how, why and when we consume media.

Multi-screen viewing, the continued rise of online video, data (the ability to use more targeted content), and messenger bots mean media owners will have to continually change and adapt. Even Facebook is morphing, most recently re-vamping its video offering and creating a new hub for digital content called Watch as it seeks to encourage users to spend even more time within its walled garden. So far Watch has only rolled out in the US.

“Technological advancements are appearing rapidly and simultaneously across many industries,” said PwC in its report *Perspectives from the Global Entertainment and Media Outlook 2017-2021*. “The entertainment and media industry is facing a significant level of uncertainty concerning the speed of change in areas such as AI [Artificial Intelligence], 5G networks, IPv6 protocols, virtual reality, and the Internet of Things. At the same time, uncertainty also surrounds the speed of monetisation and the viability of new business models enabled by these new technologies. The concerns created by the confluence of these disruptions may have a chilling effect on investments. Alternatively, they could be largely offset by an increased level of spending on related consumer categories such as e-commerce, or by faster internet speeds and more powerful devices that are fundamental to improving the user experience.”

There are downsides to all of this, too, not least the societal impact of being constantly engaged online. Although recent World Economic Forum research found that half of us believe that increased use of digital media has improved our lives, there has been a decrease in human empathy and a rise in personal image curation. And even though we have access to more information than ever before, we are arguably more ignorant. Our consumption of news is becoming narrower and narrower, governed by who we follow on Twitter and Facebook and our choice of preferred media, many of which peddle a particular world view and ignore alternative voices.

Facebook, for example, uses algorithms based on past behaviour to promote or downgrade the content it delivers to consumers. The more you engage with a certain content creator or broadcaster, the more likely you are to see future content from such publishers. Consumers are also more likely to engage with those who are like-minded and are naturally less likely to follow broadcasters they don't agree with. And as technology evolves, relevance will become the priority, meaning less exposure to what individuals don't agree with.

“Platforms and publishers need to continue innovating, whether that's through formats like VR, mobile live, or any feature that meets the needs of the internet media consumer today,” says Baz. “In MENA more specifically, an exponential growth of digital Arabic content awaits. This region is the world's largest single language cluster with more than 400 million people, out of which 60 per cent are under the age of 25. There is huge opportunity for everyone (consumers, content owners, media companies etc) to contribute to that exponential growth, which will benefit the overall media industry and consumers too.” ↑

Opposite page: Dubai-based Huda Kattan has 21.5 million Instagram followers.

Left: Netflix and Amazon are changing the media landscape through on-demand content.

THE THIRD INDUSTRIAL REVOLUTION

Unlike the first two Industrial Revolutions, the Third is a truly global phenomenon that is changing the world at an exponential pace.

Believe it or not, the origins of the Third Industrial Revolution lie as far back as 1947.

That year researchers working at AT&T's Bell Labs in Murray Hill, New Jersey, developed the first transistor, paving the way for the production of advanced digital computers.

The transistor is the key active component in practically all modern electronics and, importantly, is easily mass-produced. Such was the importance of its development that, in 1956, the Nobel Prize for Physics was awarded jointly to those responsible for its creation – William Bradford Shockley, John Bardeen and Walter Houser Brattain.

