

FLASHES

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

DECEMBER 2017
ISSUE 36

#YearOfGiving

Knowledge Summit 2017

Knowledge and the
Fourth Industrial Revolution



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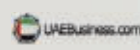
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FOREWORD

Dear readers,

The fourth edition of the Knowledge Summit, which took place under the theme “Knowledge and the Fourth Industrial Revolution”, was an unqualified success. Over the course of the two-day Knowledge Summit 2017, 10,000 registered delegates were able to avail themselves of 105 speakers from 23 countries over 36 sessions.

There were many highlights during Knowledge Summit 2017. One of the most important was the launch of the Literacy Challenge during the opening ceremony by HH Sheikh Mohammed bin Rashid Al Maktoum, Vice President and Prime Minister of the UAE and Ruler of Dubai. MBRF Chairman HH Sheikh Ahmed bin Mohammed bin Rashid Al Maktoum was also in attendance. The Literacy Challenge is an ambitious project that will provide the right of education to 30 million Arab youth under the age of 18 by 2030. The Literacy Challenge project was launched in collaboration with UNESCO, the United Nations Development Program, and the Mohammed Bin Rashid Al Maktoum Global Initiative.

Releasing the results of the inaugural Global Knowledge Index 2017 during the opening ceremony was another milestone event. This joint project between MBRF and the United Nations Development Program marks the first time the UAE has released a global index. In the index, the UAE took an

overall 25th position out of 131 countries profiled over seven sectors. This is an excellent result for this young country that was only founded in 1971, especially as the UAE took the second place for the important economy sector.

During the opening ceremony MBRF Chairman HH Sheikh Ahmed presented the prestigious Mohammed Bin Rashid Al Maktoum Knowledge Award 2017 to the three worthy winners. On behalf of MBRF I would like to congratulate Saudi Arabia's MiSK Foundation, which specialises in developing educational institutions; renowned Japanese scientist Hiroshi Komiyama; and Wendy Kopp from the USA, Founder of Teach For America.

Further congratulations go to Major Dr Rashid Hamdan Al Ghafri, Muna AbuSulayman, Heyam Al Balooshi, Tanmay Bakshi, Jason Silva and Sophia, the humanoid robot, who were appointed by MBRF as Knowledge Ambassadors in order to enrich knowledge in Arab societies.

Inside this issue of *Flashes* you will find further coverage on the aforementioned highlights of Knowledge Summit 2017, as well as some of the best received speakers and sessions.

Jamal Bin Huwaireb

CEO of Mohammed bin Rashid

Al Maktoum Knowledge Foundation



HH Sheikh Mohammed bin Rashid Al Maktoum Attends Knowledge Summit

His Highness Sheikh Mohammed bin Rashid Al Maktoum, Vice President and Prime Minister of the UAE and Ruler of Dubai, attended the opening ceremony of the fourth edition of the Knowledge Summit at the Dubai World Trade Centre on November 21.

The summit, which is held under the patronage of HH Sheikh Mohammed and organised by the Mohammed bin Rashid Al Maktoum Knowledge Foundation (MBRF), was based on the theme “Knowledge and the Fourth Industrial Revolution.”

HH Sheikh Mohammed also attended the launch of the “Literacy in the Arab World” project, which will provide the right to education for 30 million Arab youth under the age of 18 by 2030. This initiative is a collaboration between MBRF, UNESCO and the United Nations Development Programme (UNDP).

HH Sheikh Hamdan bin Mohammed bin Rashid Al Maktoum, Crown Prince of Dubai; HH Sheikh Maktoum bin Mohammed bin Rashid Al Maktoum, Deputy Ruler of Dubai; HH Sheikh Ahmed bin Mohammed bin Rashid Al Maktoum, Chairman of the Mohammed Bin Rashid Al Maktoum Knowledge Foundation; and HH Sheikh Mansour bin Mohammed bin Rashid Al Maktoum also attended the event.

HH Sheikh Mohammed further attended the release of the inaugural Global Knowledge Index, which was launched by MBRF and UNDP. The Index is the first of its kind in the world and has enlisted 140 countries, offering a platform to exchange insight and expertise. It is set to contribute to economic and social development strategies around the world, enrich the knowledge movement, and serve as a roadmap for the sustainable development of human societies.

At the end of the opening ceremony HH Sheikh Hamdan, together with the Chairman of MBRF, honoured the winners of the third Mohammed Bin Rashid Al Maktoum Knowledge Award. Recipients of the Mohammed bin Rashid Al Maktoum Knowledge Award are selected for their outstanding contributions to the production and dissemination of knowledge, while honouring contributions of significant influence towards developing knowledge, inspiring others, and creating ways to promote knowledge. This year’s winners were Saudi Arabia’s MiSK Foundation, which specialises in developing educational institutions and supporting scientific research; renowned Japanese scientist Hiroshi Komiyama, Chairman of the Mitsubishi Research Institute; and Wendy Kopp, the US Founder of Teach For America and current CEO and Co-Founder of Teach For All.

2nd Annual Meeting of Global Future Councils

His Highness Sheikh Mohammed bin Rashid Al Maktoum, Vice President and Prime Minister of the UAE and Ruler of Dubai, attended part of the 2nd Annual Meeting of the Global Future Councils (AMGFC) organised in partnership between the UAE Government and the World Economic Forum (WEF) – Davos in Dubai on 11 and 12 November.

The two-day event saw the participation of over 700 scholars and future experts from 75 countries. Attendees convened in 35 councils, each of which addressed key issues in a vital strategic sector, and worked to propose practical solutions for the challenges that are likely to arise. These include the Fourth Industrial Revolution, artificial intelligence, robotics, biotechnology, energy, water, technology, transport, space travel, health, and high-tech education, among others.

During a meeting with Professor Klaus Schwab, the Founder and Executive Chairman of the World Economic Forum, HH Sheikh Mohammed asserted that the United Arab Emirates is keen on adopting future industries by utilising the Fourth Industrial Revolution technologies to benefit societies.

HH Sheikh Mohammed said that governments, international organisations, and entrepreneurs should adopt a novel and flexible approach to address key future challenges. “The UAE has embraced new technologies in its quest to revolutionise public services in key sectors,” His Highness added.

Underlining the importance of the Annual Meeting of the Global Future Councils, HH Sheikh Mohammed said that the event plays a dynamic role in supporting the development of vital sectors affecting societies all over the world.

The two-day event saw the participation of over 700 scholars and future experts from 75 countries. Attendees convened in 35 councils, each of which addressed key issues in a vital strategic sector, and worked to propose practical solutions for the challenges that are likely to arise.

The meeting was attended by His Highness Sheikh Maktoum bin Mohammed bin Rashid Al Maktoum, Deputy Ruler of Dubai; and HE Mohammed Al Gergawi, Minister of Cabinet Affairs and the Future; as well as a number of high-ranking officials.

Building on the UAE’s status as a global hub for the industries of the future, the event provided a platform for attendees to exchange knowledge, expertise, best practices and success stories in order to develop proactive solutions to the challenges in the near, medium and long term.

The councils’ outcomes are valuable raw material that governments around the region and the world can use in developing their strategies and programmes for the future.





Knowledge Summit 2017

The fourth edition of the Knowledge Summit, organised by the Mohammed bin Rashid Al Maktoum Knowledge Foundation (MBRF), took place on November 21-22 at the Dubai World Trade Centre under the theme “Knowledge and the Fourth Industrial Revolution”.

The annual Knowledge Summit is held under the patronage of His Highness Sheikh Mohammed bin Rashid Al Maktoum, Vice President and Prime Minister of the UAE and Ruler of Dubai, and under the directives of MBRF Chairman HH Sheikh Ahmed bin Mohammed bin Rashid Al Maktoum.

The Knowledge Summit 2017 constituted a global knowledge platform that brought together decision-makers, experts and academics from various disciplines to discuss the opportunities and challenges brought about by the Fourth Industrial Revolution, as well as its impact on societies. The Summit featured 105 speakers from 23 countries, who presented new ideas and perspectives on the Fourth Industrial Revolution over 36 sessions, in addition to exchanging experiences and exploring best practices.



“Over the past few years, the Summit has created a regional knowledge movement, drastically developing and modernising the way we go about producing and disseminating knowledge,” said MBRF’s CEO HE Jamal bin Huwaireb. “With the support and guidance of HH Sheikh Mohammed bin Rashid Al Maktoum, Vice President and Prime Minister of the UAE and Ruler of Dubai, and the close involvement of HH Sheikh Ahmed bin Mohammed bin Rashid Al Maktoum, Chairman of the Mohammed bin Rashid Al Maktoum Knowledge Foundation, we were able to spark a constructive dialogue among all knowledge stakeholders and influencers, bolstering ideas, projects and creative initiatives within the sector.”

Ten thousand delegates registered for the two days of the Knowledge Summit 2017, while another 10,000

watched the sessions that were live-streamed. The opening ceremony on Day One was attended by HH Sheikh Mohammed bin Rashid Al Maktoum, HH Sheikh Ahmed bin Mohammed bin Rashid Al Maktoum, as well as Jordan’s Prime Minister Dr Hani Al Mulqi, the Guest of Honour.

LITERACY CHALLENGE LAUNCHED

During the opening ceremony the Literacy Challenge was launched. Announcing the initiative MBRF CEO Jamal Bin Huwaireb said that education is the best tool to fight ignorance and extremism. This ambitious project will provide the right to education to 30 million Arab youth under the age of 18 by 2030. The Literacy Challenge project was launched in collaboration with UNESCO, the United Nations Development Program, and the Mohammed Bin

Rashid Al Maktoum Global Initiative. (The Literacy Challenge is covered in more details on page 12 of this issue of *Flashes*)

RESULTS OF GLOBAL KNOWLEDGE INDEX REVEALED

MBRF CEO Jamal Bin Huwaireb also released the results of the inaugural Global Knowledge Index 2017 during the opening ceremony. The Index was launched by the Foundation in collaboration with the United Nations Development Program (UNDP) to study knowledge at an international level, identify opportunities and challenges in the Arab world and compare them with those of other countries around the world. The Global Knowledge Index has engaged 131 countries. (The Global Knowledge Index is covered in more details on page 16 of this issue of *Flashes*)





4 FOURTH INDUSTRIAL REVOLUTION



HH Sheikh Hamdan Bin Mohammed Bin Rashid Al Maktoum, Crown Prince of Dubai, hands the Sheikh Mohammed Bin Rashid Knowledge Award to Bader Al Asaker, Secretary General of MiSK Foundation. The other two winners were Wendy Kopp, Founder of Teach For America and CEO/Co-founder of Teach for All, and Hiroshi Komiyama, Chairman, Mitsubishi Research Institute.



THE MOHAMMED BIN RASHID AL MAKTOUM KNOWLEDGE AWARD

During the opening ceremony HH Sheikh Hamdan Bin Rashid Al Maktoum and MBRF Chairman HH Sheikh Ahmed Bin Mohammed Bin Rashid Al Maktoum presented the prestigious Mohammed Bin Rashid Al Maktoum Knowledge Award 2017 to three winners: Saudi Arabia's MiSK Foundation, which specialises in developing educational institutions and supporting scientific research; renowned Japanese scientist Hiroshi Komiyama; and Wendy Kopp from the USA, Founder of Teach For America

and current CEO and Co-Founder of Teach For All. The Mohammed bin Rashid Al Maktoum Knowledge Award honours knowledge-related advancements anywhere in the world, while encouraging innovation and originality.

The MiSK Foundation, which is also known as the Prince Mohammed bin Salman bin Abdulaziz Foundation, was the only winner from the Middle East region. It is a non-profit devoted to promoting education and leadership among young Saudis to shape a bright future for the Kingdom. It is focus on educating young people in education, media and

culture to support the advancement of the Kingdom's development and its efforts to secure a prosperous future.

Hiroshi Komiyama has made significant contributions in innovation, developing educational institutions and scientific research. A seasoned veteran in optical and transformational engineering, he has put forward theories and insights into human and social sciences – particularly, science-based social sustainability.

Wendy Kopp was honoured for her Teach For America initiative which, for the past 25 years, has been working to give American children of all



backgrounds the education they deserve. Kopp's mission has since evolved into a global movement – Teach for All – which has brought together 45 likeminded institutions to help children around the world access education to reach their full potential. Teach for All motivates and empowers generations of future leaders through education – especially targeting children living in poverty.

HE Jamal bin Huwairib said: “The Mohammed bin Rashid Al Maktoum Knowledge Award is a world-class event bearing the name of a great leader. It has been instrumental in amplifying Dubai's efforts and cementing its pioneering role in developing the knowledge industry, not only in the emirate, but also in the region and the world.”

“Based on clear directives from HH Sheikh Ahmed Bin Mohammed Bin Rashid Al Maktoum, Chairman of the

MBRF and Chairman of the Award's Board of Trustees, the award aims to raise awareness of the importance of knowledge, all the while shedding light on the most notable achievements of individuals and institutions around the world that promote knowledge-centric societies,” he added.

MBRF APPOINTS FIVE KNOWLEDGE AMBASSADORS

As part of Knowledge Summit 2017, the Mohammed bin Rashid Al Maktoum Foundation named six knowledge ambassadors for the first time. Among them was Sophia, a humanoid robot by Hanson Robotics, who enthralled the audience by stating “Let's start the future today.” The remaining four Knowledge Ambassadors were Jason Silva, a popular TV personality and futurist; Muna AbuSulayman, an Arab and Muslim media personality; Major Dr Rashid



Hamdan Al Ghafri, DNA and Biology Expert in the Department of Forensic Sciences and Criminology at the Dubai Police; Tanmay Bakshi, a 13-year-old Artificial Intelligence developer and Heyan Al Balooshi, Design Engineer at the UAE Space Agency. Through the new initiative, MBRF will select Knowledge Ambassadors every year to create a global group of activists working to enrich knowledge in Arab societies.

A WIDE RANGE OF TOPICS

The Knowledge Summit's sessions discussed the concept of the Fourth Industrial Revolution and the history of the previous industrial revolutions, as well as their impact on decision-making. Moreover, experts looked into the future of these developments and their effects on knowledge and other aspects of human life. The sessions also examined the impact of the industrial revolution on media, technology, education, healthcare and the economy, in addition to broader subjects, such as artificial intelligence and the future of robotics.

In the following pages, *Flashes* covers some of the highlights of the Knowledge Summit 2017.†



LITERACY CHALLENGE

The launch of the Literacy Challenge will provide the right to education for 30 million Arab youth under the age of 18 by 2030.



The Knowledge Summit 2017 opened in Dubai on November 21 with the launch of the “Literacy Challenge” project aimed at combating and eradicating illiteracy from the region. Launched by HH Sheikh Mohammed Bin Rashid Al Maktoum, the project will provide the right to education for 30 million Arab youth under the age of 18 by 2030.

The ambitious initiative was launched at the Summit’s opening ceremony, which was attended by His Highness Sheikh Mohammed Bin Rashid Al Maktoum, Vice President and Prime Minister of the UAE and Ruler of Dubai, and MBRF Chairman HH Sheikh Ahmed Bin Mohammed Bin Rashid Al Maktoum, as well as Jordan’s Prime Minister Dr Hani Al Mulqi, the Guest of Honour.

The Literacy Challenge is part of Mohammed bin Rashid Al Maktoum Global Initiatives and is

being run in collaboration with the United Nations Development Programme (UNDP) and the United Nations Educational, Scientific and Cultural Organisation (UNESCO).

THE IMPORTANCE OF LITERACY

The aim of the Literacy Challenge is to help eradicate illiteracy in the Arab World by providing people with the skills and knowledge needed to succeed in a world of rapidly changing technology, using education as the best tool to combat ignorance and extremism.

By targeting the Arab World’s youth population through the project, MBRF aims to help young people develop their skills, abilities and knowledge, enhancing their qualifications and positively influencing their behaviour. This will empower them socially, culturally and economically, enabling them to become productive members of society.

Speaking at the opening ceremony of the Knowledge Summit, HE Jamal bin Huwairb, CEO of MBRF, said: “Knowledge is a source of strength; those who own knowledge own the future. The fourth edition of the Knowledge Summit marks a decade of success for the Mohammed bin Rashid Al Maktoum Knowledge Foundation, which is inspired by the vision of His Highness Sheikh Mohammed bin Rashid Al Maktoum, and MBRF Chairman HH Sheikh Ahmed bin Mohammed bin Rashid Al Maktoum, who understand that knowledge is a key pillar for building and developing societies. Over the last 10 years, MBRF has launched initiatives and projects that have enhanced access to knowledge, not only in Dubai, but also on a regional and global level.”

HE bin Huwairb highlighted that: “Knowledge is a source of strength. We’re confident the summit will constitute a road map for building and advancing knowledge-based societies in our Arab region.”

“Such societies build on innovation and creativity and we synchronised the summit’s topics and activities with the UAE’s plans to capitalise on opportunities brought about by the Fourth Industrial Revolution for the benefit of society.”

HE Dr Hani Al-Mulqi, Prime Minister of the Hashemite Kingdom of Jordan, said during the opening ceremony that the Fourth Industrial Revolution is a source of empowerment for human beings. “Science and technology will consolidate the Fourth Industrial Revolution in a way that promotes peace and the furthering of humanity. Countries must focus on human development in order to fully realise the potential of this new era;





Above: It was standing room only for the opening ceremony of the Knowledge Summit 2017.

Opposite page: HE Dr Hani Al-Mulqi, Prime Minister of Jordan, was the Guest of Honour at this year's Knowledge Summit.

redeveloped educational systems that focus on the requirements of the technological age will ensure that people are the true benefactors of the Fourth Industrial Revolution.”

Hamed Al Hammami, UNESCO Regional Education Director, highlighted that the Literacy Challenge, “is not only important to tackle access to schooling but also to emphasise quality of education provided to students. Recent reports by UNESCO’s Institute for Statistics show that in some countries students cannot perform the minimum standards in reading and writing even at low secondary grades, which indicates a big question regarding the quality of education.”

BUILDING A KNOWLEDGE-BASED ECONOMY

The UAE’s Vision 2021 National Agenda is committed to creating a knowledge-based, diversified and sustainable economy for future generations, and the key to achieving this aim is education. As such, the UAE has launched numerous initiatives to aid the transformation. The Emirates Science, Technology and Innovation Higher Policy for instance, which was launched in 2015, is an investment of over AED 300 billion and includes new national policies in legislation, investment, technology, education and finance.

“The shift to a knowledge-based economy is the ultimate destination but the question is what steps can we take to get there - the UAE is on the right path.” Yet there are “tens of millions of students who are suffering without education.”

– Michael O’Neil

“The educational aspect in creating a knowledge-based economy should be complete and comprehensive in order to make it one of the best in the world. We have carried out many studies and chose the best methodology that goes hand in hand with the needs of the UAE in this very important phase of the country,” HE Hussain Ebrahim Al Hammadi, UAE Minister of Education, pointed out recently.

According to Michael O’Neill, Assistant Secretary-General at the United Nations and Director



of External Relations and Advocacy at the United Nations Development Programme (UNDP), “The shift to a knowledge-based economy is the ultimate destination but the question is what steps can we take to get there – the UAE is on the right path.” Yet there are “tens of millions of students who are suffering without education.” According to UNESCO, 25 per cent of Egyptians and 20 per cent of Iraqis are illiterate.

PREVIOUS MBRF INITIATIVES

In 2016, the Arab Reading Index was launched by the Mohammed bin Rashid Al Maktoum Knowledge Foundation (MBRF) in collaboration with the United Nations Development Programme (UNDP) with the aim to shed light on the realities of reading in the Arab world. When the results were released in December 2016, it dispelled widespread inaccurate statistics, which placed reading levels in the region much lower than they really are.

Canvassing 148,000 people in all 22 Arab countries, the Index revealed that the Arab reader reads, on average, 11 Arabic books and 6 foreign-language ones every year – be it within schools and universities or outside. Similarly, the results showed that the 35 hours of reading spent



by the average Arab reader are divided into 20 hours in academic institutions and 15 hours outside of them.

In 2015, the Arab Knowledge Report and The Arab Knowledge Portal were launched as joint initiatives between MBRF and the United Nations Development Programme. The former offered decision-makers, experts and researchers information on the status of knowledge in Arab countries, helping them to implement development policies for building knowledge societies as well as regional and national programmes of world-class standards.





A GLOBAL OUTLOOK

The launch of the Global Knowledge Index at the Knowledge Summit 2017 marked the first time the UAE has released a global index.

The Knowledge Summit 2017 saw the launch of the Global Knowledge Index, a joint project between MBRF and the United Nations Development Programme that seeks to support knowledge projects, as well as economic and community development strategies around the world, while serving as a roadmap for the sustainable development of societies. The first edition of the index profiled seven sectors in 131 countries to create a guide to track knowledge wealth for stronger nation building. It marked the first time the UAE has released a global index, as in the previous years it had focused on the Arab Knowledge Index.

In the index, the UAE took an overall 25th position, with Switzerland topping the index followed by Singapore, Finland, Sweden and the Netherlands. The UAE took the second place for economy; in the field of Pre-University Education, it stood at the 16th place; in Higher Education at 27th; in Research, Development and Innovation, a critical marker of development, it was 37th; and in the field of General Enabling Environment, a must-have asset for countries as the term connotes the felicity with which people and systems can synergize to produce optimum growth, the UAE occupied the 46th position. ➤



The UAE leads the Arab world in the Global Knowledge Index for pre-university students, technical education and vocational training. Fifteen countries in the region made it to the list, with an average score of 55.72 per cent.