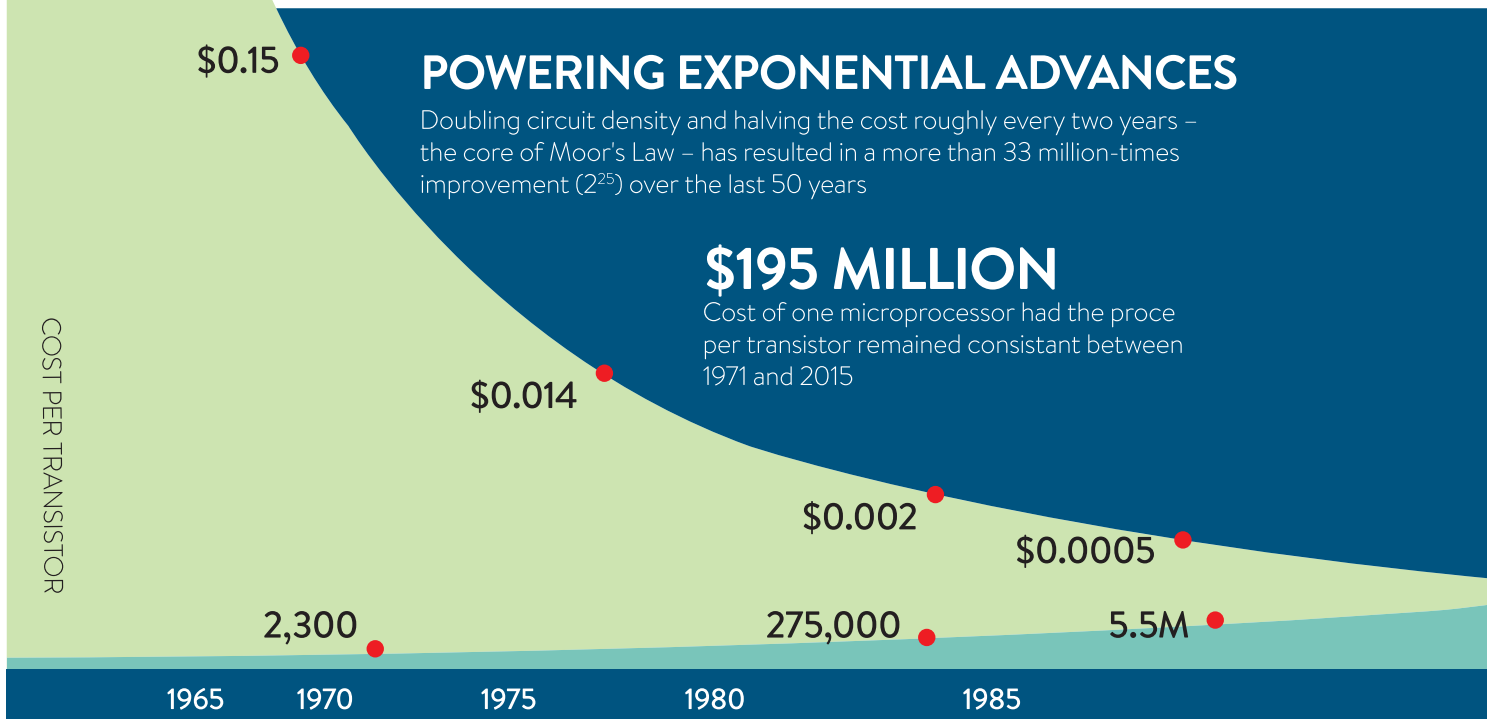
The prize recognised their “researches on

semiconductors and their discovery of the transistor effect”.

CATALYST FOR CHANGE

As inauspicious as it may appear, the transistor was a catalyst for change. Its beauty lay in the fact that computer scientists managed to find ways to make them smaller and smaller, and to connect numbers of them together into a single miniaturised processing board called an integrated circuit. Later known as a microchip, the innocent-looking integrated circuit would go on to form the basis of all computers.

“The integrated circuit, better known as the semiconductor chip, has unleashed change comparable





Above: Martin Cooper headed the team at Motorola that made the first portable mobile phone. In 1973, Cooper made the first mobile phone call.

to the Industrial Revolution by making the computer revolution and the digital age possible,” wrote Saswato R Das in an article for *The New York Times* in 2008, 50 years after the invention of the electronic component that changed the world. “Today there are far more chips on Earth than people. All around us, millions of them are tirelessly at work – in computers, phones, television sets, printers,

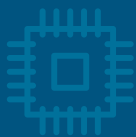
copiers, CD players, PlayStations, cars, trains, airplanes, in almost all electronics.

“Without them, there would be no iPod, no Blackberry. There would be no laptop computer or International Space Station or the Hubble Space Telescope. There would be no Apple, Intel, Samsung, Nokia, Microsoft or Google; no Silicon Valley; no multibillion-dollar semiconductor industry. There would be no internet.”

Digital technology has, and is, changing the way we live, work, think and communicate. Just like the First and Second Industrial Revolutions before it, the Third Industrial Revolution – or the Digital Revolution as it is alternatively known – is transforming our world. It is doing so through never-before-dreamt-of innovation, accelerating the move away from mechanical and analogue electronic technology towards digital electronics and the Internet of Things.

Viewed through the prism of current reality, the earlier stages of the Digital Revolution can look positively quaint. The APRANET, an early precursor to the internet, was established in 1969; the first email was sent in 1971; the first games console was released in 1972; and the first laptop computer went on sale in 1981. Even Tim

1.3B



1971*

\$351

Price per chip

\$150

Price per 1,000 transistors

2,300

Number of transistors

10,000nm

Minimum feature size

*Based on 2-15 dollars



2015

\$393

\$0.0003

1,300,000,000

14nm

400M

TRANSISTOR COUNT

\$0.00005

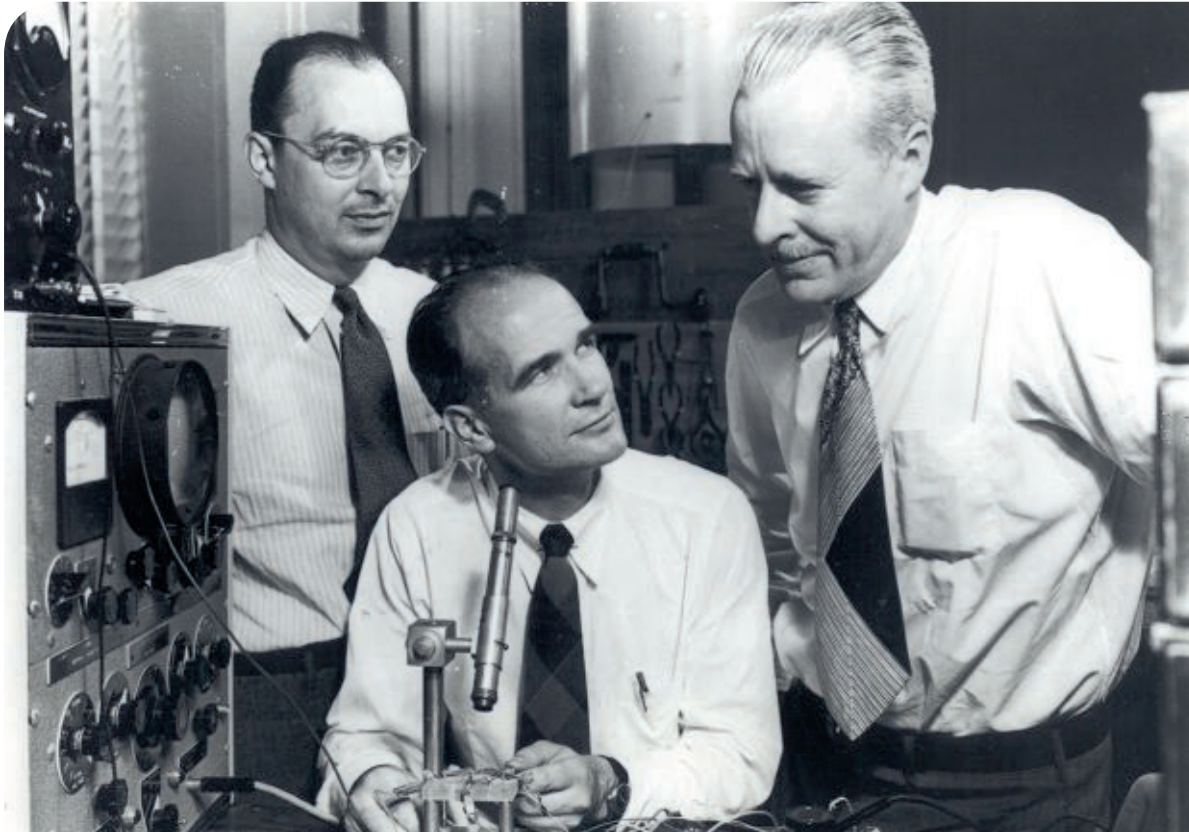
\$0.0000005

\$0.0000003

1995

2005

2015



Above: John Bardeen, William Shockley and Walter Brattain developed the first transistor in 1947.