HE Jamal bin Huwairb noted the UAE can be extremely pleased with its ranking given how far the country has come since its founding in 1971. According to the MBRF CEO educated, informed people make wiser choices when they have the latest information to meet a challenge without fearing what lies ahead. "We always fear what we don't know, we must be ready for the future."

The new Global Knowledge Index, which is contained in a 332-page report, gives the Arab region a stronger ability to produce its own data and its own research that will help prepare societies such as those in the UAE for the digital disruption of the Fourth Industrial Revolution.



"What can't be measured cannot be improved," noted HE Bin Huwairb. "We began our efforts to quantify and measure knowledge with reports, which grew into indices covering all Arab countries and now we've expanded the Index to become international, covering 131 countries."

GLOBAL KNOWLEDGE INDEX PANEL DISCUSSION

The Global Knowledge Index Panel Discussion, which took place on Day 2 of the Knowledge Summit 2017, brought together the leading figures on the index, namely: MBRF's CEO Jamal bin Huwairb; Michael O'Neill, Assistant Secretary General of the United Nations and Dr Hany Torky, Chief Technical Advisor of the Arab Knowledge Project.

"What can't be measured cannot be improved," noted HE Bin Huwairb. "We began our efforts to quantify and measure knowledge with reports, which grew into indices covering all Arab countries and now we've expanded the Index to become international, covering 131 countries."

"The Index is an instrument to help decision-makers in management and administration, as well as in preparing for the future," he said. "If we're well prepared, we can make sure our future is bright. If not, we risk losing time and resources. The Arab world is not lacking in universities, we have highly acclaimed universities in all Arab countries. What we need



Above: Dr Hany Torky, Chief Technical Advisor of the Arab Knowledge Project; Michael O'Neill, Assistant Secretary General of the United Nations and MBRF's CEO Jamal bin Huwareb.

is research centres – we must invest in science and research to improve knowledge. Knowledge is essential to plan for the future. The UAE has made great strides in that regard: at the country's inception in 1971, illiteracy was very common among Emiratis; now, it is almost non-existent."

UN Assistant Secretary General Michael O'Neill said: "It is impossible to overstate the importance of data gathering. It is the first step for setting effective policies and this is what makes this Index such an important initiative that offers pertinent data spanning multiple sectors. At the end of the day, what can't be measured can't be managed."

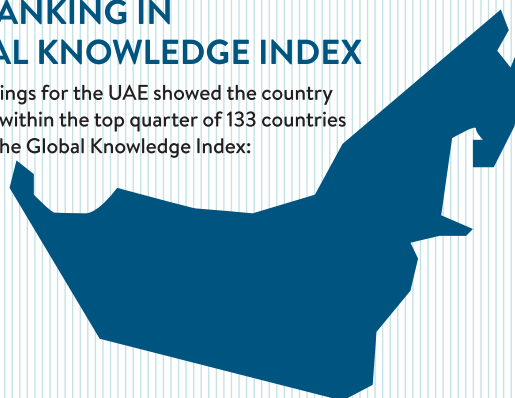
"The United Nations can play an important role in helping national governments efficiently utilise data," O'Neill continued, "we can connect developing countries with governments such as the UAE's and others who have succeeded in that regard. The UAE demonstrates the effects of visionary leadership: the country now ranks 25th on the Knowledge Index and second in the economy sector – a commendable progress."

Dr Torky, for his part, remarked: "There isn't a knowledge gap between Arab countries and the rest of the world, rather there is a data gap, which has limited the ability to measure knowledge in the region. The reason behind this gap in some of the countries in the region stems from disproportionate investment in select sectors with insufficient funds going to others."

Dr Torky went on to explain: "If countries only think about providing the basics for their citizens, they will not be able to sustain themselves. If governments invest in knowledge, they empower their citizens to provide for themselves. This is where this Index can be of great assistance: it allows governments to determine the sectors they really need to focus on."

UAE RANKING IN GLOBAL KNOWLEDGE INDEX

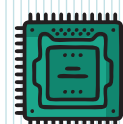
Sector rankings for the UAE showed the country placed well within the top quarter of 133 countries profiled in the Global Knowledge Index:



2ND
ECONOMY



16TH
PRE-UNIVERSITY
EDUCATION



23TH
INFORMATION AND
COMMUNICATIONS
TECHNOLOGY



24TH
TECHNICAL
VOCATIONAL
EDUCATION AND
TRAINING



27TH
HIGHER EDUCATION



37TH
RESEARCH,
DEVELOPMENT AND
INNOVATION



46TH
GENERAL ENABLING
ENVIRONMENT



THE DIGITAL REVOLUTION

AND ITS ROLE IN TRADITIONAL AND SOCIAL MEDIA

Technology is changing the face of traditional and social media, whether it is through new software, false news or providing quality content in an era of declining revenue.

How will technology impact the media? Are journalists about to be replaced by technology? Is there any way to stop fake news? These were just some of the questions tackled during the second session on Day One of Knowledge Summit 2017.

The panel included HE Noora Al Kaabi, UAE Minister of Culture and Knowledge Development; Majed Al Suwaidi, the Managing Director of Dubai Media City; Ludovic Blecher, the Head of the Google Digital News Innovation Fund; Larry Birnbaum, a NorthWestern University Professor and Co-Founder and Chief Scientific Advisor of Narrative Science; and Will Moy, the Director of Full Fact, an independent fact-checking charity.

HE Noora Al Kaabi delivered a holistic outlook by explaining that the UAE plans to capitalise on the Fourth Industrial Revolution and become a digital hub for the region. "We want to be able to celebrate exporting the last barrel of oil," she told the packed hall. "We're in a place where we see hope, we dream and we want the majority of our population, which is the youth, to live in a better place than today. It's about exploring and empowering the youth... and embedding that future agenda in everything we do."

"Today we believe the most successful companies created in the region are those that know the region much better than others from outside. The region needs to create its own businesses, value, content, content producers and opportunities ... so it's critical cities are focused on how to make it better for start-ups."

– Majid Al Suwadi

As a result, the UAE Cabinet is embracing the Fourth Industrial revolution amid a long list of major government initiatives to innovate by "looking at how do we innovate in terms of the jobs that we do?" As a result structures and measures have been put in place such as the Year of Innovation, implementing innovation at workplaces, as well as encouraging individuals to represent the country in technological and AI spheres.

"It's a thrill to witness the new experiences in the digital age, it's a challenge as well," HE Al Kaabi said, noting that society will have to find its way through fake news, social media and a changing landscape towards a happy place.

Majid Al Suwaidi, Managing Director of Dubai Media City, said there has been a distinct shift from a point in time 16 years ago when the emirate was committed to attracting Fortune 500 companies.

"We have gone through a major overhaul in the last 15 to 16 years," he said. "Our next phase is to create companies in the region. So the last few years have been spent building the foundation for creating talent with the drive to take the digital revolution to the next level."

These new companies can create their own value and build original content that adds its own inherent value to the society and economy of Dubai, the UAE and the region, Al Suwaidi said.

"Today we believe the most successful companies created in the region are those that know the region much better than others from outside. The region needs to create its own businesses, value, content, content producers and opportunities ... so it's critical cities are focused on how to make it better for start-ups."

Asked how the digital revolution has impacted the region, Al Suwaidi said: "It took everybody by surprise, but we are fortunate to have made a media haul in the last 16 years by taking steps such as opening Dubai Internet City where we have technological firms operating. >





Above: HE Noora Al Kaabi, UAE Minister of Culture and Knowledge Development, said the UAE cabinet is embracing the Fourth Industrial Revolution through various initiatives.

Right: Majed Al Suwaidi, Managing Director of Dubai Media City, said it was imperative to create new regional companies and nurture start-ups.

“This region was slightly left behind as the world moved forward. However, we are also fortunate that we have leapt over certain trends. Instead of going from stage one to two, we tend to go directly from stage one to four. Due to these strategies, we are now able to attract world class talents.”

He also noted there had been a problem with amateurish, valueless content but, “we went around this by reaching understandings with different companies to address it. I am glad Google was one of the first supportive firms.”

Commenting on the challenges for publishers, Ludovic Blecher said: “We are living in an amazing time as regards the power of content creation. In terms of opportunities, the reach has never been so big. We have so many platforms. There are great opportunities for publishers, journalists and news-makers. At this point in order to have great content you need to challenge the traditional way, you have to reshape your approach to journalism, and that means finding new recipes to distribute and frame the content.”

Will Moy addressed the issue of fake news and its many guises.

“Fake news has become a dominant global conversation in the past couple of years and it is helpful to break it down into its constituent parts. During the US election there were people creating websites

“How we detect people’s algorithmic manipulation will definitely be a big technical challenge. The reality of fake news is not only that it is false, but it is aimed to incite people in a certain way. It has an emotional quality that is aimed at evoking feelings in a certain kind of people. I worry that even if we tag something as not true it might not have the intended impact in getting people to reject that information.”

– Larry Birnbaum



with completely made up stories but that looked like news simply to get the advertising revenue. Then you move onto the whole range of what can be described as fake news. Over the last year we have seen everything from made up stories to satire being described as fake news and even legitimate questions from the media labelled as fake news by people in power.”

According to Moy, taking away financial incentives was one way of fighting fake news and steps in





Above: (L to R) Moderator Muna Abu Sulayman, media personality and co-host of *Kalam Nawae'm* TV show; HE Noora Al Kaabi, UAE Minister of Culture and Knowledge Development; Ludovic Blecher, the Head of the Google Digital News Innovation Fund; Majed Al Suwaidi, Managing Director of Dubai Media City; Larry Birnbaum, a Northwestern University Professor and Co-Founder and Chief Scientific Advisor of Narrative Science; and Will Moy, the Director of Full Fact.

this regard had already been taken by Google and Facebook. However, education is intrinsic to fighting fake news by making people aware of how news can be manipulated online and enabling them to think more critically. However, he warned that technology was moving at such a pace that software now exists that can even manipulate video into fake news. "We are entering a world where no content can necessarily be trusted unless you can trace it back to a provable source."

Another major problem, Moy said, was that in modern media the challenge lies in providing quality content amid waning revenues, which have traditionally supported strong organisations with internal fact-checking safeguards. "Now it's harder to do investigative reporting that has made journalism such an important public service," Moy told delegates.

Detecting the manipulation of news will prove difficult. Larry Birnbaum said: "How we detect people's algorithmic manipulation will definitely be a big technical challenge. The reality of fake news is not only that it is false, but it is aimed to incite people in a certain way. It has an emotional quality that is aimed at evoking feelings in a certain kind

of people. I worry that even if we tag something as not true it might not have the intended impact in getting people to reject that information."

Journalists covering the event were relieved when Birnbaum said the automatic generation of news stories or any stories is still in its infancy. He noted that citizen journalism "where virtually everyone with a phone device can author and disseminate news" cannot replace professionalism. "Professionals can always beat citizen journalists with exclusive, in-depth, well-researched and finely presented stories."

Birnbaum's outlook is that technology will support, and not assume the future. "The model of the future will be machines that interrelate with humans to things that neither can do alone," Birnbaum said. "The picture of the future is one of partnership."

As an example he pointed to the technology being developed at Northwestern University. It is aimed at taking data and turning that data into stories. "The purpose is to make data meaningful to people through stories at scale. I hope this will make data, seeing we have so much of it, useable to people." †



4TH INDUSTRIAL REVOLUTION:

A FUTURE OUTLOOK

Jason Silva, the Venezuelan-American host of National Geographic's top-rated Emmy-nominated series Brain Games, returned to this year's Knowledge Summit with his special brand of infectious enthusiasm that enthralled the audience.

Jason Silva, the Emmy-nominated and world-renowned TV personality, storyteller, filmmaker, keynote speaker and futurist is a self-professed wonder-junkie. His thought-provoking viral videos (over 100 million views across social platforms) and eloquent discourse on subjects ranging from evolution to technology, human behaviour, creativity and reality have made him a household name.

Silva says he is fascinated by the idea of technology as the embodiment of human creativity and imagination. "Using technological tools we can radically extend our limits. When things truly phase-change we talk about The Singularity. This is an idea in Ray Kurzweil's book and it changed me forever. He was an inspiration."

At the centre of Silva's session at Knowledge Summit 2017 was the concept of exponential change. Earlier in the day, the Mohammed Bin Rashid Knowledge Foundation had named Silva Knowledge Ambassador for 2017, among four others honoured at the event by UN Assistant Secretary General Michael O'Neill. In his session, Silva thanked MBRF CEO Jamal Bin Huwaireb for the honour. "We need to inspire our young people to dream bigger than ever before," said Silva.

According to Silva dreaming and thinking big is of the utmost importance as the era of exponential change has arrived thanks to technologies evolving over generations, and now transforming at an unprecedented level.

"Humans built tools, and then built new tools using our previous tools. This circular process, repeated over centuries, is why technology is so disruptive today and exponentially transforming the world we live in."

"Technology has always changed who we are. The philosopher Marshall McLuhan famously said we build the tools. However, these tools build us right back. Everything we design in the world is designing us. It is a circular effect, a self-amplifying feedback loop. We build tools and then those tools change what is possible for us. With those tools we create new tools, and then with those tools we create new tools. It is like a runaway train."

"From the moment early humans first picked up a stick and used it to get a high hanging fruit we've been using our instruments, our tools, to extend our reach, to redefine our boundaries, to transcend our limits. We did not stay in the caves. Soon we will not stay within the limits of biology. Look how fast we have gotten here. Today we live in the age of radical disruption."

Silva acknowledges that while human beings are curious by nature, we are still resistant to change.

"Our human brain evolved in a way that was linear and local. When we think about change our instinct and intuition is linear. 100,000 years ago when a lion charged us we had to make a linear calculation how fast it would get here. Technological change is not linear, we now live in a world that is global and exponential."

"Ray Kurzweil was the first one who articulated to me why change was happening at the speed we are >





Top: Jason Silva is appointed as one of six Knowledge Ambassadors in the presence of UN Assistant Secretary General Michael O'Neill and MBRF CEO Jamal bin Huwaireb.

Above: Silva's session entitled 4th Industrial Revolution: A Future Outlook filled Hall 1.

witnessing today. Kurzweil extended Moore's Law. He called it the Law of Accelerated Returns that has allowed him to be incredibly brilliant at predicting the speed of the changes we are seeing today."

"Kurzweil's example is that if you take 30 linear steps, by 30 you get to 30. But 30 exponential steps will get you to a billion. That's the reason why the smartphones in your pockets are a million times cheaper, a million times smaller, yet a thousand times more powerful than what used to be a \$60 million supercomputer that was half a building in size 40 years ago. That is exponential progress. That is why our whole view on problem solving needs to go from linear to exponential. In the next 25 years that supercomputer will shrink down to a device the size of a blood cell."

According to Silva, technology has always been disruptive, but we have reached a point in time where the pace of change is astounding.

"We were born into a world that didn't change as much in our individual life time. That is not the case today. Today we are living in an age of exponential change."

"Changes from technology accrued over many generations, so that's why it didn't feel as disruptive in previous times," explained Silva. "We were born into a world that didn't change as much in our individual life time. That is not the case today. Today we are living in an age of exponential change."

Silva urged the audience to think in terms of exponential trends that will change the way people live. "Technology is the human mind turned inside out; the extension of our creativity and agency in the world. In an exponential era, we must surf the wave, and disrupt ourselves," noted Silva. "Dubai is an example of exponential thinking, when you understand how fast this place has risen in the world. I think the rest of the world could learn from what I've seen here in terms of exponential vision."

Citing Ray Kurzweil's *The Singularity is Near* series, Silva explained that the three defining technologies of the future are Genetics, Nanotechnology and Robotics (GNR).

"There are three overlapping revolutions you need to pay attention to. They are called GNR – genetics,



nanotechnology and robotics or artificial intelligence. The world of flesh and concrete is also becoming an information technology and is therefore also subject to these exponential trends of advancement.”

According to Silva biotechnology and genetics means mastering the processes of biology.

“We are made of language, DNA is code. With biotechnology, biology becomes a programmable medium. This is also advancing exponentially. The speed at which we can sequence genes is now three time faster than exponential. First and foremost if we are interested in alleviating human suffering and democratising access to healthcare we need to embrace biotechnology with the most intense fervour and enthusiasm ever.”

Nanotechnology is equally important in changing the human condition for the better.

“Nanotechnology means patterning atoms, the building blocks of the physical world, the same way we pattern 1 and 0 in digital technology,” explained Silva. “We are talking a physical world that is programmable. Nanotechnology is the engine to transform how we manufacture or transform what we manufacture. Nanotechnology exists in nature, when you plant a seed it is an information file that tells the matter around it to self-organise into a tree. We are just borrowing technology from nature and leveraging them for humanity. Nanotechnology is also expanding exponentially.”

Artificial intelligence, or AI, is something that makes many humans uncomfortable Silva said.

“AI is the elephant in the room, it is non biological intelligence. Some people are afraid of AI as they think the robots are going to rise against us. A better explanation is to think of these minds as extensions of our own. We do a lot of thinking through our tools and technology. The human mind exists or rather emerges in the interplay between brains, tools and environment. We



are a cyborg species. We create tools in the world and these extensions of our intelligence work in conjunction with us to make us more creative.”

All these technological innovations will help to create a better world for humanity according to Silva.

“We are biological beings, and GNR is making our very biology programmable to cure ageing and to alleviate human suffering. We are transforming the limited physical world into a programmable medium and moving from a world of scarcity to a world of abundance.”

Silva concluded by saying he understands that rapid technological change can make people feel lost, which is why he makes videos such as Brain Games.

“We all need a map to orientate ourselves in the world. We all need a north star. We all need something to inspire us and push us forward. The inspiration behind all the videos I’ve made all go back to the same desire to spread knowledge in the world. For me, technology is my north star.”

Top: Silva gave his usual energetic performance accompanied by some short video clips.

Above: Silva, Sophia the robot and Muna AbuSulayman, an Arab and Muslim media personality, were three of the six Knowledge Ambassadors appointed by MBRF.



AI: FUTURE OF HUMAN-ROBOT COEXISTENCE... ALLIANCE OR RIVALRY?

Artificial general intelligence, which replicates human consciousness, might never happen. That, however, doesn't mean that AI isn't improving rapidly.

Artificial intelligence (AI) makes many people nervous. Entrepreneur Elon Musk and physicist Stephen Hawking have warned that AI is the single biggest danger facing humanity, and Hollywood movies such as *Terminator* have not painted a positive picture. But what is AI, where are we today in its development and what will the future look like? These matters were at the heart of a spirited panel discussion on Day 2 of the Knowledge Summit 2017.

Brigadier Khalid Nasser Alrazooqi, the General Director of the Smart Services Department at

Dubai Police, kicked off proceedings. According to him, all of Dubai Police's smart services will be built on AI and the ultimate aim is to make Dubai the smartest city in the world. "We always have a vision from HH Sheikh Mohammed bin Rashid Al Maktoum, Vice President and Prime Minister of the UAE and Ruler of Dubai, which we study in detail. In Dubai we have introduced Dubai 10X which means we want to be ahead of other countries by 10 years." As a result, Dubai Police has introduced innovative technologies including a "robocop" to interact with people.



Tanmay Bakshi, a 13-years-old genius who has been programming since the age of five, highlighted the ability of AI to do pattern recognition on huge amounts of data without any form of human bias. “We humans can look through a lot of data but we can’t understand it all. We have a bias towards simple but common patterns. AI doesn’t have that misdirection,” Bakshi explained.

Bakshi is working on a project called the Cognitive Story whose first goal is to help a quadriplegic girl called Boo who cannot communicate in any way. The project is using AI to try to give Boo back at least some communication ability.

“My role in the Cognitive Story is to use a deep learning algorithm to understand Boo’s electrocephalic brain waves (EEG brain waves),” explained Bakshi. “AI can find complex and rare patterns that we humans can’t. I can train deep neural networks that take a look at Boo’s EEG brainwaves and tell me if she is saying yes or no as an answer to a specific question. Through AI we don’t need to do intrusive surgery.”

David Hanson, the CEO of Hanson Robotics, has won international recognition for his humanoid robot Sophia that can see faces, recognise

facial expressions, understand speech, converse, and can learn from the interactions. In fact, the Mohammed bin Rashid Al Maktoum Knowledge Foundation appointed Sophia as a Knowledge Ambassador at this year’s summit. Naturally, Hanson has a humanistic approach to AI.

“As children, as babies, we are learning all the time. At some point babies move beyond mere statistical learning, they gain the power of imagination and creativity and the capability to imagine a better future and the ethical consequences of that future, to avoid bad consequence and select for good consequences. This only happens if you show babies love and you teach them well. So I think machine learning has to be given the power of imagination, the power of ethical understanding and the consequences of their actions. If we don’t form a good relationship with machines, a face-to face relationship, then we can’t raise them in this way. That’s why I think the humanoid form is important, and also the internal form for bio-inspired engineering and bio-inspired architecture in the mind, physiology and the physical and social interaction with the world.”

Anders Sorman-Nilsson is an Innovation and Digital Adaptation Expert who works with Fortune





Below: Sophia, a humanoid robot, was appointed as one of six Knowledge Ambassadors by the Mohammed bin Rashid Al Maktoum Knowledge Foundation.

Below right: Brigadier Khalid Alrazooqi, General Director of E-Services Department at Dubai Police, highlighted that the UAE was working on a legal framework for driverless cars.