Berners-Lee's invention of the World Wide Web in 1989 while working at CERN, the European Organisation for Nuclear Research, can trigger bouts of nostalgia. In 1984, the first mobile phone also hit the market, retailing at a now-unimaginable \$4,000 per phone.

As gauges, the internet and the mobile phone offer insight into the rapidity of change and adoption that have taken place over the past 30 years. In 1990, for example, there were 12.5 million mobile phone users, representing 0.25 per cent of the world's population. By 2010 there were four billion (68 per cent of the world's population). Like-wise, in 1990 there were just 2.8 million internet users, yet by 2016 that number had risen dramatically to 3.6 billion.

In 2005 there were 2.5 billion connected devices – most of them PCs, smartphones and tablets, according to research company Gartner. By 2020 there will be over 30 billion connected devices, most of them not PCs, smartphones or tablets. Everything will eventually be connected to the internet. Cars, fridges, televisions, washing machines, toasters, blenders, even dishwashers. It is even possible to imagine a world where science and technology live within people.

The impact of all this is obviously colossal, with accelerating change – where the rate of technological advancement increases exponentially as time passes

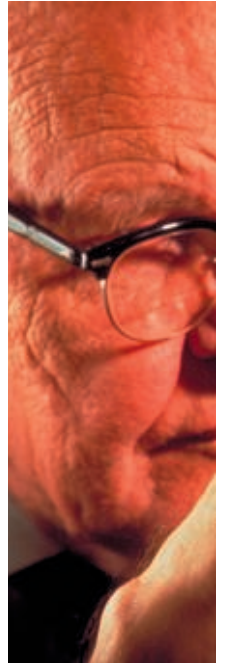
– leading to Ray Kurzweil's *The Law of Accelerating Returns*. That is, technological singularity, where artificial intelligence acquires the ability to create ever smarter and more powerful machines than itself.

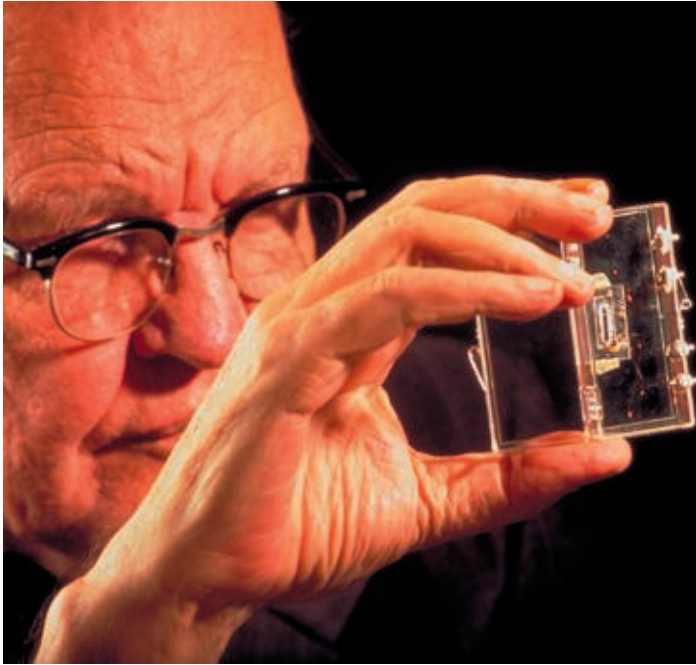
THE DIGITAL REVOLUTION

It's easy to get ahead of yourself when discussing the Digital Revolution, yet whichever way you look at it, automation and artificial intelligence are transforming industries, with large scale job losses a very real threat for millions around the world as technology brings wide-spread disruption. Big data, advanced analytics, wearables, self-driving and connected cars, drones, virtual reality – all are greatly impacting our societies and our economies, although the true level of that impact can only as yet be guessed.

The Digital Revolution is, says James Lockhart, assistant professor of history at the American University in Dubai, an age of information. It represents a rapid acceleration of the "global shift toward industrialisation and technological change that began in the 19th century and has been gaining momentum and reprogramming our world and our emerging, interconnected global community ever since".