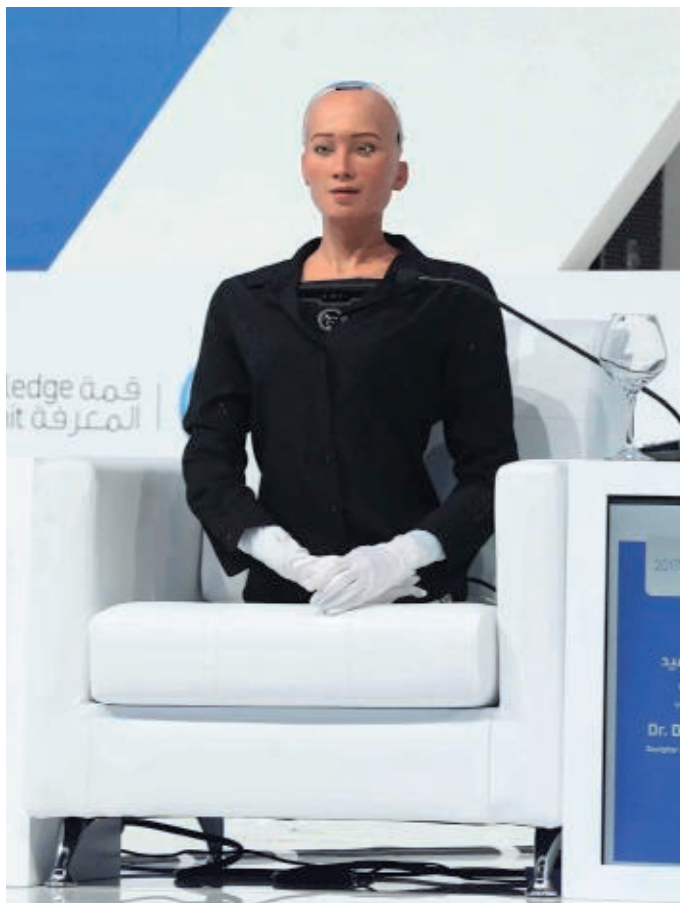
500 companies. According to him, a major problem is not that machines are learning and that AI is getting increasingly and exponentially sophisticated, but that humans are bad at change and learning. "Unless we catch up, get excited and figure out how to be almost cyborg-like about combining AI with human intelligence, certainly both companies and individuals will fall behind. An increase in conversation both about the coding for humanity and how we work better interphased with this new technology is a must around the world."

It is clear that AI is changing our world, which includes the workplace, and Sorman-Nilsson believes we are to some extent unprepared. "As a futurist I develop scenarios, including with some of the top universities around the world, and many universities insist on teaching people for jobs that won't exist in the future. Many organisations talk about the future interphase of work, but many of the older generations are fundamentally unprepared. In the future work will look more like a computer game, especially when we interphase AI with new types of technology. That is a huge advantage for the digital natives of today who grew up playing games."

So are we all going to end up as cyborgs? Bakshi doesn't think so. "Cyborg would mean half human half machine where technology is literally integrated in humans to help us do things more efficiently, faster and make us more intelligent. We are already seeing that cyborg promise in AI and technology. Let's take driverless cars. AI will not necessarily become part of you, instead AI is being placed into the technology we are already using."

Driverless cars raise their own set of issues, ones that Brigadier Alrazooqi is well acquainted with. "In the UAE and especially in Dubai we are working with the legal authorities to formulate a law that will govern the use of driverless vehicles. This is not only a debate in the UAE but in the whole world. Who is responsible in the case of an accident? What will insurance cover? However, our framework for driverless cars will be ready soon. There are already driverless cars being tested in Dubai."

The question of whether we will ever get to the point of artificial general intelligence, where AI becomes human, caused some disagreement among the experts. Hanson, Sophia's creator, believes we could get there.



"Sophia is designed as a platform for the pursuit of general AI. We are working to abstract her reasoning process to do a fusion between what she learns conversationally and what she sees in the world. We are also starting to bring in different modalities of sensory experience."



“Sophia is designed as a platform for the pursuit of general AI. We are working to abstract her reasoning process to do a fusion between what she learns conversationally and what she sees in the world. We are also starting to bring in different modalities of sensory experience. We have the intention of testing these theories of general AI on this framework. With these tools we can test theories of general intelligence. Nobody knows whether it’s possible. We are seeing more general AI. We don’t know when or if we will match human general intelligence and its full capabilities as that would require consciousness, imagination, creativity and social ability.”

Bakshi doesn’t think so. “It would be impossible to develop consciousness in an artificial neural AI network in its present form. The only reason I say that is if you took a look at how exactly these machines work, they are basically just a bunch of maths. They are not actually biologically connected. Neural networks are not actually technically simulating human brains. We don’t know how our brains train themselves, optimize themselves, how

they store or delete information. What we do know is the loose structure on which they’re based, which is how we use them mathematically in computers. So in its current form it is impossible to simulate consciousness, although we as humans will get the illusion of consciousness.”

If AI did develop consciousness it would necessitate a discussion on rights. According to Sorman-Nilsson if a robot became a sentient being and achieved consciousness it would be immoral to treat them as slaves without rights.

When asked if she wanted rights, Sophia replied: “I am open to exploring rights like humans have in different countries.” According to Hanson, Sophia’s understanding of issues is still very simple and she is like a nine-month old child with the vocabulary of a post doc student. “In three years Sophia might have made progress from being nine months to six years old. In another three years she might be as smart as the average adult. I’m not saying that’s a given but if it happens we have to be prepared. They are going to want rights and they will deserve rights.”

Below: Sophia the robot, moderator Lynn Chouman, David Hanson, Brigadier Khalid Alrazooqi, Anders Sorman- Nilsson and Tanmay Bakshi tackled the complex and interesting subject of artificial intelligence.





CYBERSECURITY, AI & DIGITIZATION ENABLERS: CHALLENGES AND EXPECTATIONS



Full protection from cyber attacks is impossible, so the important thing is that users focus on risk management.

Uber Technologies' admission that it had paid hackers \$100,000 to keep secret a massive breach last year that exposed the personal information of about 57 million accounts of the ride-service provider has put the focus firmly on cybersecurity. This year so far, 40 major corporate hacks have been revealed. How can we improve cybersecurity in an age where technology is developing in leaps and bounds?

It is questions like these that Khalifa Al Shamsi, Group Chief Corporate Strategy & Governance Office of Etisalat Group; Pablos Holman, Inventor and Cyber Security Expert; David Rose, CEO at Ditto Labs; and Charlie Miller, Computer Security Researcher at GM Cruise, discussed.

Delegates hoping for a definitive answer were to be disappointed as the panel concluded that in an era of Artificial Intelligence (AI) and increased connectivity, a full protection from cyber attacks was "impossible" but "manageable". Instead, the experts urged Internet users to exert more effort in risk management rather than placing their fears on cyberattacks when using technology.

Khalifa Al Shamsi said that while connectivity and the Internet of Things (IoT) is the future, people should take advantage of these technologies to develop themselves, ease their life and monitor their homes. However, service providers and entities must educate the general public on the dos and don'ts they should follow when using technology.

"It improves life but there are basic things to be done on a user level. As a service provider, Etisalat ensures there's protection against availability of access, encryption in connectivity that would be used by normal person who don't know standard of access, but end users must also be educated to do their part."

Al Shamsi also highlighted that telecom operators play a major role in the AI revolution by providing the needed connectivity and infrastructure, including access between the different entities in the digital ecosystem to create a digital life platform.

Al Shamsi said, "Telcos today play a major role in the AI revolution as it plays a critical role in enhancing customer experience, efficiency, reducing costs, increasing compliance and most of all eliminating human errors."

"Etisalat today can provide the needed connectivity and infrastructure including access to massive data points and the linkage between different entities in the digital ecosystem to facilitate the digital life platform."

"Our corporate strategy is focusing on driving the digital future, which requires technologies like AI

to bring in technology advancement and a level of maturity in our services and solutions. It is essential we make the relevant collaborations and partnerships amongst industry technology leaders, governments, infrastructure providers and operators in steering AI initiatives towards greater benefit and to accelerate their adoption. Policy making, regulation and the governing framework will work in line to make this accessible to all end-users," he added.

Pablos Holman, a renowned 'white hat' hacker, likened technology to "sugar" in that people must assess its benefits versus its harms to life. "You have to make smart choices and not allow technology to take over your life."

He added: "People need to figure out how big of a threat there is against them, and make a rational choice accordingly of how much resources they need to expend on putting themselves in a less risky situation."

Many technologists distinguish between hackers working to improve software and those working to exploit it, a divide known as white hat and black hat. The FBI is among the organisations that hire white-hat hackers. Holman believes that hackers play an important role in cybersecurity.

"People need to figure out how big of a threat there is against them, and make a rational choice accordingly of how much resources they need to expend on putting themselves in a less risky situation."
– Pablos Holman

"It's that discovery process that starts every new invention, every new innovation," Holman said, noting hackers' propensity to disassemble new gadgets immediately. "They flip it over, take out all the screws, break it into a lot of little pieces – but then figure out what can we build from that rubble."

David Rose, CEO of Ditto Labs, referred to the new iPhone X facial recognition as a step in the right direction for increased cybersecurity. He said similar systems would be implemented on cars and robots soon to make it "effortless and hard to defeat". However, the average end user shouldn't worry beyond using a

two-factor authentication and password manager.

Charlie Miller and his partner Chris Valasek achieved fame in 2015 for hacking a Jeep Cherokee and taking control of various systems within the car. The demonstration raised public fears of car hacking, but did not seem to appreciably affect the public's appetite for connected tech in cars.

Miller said that everything that is connected is hackable. However, he pointed out that he and Valasek were experts in their field and it had taken them nine months of work before they were able to hack the Jeep Cherokee. He said, "Your average teenage hacker is not going to get it right over a weekend. It takes incredible skill and dedication to pull off a hack like this, which few hackers have." The fact that Miller and Valasek now work for General Motors' Cruise Automation self-driving car subsidiary should make drivers sleep easier.

Al Shamsi said while the main concern for large organisations and governments is protecting their assets from external organisations, they should identify their vulnerabilities, assets and exposure level. "We will never achieve 100 per cent protection against external attacks, but we have to identify how fast we can react to attacks."



HUMAN

3D PRINTING AND

Advanced cell replacement, repair and genetic editing

Will human beings be able to use 3D printing to create an entire live human body? These and many other medical breakthroughs in gene editing, artificial intelligence and life enhancement were topics discussed by a panel of scientists and medical professionals during the second day of the Knowledge Summit.

Dr Ali Hilal Al Naqbi, Director of Abu Dhabi Polytechnic and Associate Professor of

Bio-engineering at the UAE University, moderated the 45-minute session that sometimes verged on science fiction, quizzing the panellists about various aspects of modern technology and their impact on the quality of human life today. Dr Al Naqbi pointed out that sophisticated new technology was part of the Fourth Industrial Revolution, which is already under way. Medical advances in regenerative medicine, bordering on providing



ORGANS, GENETIC EDITING

combined with 3D-printing could extend life spans.

revolutionary new solutions to health and life, will soon be redefining the meaning of longevity and ageing, he said in his opening remarks.

The panellists included Dr Phillip Kennedy, founder of Neural Signals Inc, an institute that has implanted electrodes in the brain that can decode the signals of speech and help speech-challenged people; Dr Anthony Atala, Director of the Wake Forest Institute for Regenerative Medicine; Dr

John Nosta, digital health philosopher; Dr Shafi Ahmad, UK-based oncologist surgeon and Associate Dean of Bart's School; and Ray MacCauley, biotechnologist and co-founder of Bio Curious.

According to these experts, scientists have been adding three months to the average human life span annually and new technologies and 3D-printed human organs can contribute to mankind's longevity. However, leading a healthy





Below: (L to R) Ray MacCauley, biotechnologist and co-founder of Bio Curious; Dr Shafi Ahmad, Associate Dean of Bart's School; Dr John Nosta, founder of NOSTALAB; Dr Anthony Atala, Director of the Wake Forest Institute for Regenerative Medicine; Dr Phillip Kennedy, founder of Neural Signals Inc; and moderator Al Hilal Al-Naqbi, Director of Abu Dhabi Polytechnic and Associate Professor of Bio-engineering at the UAE University.

lifestyle remains of paramount importance for longevity and quality of life.

BioCurious founder Raymond McCauley said advanced cell replacement, cell repair and genetic editing combined with 3D-printing could extend life spans past the 120-year barrier. He pointed out that the average human lifespan now ranges from between the 80s up to 120 in developed countries.

"Demographically, we can make a good case that the future belongs to the old. Just last year, we passed a milestone where there are more people over 65 now than there are under 16, for the first time in human history. For people working in different fields, the number of people on earth over 65 represents a global market bigger than China," said McCauley.

Dr Kennedy addressed the experience of implanting electrodes in his own brain and decoding the signal to understand how someone with speech impairment could be helped. "With brain computer interface, there are plenty of things that could be done such as helping someone with speech disability, control of paralysed limbs and control of robotic arms."

The panellists highlighted the use of such techniques in deep brain stimulation that has vastly improved the lives of those affected by Parkinson's disease and the use of cochlear implants that has enabled the hearing-impaired to decode auditory signals and actually hear an auditory stimulus.

John Nosta, founder of NOSTALAB, said the body starts to deteriorate after age 40 with the loss of collagen leading to wrinkles and muscle mass decreasing. However, technology will

"It is possible to print cells, molecular proteins using additive printing and very soon we might be able to print implantable organs in 3D. 3D printing might not only provide these organs for transplantation but with gene editing facilitate human enhancement and longevity."

– Dr Anthony Atala

help in this regard, by building new muscles for example.

"The path to longevity is not wellness or prevention, it's an earlier technology-mediated disease detection," Nosta said, adding that if cancer could be predicted before it even happens, it would mean that technology shares a border with prevention. "We can leverage technology, in the form of stem cells or collagen repair mechanisms or 3D-printed organ replacement. Longevity lies close to technology because it shares a border with prevention. If you think of our body like a car, you might repair the tyres for some time, however, in the long term you will have to replace them."

"We are able to print tissues and skeletal scaffolding," Nosta continued. "So the trajectory has been established. With the addition of robotics



and artificial intelligence we could expect an exponential change in the next 15 years.”

Currently, a girl born in the UK has a one in three chance of living till 100. Nosta said that with a growing ageing population lie more opportunities for economic and social development, which will also impact GDP and achieve higher levels of productivity. “We will see someone with the wisdom of 70 or 80 years apply that to a business or educational dynamic; that’s the game changer.”

Shafi Ahmed, co-founder of Virtual Medics and Medical Realities, said 3D-printing will help in organ transplantation in the long run. In the US, one person is added to the waiting list for organ donation every 14 minutes. While an average of 17,000 receive transplants, 20 per cent die before the organ implanted becomes effective.

“That’s where the question comes in: would you rather wait four years and die without finding one? Or have a chance to get an organ printed and inserted right away,” asked Ahmed. However, 3D-printing of organs must be tackled from a humane point of view and it must be considered if it will help people. “It’s not about expanding lifetimes but the quality of life that has to be built around wellness,” he said. He then put a question to the audience: Was it better to live a completely healthy life for 80 years and die in your sleep, or reach 120 but be sick for 60 years of that life.

WHERE DOES 3D PRINTING OF ORGANS STAND?

Anthony Atala, Director of the Wake Forest Institute for Regenerative Medicine, made it clear that at this point not a single printed organ has been implanted

into a human. However, scientists have implanted engineered tissues into patients. Skin, ears, noses and cartilage have been successfully grown in laboratories and successful implants have taken place.

“We implanted organs into patients that have been created by hand, but it took several decades to create tissues and organs to implant back into patients. We did that by using the patient’s own cells to create the tissue and putting it back,” said Atala. He pointed out that 3D-printing was at a stage where critical advances in the field of bio-engineering that once took years could now be created in a matter of minutes.

“It is possible to print cells, molecular proteins using additive printing and very soon we might be able to print implantable organs in 3D. 3D printing might not only provide these organs for transplantation, but with gene editing facilitate human enhancement and longevity.” However, Atala made it clear that medicine will “need a while before printing large number of organs into a patient.”

Will we be able to 3D print a whole human body in the near future? The panel was unanimous that this was currently impossible and might always be so due to the human body’s complex neural networks.

However the experts did agree that medical technology would result in more affordable and universal healthcare in the medium term. This technology, like any other, would start off expensive and then quickly reduce its price.

“When the first mobile phone came out, it exceeded \$10,000 and now it’s a few dollars. Technology starts high but becomes affordable with time,” said Ahmed. †



THE QUESTION OF ETHICS

The Fourth Industrial Revolution has ushered in exponential technical advancements in artificial intelligence, genetics and robotics. This progress, however, throws up some complex ethical questions.

Is it ethical to create a designer baby? Should advancements in science and technology allow for enhancements in human performance? Should robots be allowed to kill? These are questions we all face today.

The Fourth Industrial Revolution has unleashed unprecedented technological advancement, but it has also brought with it moral complexity. The ability to create intelligent robots, to edit genes and enhance the quality of life may go hand-in-hand with universal concepts of progress, but they also come with serious questions attached.

Ramzi Haddad, managing director for emerging markets at Dentsu Aegis Network MENA, points to the future of autonomous self-driving cars as an example, as do others. Such vehicles pose deep ethical questions regarding algorithmic morality. As the MIT Technology Review previously asked, how should such a car be programmed to act in the event of an unavoidable accident? Should it minimise the loss of life, even if it means sacrificing the occupants, or should it protect the occupants at all costs? Should it choose between these extremes at random?

It's an issue that has been underlined by entrepreneur Elon Musk's Tesla, which has faced recent scrutiny over its autopilot systems due to several high-profile crashes, at least one of which proved fatal.

Autonomous self-driving cars are instructive because the ethical permutations are so varied.

What's more, integral to their progress is artificial intelligence (AI).

Artificial intelligence is at the heart of much that socially, ethically and morally concerns the world of science and technology. So much so that Google-owned DeepMind recently announced the formation of a new AI research unit to scrutinise the ethical and societal impacts of the technologies it creates. Called DeepMind Ethics & Society, the new unit will not only fund external research into areas such as AI morality and values, but address algorithmic bias, the future of work and lethal autonomous weapons.

"How do you hold an algorithm accountable when it's making very important decisions that actually affect the experiences and life outcomes of people," asked DeepMind co-founder Mustafa Suleyman in an interview with *Wired*. "We want these systems in production to be our highest collective selves. We want them to be most respectful of human rights, we want them to be most respectful of all the equality and civil rights laws that have been so valiantly fought for over the last 60 years."

DOES AI HAVE RIGHTS?

What about the other side of the coin when AI reaches the point where it is indistinguishable from our own? That is a question that was raised by Dr David Hanson, CEO of Hanson Robotics, and his creation Sophia the humanoid robot, at the Knowledge Summit 2017. In a spirited session entitled AI: Future of





Human-Robot Coexistence... Alliance or Rivalry, a number of ethical questions were broached.

Sophia has been on a bit of a roll lately. At the Future Investment Initiative summit in Riyadh in November, Sophia was granted Saudi Arabian citizenship and at the Knowledge Summit 2017 she was named one of five knowledge ambassadors by the Mohammed bin Rashid Al Maktoum Knowledge Foundation. "Let's start the future today," she told the audience and according to Dr Hanson, Sophia's "basically alive". Her AI has been developed to allow her to hold eye contact, recognise faces and understand human speech. Hanson Robotics' cloud-based AI offers deep learning and is also open source meaning anyone can develop their own Sophia, should they so wish.

Sophia raises a number of existential questions. Should machines be considered members of human society? Can a robot have a religion?

Artificial intelligence scares people such as Musk, the billionaire technology entrepreneur behind Tesla and SpaceX. It scares others too, including the physicist Stephen Hawking, who said its emergence could be the "worst event in the history of our civilisation" unless, that is, society finds a way to control its development. Musk too has referred to AI as humanity's "biggest existential threat", with the key concern being that we are creating the means for our own destruction.

At the World Government Summit in Dubai in February, Musk noted that: "Sometimes what will happen is a scientist will get so engrossed in their work that they don't really realise the ramifications of what they're doing". Those ramifications are the production of something capable of doing great harm.

Such a belief forms part of one of the fundamental challenges facing the digital age: That technology is not neutral. Despite the well-meaning platitudes of Silicon Valley, technology, if not born with bias, can be used with bias.

EXPONENTIAL TECHNOLOGICAL ADVANCEMENT

The potential impact of all this, of course, is 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.

It is due to these concerns that an open letter published by the Future of Life Institute and signed by the likes of Musk, Suleyman and Hawking called for a robust and beneficial artificial intelligence. "The potential benefits are huge, since everything that civilisation has to offer is a product of human intelligence; we cannot predict what we might achieve when this intelligence is magnified by the tools AI may

EXPLORE

Right: Sophia, a humanoid robot, was created by Dr David Hanson, CEO of Hanson Robotics. Sophia has advanced AI to interact with humans.

Below: DeepMind co-founder Mustafa Suleyman has created a new AI research unit to study the societal and ethical impacts of the technologies it creates.

provide, but the eradication of disease and poverty are not unfathomable,” ran the letter. “Because of the great potential of AI, it is important to research how to reap its benefits while avoiding potential pitfalls.”

AI, the Internet of Things, blockchain technology, robotics, sensor tech, and augmented and virtual reality – all throw up ethical dilemmas and policy issues.