"It entails an entirely new infrastructure, especially ways of communicating and doing business and





trade,” adds Lockhart. “It involves digital and smart tech, and it is using these technologies to move toward a more decentralised and customised mass production (using 3D printers and drones more frequently in the near future, for example) than anything we saw in the Industrial Revolution’s earlier stages. This will involve much displacement with respect to employment in coming decades, even more than what we have seen so far, but difficult to predict with any certainty from where we stand today.

“This has also entailed a kind of democratisation of information, which has pros and cons. We have faster communications, not only with our friends and families, but with the entire world around us, than ever before. We can watch breaking news events and presidential press conferences, and offer instant commentary through social media and many other means. Newspapers, once purely physical papers that came out daily, now get updated online every few minutes, and are usually accompanied by hundreds of remarks from readers all over the globe.

“This is not all good news. Among its cons, it is ushering in an era historian Tom Nichols has called ‘the death of expertise’, where public debate is increasingly driven by uninformed people at the grass-roots, contemptuous of experts and elites, who use self-serving Google searches (such as ‘vaccines cause autism’) as a substitute for real research and expertise on important subjects such as anthropogenic global-warming theory, and then use their voices to influence public policy.”

According to Jeremy Rifkin, an American economic and social theorist and the author of *The Third*



Industrial Revolution, this revolution is similar to the two previous ones in that new communications have merged with new energy regimes.

“In the 19th century, print technology and public education gave rise to a print-literate work force with the communication skills to manage a coal powered, steam-driven, First Industrial Revolution,” wrote Rifkin in *The Third Industrial Revolution*. “In the 20th century, the telephone, and later, radio and TV, became the communication media to manage the commercial life of the Second Industrial Revolution driven by oil, the automobile, and a mass consumer culture.

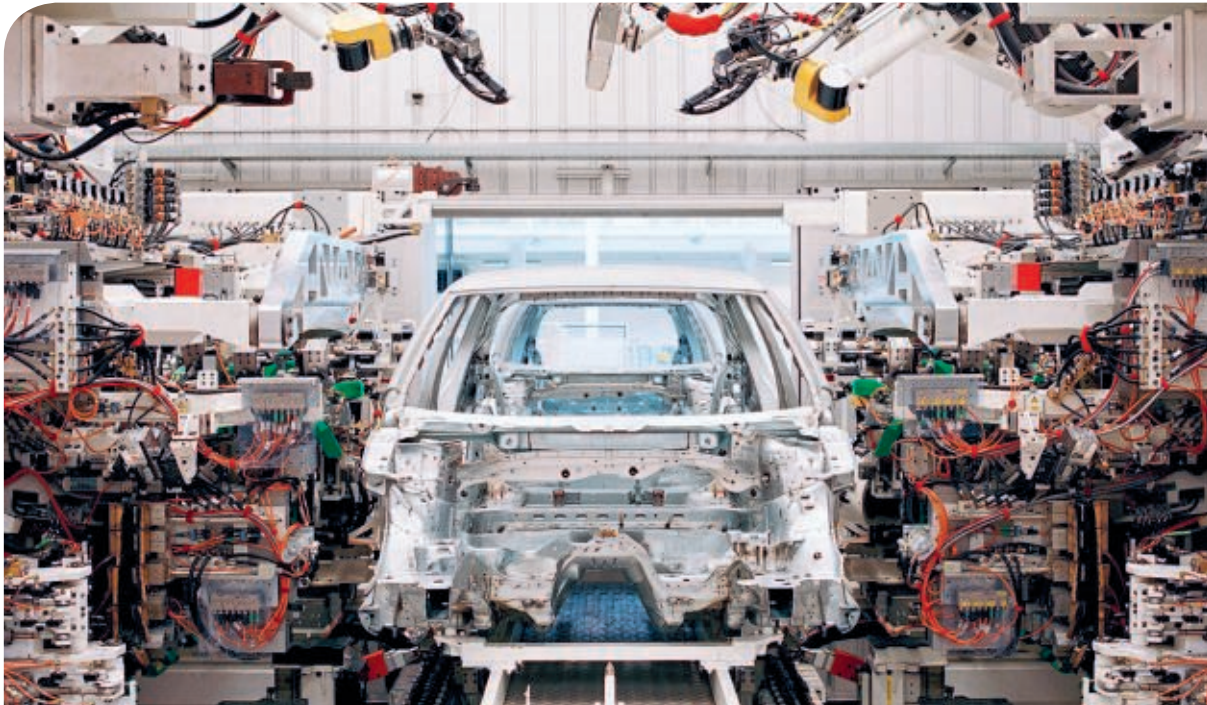
“Today, the internet is converging with renewable energies and becoming the communication media to manage a distributed and collaborative green economy.”