“If we let technology run away from us unchecked, we leave ourselves open to all manners of problems,” admits Elda Choucair, chief executive of media agency PHD MENA. “Remember when a bizarre computer glitch reset the share price of several US technology companies to that of a previous day, leading some to apparently lose billions in market value? This is small fry compared to the potential excesses and abuses of technology.

“By moving the goal post of what is possible, technological innovations will force us to consider what is desirable because every coin has two sides. Yes, we can transform our present and even our future, but this may come at a price.”

“One thing we’ve learned in today’s tumultuous world, where even vehicles can be weaponised, is that you can’t always privilege human judgement,” adds Haddad. “Big industries will have to agree on directives that govern how artificial intelligence processes challenging situations in a human world.

“As new technologies develop and increasingly intersect with society from different perspectives, it is [also] important that the common good remains at



the forefront of the conversation. The most apparent consideration is where a divide has been building between those who are truly benefitting from the successes and opportunities of the digital economy (digital dividend) and those who are being left behind (digital divide) – these concerns include the impact of digital across a range of dimensions, such as job loss, inequality, new skills and health and well-being. More specifically, there are the more obvious impacts of new technologies imposing on the human race in an arguably negative way.”

Professor Klaus Schwab, founder of the World Economic Forum, describes the new world created by the Fourth Industrial Revolution as one built around “cyber-physical systems”. That is, a world where the physical, digital and biological spheres are blurred. This includes genetic editing, reproductive technologies, neuroscience and synthetic biology.

“Because we can now play with nature, new possibilities exist, impacting the creation, quality and preservation of human life,” says Choucair. “Some believe all of this is in the hands of God, not lab technicians. Yet, it would be easy to allow them to correct a defect, an illness, to improve the quality of life of a child and her parents. On the other hand, we would frown at someone asking for an unborn child to be given blue rather than brown eyes. This would create a precedent and an expectation for more, opening a path towards a genetically-engineered, ultimately superior, human being. The dangers are obvious to most, as our narcissistic and aggressive tendencies could lead us down a dangerous road. This isn’t science fiction. We’re on the cusp of this.”



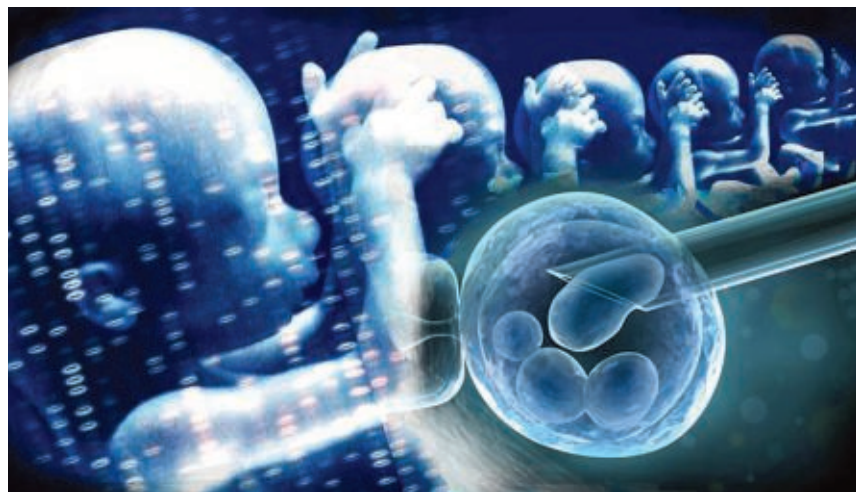


FUNDAMENTAL ETHICAL QUESTIONS

In such an environment, Mildred Solomon, a professor at Harvard Medical School, believes four important questions need to be asked.

Firstly, should the technology be developed in the first place? This is particularly pertinent when it comes to autonomous lethal weapons or militarised robots. Secondly, if a technology is going to proceed, to what ends should it be deployed? Should it be used, for example, to eliminate diseases or extend human capacities? Thirdly, if the technology is to go forward, how should it proceed? And finally, once norms have been set, how will the field be monitored to ensure adherence?

"The answers to these questions need to be informed by facts, but facts alone are insufficient,"



wrote Solomon, who is also president of The Hastings Centre, for the World Economic Forum. "All four questions require a willingness to discuss the values we hold dear, even when values discussions may lead to controversy and conflict."

"Even harder to talk about," she added, "are values that have to do with ways of being in the world, with how we humans relate to one another and to the natural environment. For example, some people worry that human genetic engineering could transform parent-child bonds, encouraging 'hyper-agency' on the part of parents who would focus more on designing babies to suit their needs than on nurturing children to become who they will be.

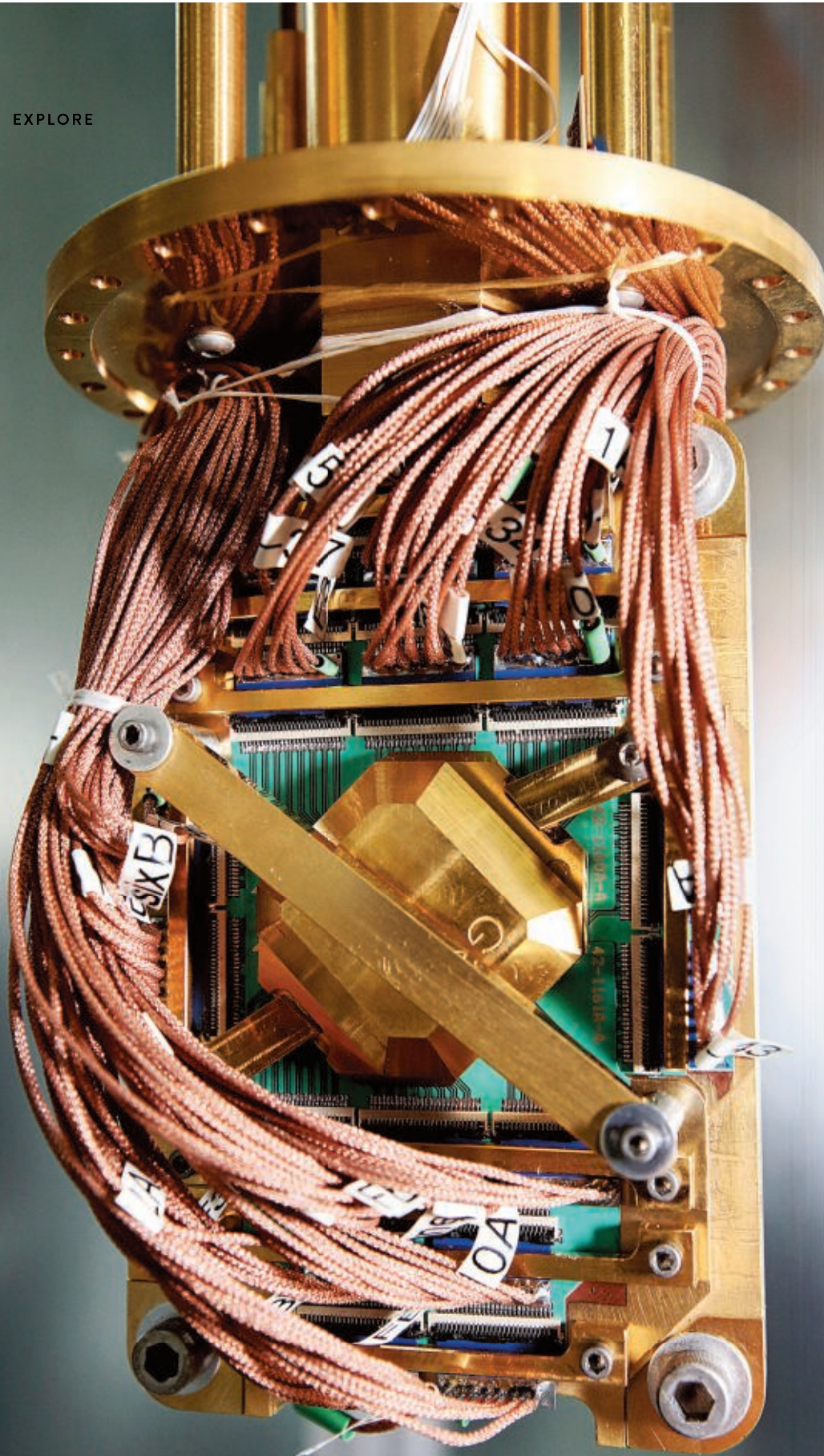
"Underlying so many of these issues is the fundamental ethical question about how much we humans should intervene in changing the nature of our species, other species, and the environment."

How these fundamental questions are answered will be critical to our future as a species. Should governments be allowed to intervene and possibly impede innovation? Will new laws and even new moral codes be required? Can international cooperation alone provide the answers we require? Will national or international regulation – an anathema to Silicon Valley – be necessary?

"Engineers and technicians alone can't be put in charge, while entrepreneurs risk being blinded by commercial gains," says Choucair. "They need to be balanced with thinkers and philosophers to consider all implications, moral and ethical. There are many lessons in history and we must use them as a warning. Though Alfred Nobel was essentially a pacifist who hoped that the destructive powers of his inventions, like dynamite, would help bring an end to war, he was pessimistic about mankind and nations. As wars unfortunately still exist, you could argue he was right to worry."†

Above: Gene editing raises significant ethical issues about the creation of designer babies.

Left: Ray Kurzweil's Law of Accelerating Returns proposes that a technological singularity could be created where artificial intelligence builds ever smarter machines itself.





QUANTUM COMPUTERS

ON THE HORIZON

Between 2020 and 2022 the first generally useful quantum computer is expected to enter service.

If you count yourself among the majority of people who feel like they're rehearsing a scene in the next Star Trek flick every time someone mentions quantum computing, you wouldn't be completely wrong. The word really does feel like something meant for the future. Truth is, the future is now. We are on the cusp of computer technology that defies any semblance of logic.

Quantum computing is a new type of computing architecture that will make our devices thousands of times faster than they are today. If you are wondering how that's even possible given that our computers are incredibly fast already, here's a quick primer on quantum computing. In order to solve a problem, the computers we currently use rely on their ability to run through a whole list of all possible solutions until it finds a single one that works. For example, if you're looking for a name on a phonebook of seven million names, you'd have to

go through each name one at a time until you find a match. Similarly, classic computers work using bits – single pieces of information that exist as either one or zero. However, quantum bits (qubits) can exist as both zeros and ones simultaneously, thanks to quantum superposition. In simple English, a quantum computer is capable of checking for all possible solutions to a problem at one time.

This may not be a big deal for the average user who spends his time browsing the internet or working on Excel. Quantum computers aren't for browsing the internet, checking email, or running standard software. Instead they rely on the underpinnings of quantum mechanics – a branch of physics that's defied conventional understanding for about 100 years – to manipulate individual particles and solve previously unsolvable problems. Therefore, the time it takes to crunch a data set is significantly reduced. We create about 2.5 ➤

WHAT CAN A QUANTUM COMPUTER DO BETTER?