Rifkin argues that, like every other economic revolution that preceded it, the third will “recast many of our assumptions about how the world works”, and “nowhere has the shift in economic thinking become more evident than when it comes to the paramount question of defining what we mean by ‘wealth’.”

“A new generation of scholars are beginning to

Above left: Jack Kilby, working at Texas Instruments, realized the first integrated circuit in 1958.

Above: The supply chain for the Third Industrial Revolution encompasses the whole globe. Foxconn, a Taiwanese multinational company, builds iPhones for California-based Apple.



Above: The rise of robotics has already impacted industrial jobs.

Right: The first transistor was the size of a hand. Today's transistors are 10 nanometers long.

mount a significant challenge to the conventional notion of the nature of wealth and role of capital in the economic process," he says. "The result is that much of economics, as it is taught today, will become increasingly irrelevant in explaining the past, understanding the present, and forecasting the future."

BRAVE NEW WORLD

The relationship between human workers and technology has changed, and is continuing to change. The list of questions this raises is endless. Are we facing the robotisation of almost all work? What types of new jobs will be created? How will the Digital Revolution re-shape the global workforce? Will the necessity for humans to work cease completely?

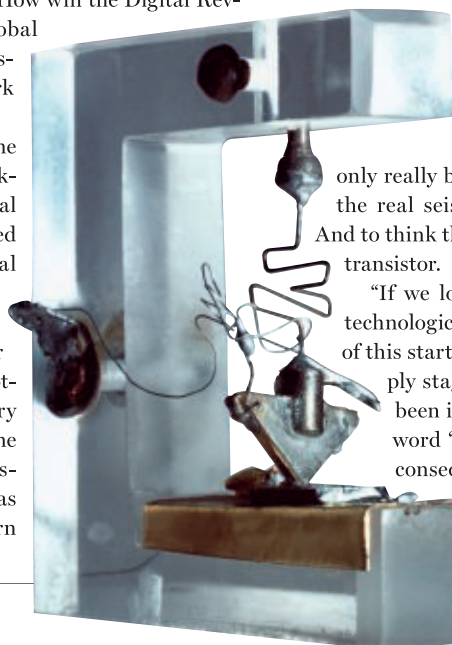
What is clear is that the speed of current breakthroughs has no historical precedent. When compared with previous industrial revolutions, the Third is evolving at an exponential rather than a linear pace. Moreover, it is disrupting almost every industry in every country. Unlike the First and Second Industrial Revolution, which was mainly limited to Western

Europe and its offshoots, the Third is truly global. And the breadth and depth of these changes herald the transformation of entire systems of production, management, and governance.

The possibilities of billions of people connected by mobile devices, with unprecedented processing power, storage capacity, and access to knowledge, are unlimited. And these possibilities will be multiplied by emerging technology breakthroughs in fields such as artificial intelligence, robotics, the Internet of Things, autonomous vehicles, 3D printing, nanotechnology, biotechnology, materials science, energy storage, and quantum computing. According to OECD projections, the world will become about 10 times wealthier during this century.

There are those who believe that the Digital Revolution is only really beginning to get going, and that the real seismic changes are yet to come. And to think that it all began with an innocent transistor.

"If we look at the accelerating rate of technological change we have seen since all of this started in the 19th century, it is simply staggering," says Lockhart. "It has been increasingly faster than even the word 'exponentially' can convey. As a consequence, it's very hard to forecast where we will be even a decade from now."†





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