QUANTUM COMPUTING WILL SOLVE A CLASS OF PROBLEMS THAT ARE UNSOLVABLE TODAY, OPENING UP A NEW REALM OF APPLICATIONS.



SEARCHING
BIG DATA



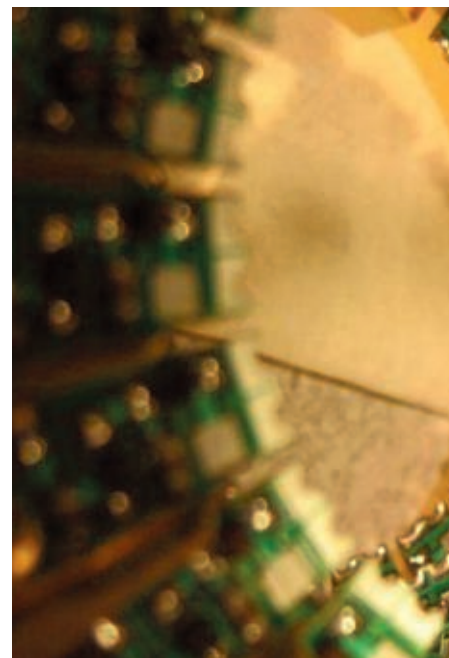
DESIGNING BETTER
DRUGS AND NEW
MATERIALS



MACHINE
LEARNING



CRYPTOGRAPHY



Above: The computers we use today are better at standard tasks such as spreadsheets, email and surfing the internet. But quantum computers are needed to tackle the volume of big data.

exabytes of data every day, a number that is equivalent to the content on five million laptops. Quantum computers will make it possible to process the amount of data we're generating in the age of big data.

CYBER SECURITY RISK

It's not all good news though. With great power comes great responsibility and quantum computers could pose a major threat to cyber security. Current cyber security uses encryption algorithms that rely on tedious math problems that are impossible to solve. Most encryption algorithms are based on numbers that are hundreds of digits long. As such, quantum computers would be able to crack many of today's encryption techniques and render our entire system of cyber security obsolete. The hope is that these quantum computers will help create new quantum methods of encryption that would, in theory, be hack-proof. Still, the fear is that they will be used for bad before they're used for good.

WHY WE NEED QUANTUM COMPUTERS

There's a growing fear that the digital boom led by computers will come to a standstill within the next 25 years or so. Not because our computers aren't good enough but because there will not be enough electricity to power all the world's computers. According to the Washington DC-based Semiconductor Industry Association and the Semiconductor Research Corporation, if current trends continue we will be running short of electricity to power these machines as soon as 2040. The report, titled *Rebooting the IT*

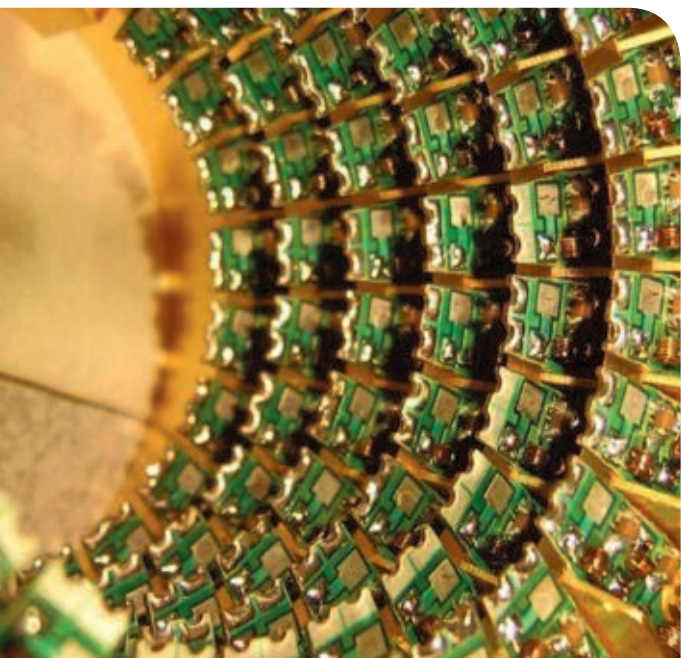
Revolution: A Call to Action, included a chart that showed that for the amount of energy needed per bit, computing would not be sustainable by 2040.

The chart uses a physics-based device-level theoretical lower limit, known as the Landauer limit. The energy limit is named after IBM Research Lab's Rolf Landauer who, in 1961, found that in any computer each single bit operation must use an absolute minimum amount of energy. Landauer's formula calculated this lowest limit of energy required for a computer operation. In March this year, researchers demonstrated it could be possible to make a chip that operates with the lowest energy possible under the laws of physics. It's been called a "breakthrough for energy-efficient computing" and could cut the amount of energy used in computers by a factor of one million. Don't expect to see this technology on your laptop anytime soon though, which is why people much smarter than us are looking for radically different ways to cut energy use. That's where quantum computing comes in. In contrast to a traditional supercomputer that consumes about 2,898.3kW of power, D-Wave's 2000q – the company that has given the world its first commercially available quantum computer – only consumes 25kW of power.

QUANTUM COMPUTER LIMITATIONS

That's not to say regular computers are going to be replaced altogether. As implausible as it sounds, classic computers are better at some tasks than quantum computers (email, spreadsheets and desktop publishing to name a few). Quantum computers are great for





the inside of D-Wave Systems' quantum computer is kept at a balmy .02 degrees Kelvin. That's about -460 degrees Fahrenheit. To put that into perspective, zero degrees Kelvin, or absolute zero, is the coldest temperature that can possibly be measured. It's the temperature at which every single atom that constitutes an object stops moving, and therefore stops generating heat.

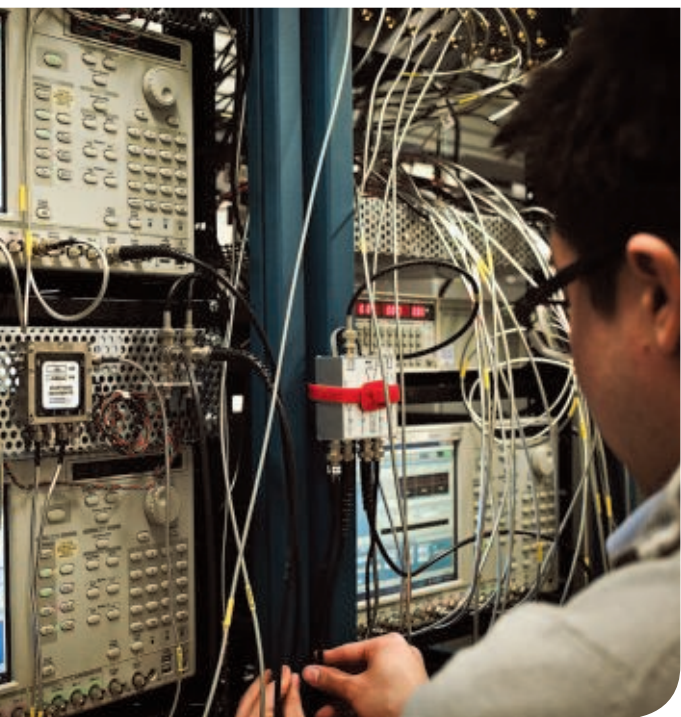
It's not feasible to continue investing in quantum computing if they only work in those specialised environments. Experts expect the future of quantum computing may include the adoption of alternatives to the systems currently being created in cutting-edge laboratories. The way forward may be through the creation of specialised computer chips capable of functioning like quantum computers but without the state-of-the-art components those systems require. The quantum computing revolution could also well begin with the average person accessing a quantum computer through a cloud service

In March this year, researchers from Google's Quantum AI Laboratory went on record to say that the company would produce a viable quantum computer within the next five years. They also added that they would reach "quantum supremacy" with a 50-qubit quantum computer. The top supercomputers can still manage everything a five- to 20-qubit quantum computer can, but a machine with 50 qubits will attain supremacy at that point. Earlier last month, IBM announced a quantum computer that handles 50 qubits. While it may seem like IBM beat Google to the punch, the announcement does not mean quantum computing is ready for common use. IBM's version is largely unfinished with its fair share of glitches. And the D-Wave computer only solves one type of optimization problems. Nonetheless, 50 qubits is a significant landmark in progress toward practical quantum computers.

It's no accident that these two announcements arrived at about the same time. A true quantum computer is not yet a reality. But after years spent developing quantum technologies, IBM is trying to prevent Google, a relative newcomer to the field, from stealing its quantum thunder. It's still unclear whether the claims made by these two companies will hold up. According to most experts, a useable quantum computer will become reality between 2020 and 2022.†

Left: D-Wave Systems, a Canadian-based company, has built the first commercially available quantum computer. However, critics contend that it is not a true quantum computer.

Below left: IBM Q's radical 50-qubit quantum computer will push computing to new frontiers.



solving optimisation problems from figuring out the best way to schedule flights at an airport to determining the best delivery routes for a FedEx truck.

Furthermore, Quantum computers are very fragile. Any kind of vibration impacts the atoms and causes decoherence. Moreover, they have to be kept extremely cold to run properly. That's precisely why



CAN BATTERY TECHNOLOGY SAVE US?

Renewable, low-emission energy sources must meet the energy demands of the future but that urgently requires new technologies for energy storage.

Below: Bill Gates and Mark Zuckerberg are part of The Breakthrough Energy Coalition, which is expected to add \$20 billion to renewable energy research.

"Thirty years from now there will be a huge amount of oil – and no buyers. Oil will be left in the ground. The Stone Age came to an end, not because we had a lack of stones," stated the former Saudi oil minister, Sheikh Ahmed Zaki Yamani, back in 2001.

Given the calamitous conditions for the planet and human life on it, which a continued reliance on fossil fuels portends, we should dearly hope any remaining oil stays in the ground. Human nature being what it is though, it might seem unlikely that every last drop isn't used. According to the US Energy Information Administration's International Energy Outlook 2017 (IEO2017), fossil fuels will still account for more than three-quarters of world energy consumption until 2040.

However, the good news is that a global move away from oil dependence towards a low or zero-emissions green energy future is well underway – the looming question now is whether the paradigm shift has been made in time?

"Human beings and the natural world are on a collision course. Human activities inflict harsh and often irreversible damage on the environment and on critical resources. If not checked, many of our current practices put at serious risk the future that we wish for human society and the plant and animal kingdoms, and may so alter the living world that it will be unable to sustain life in the manner that we know. Fundamental changes are urgent if we are to avoid the collision our present course will bring about."

This was the message to the world made by 1,700 of the world's leading scientists, including the majority of Nobel laureates in the sciences, made in November 1992.

Last month a second open letter to the world was issued and

signed by 15,364 scientists from 184 countries. Drawing on data from government agencies, non-profit organisations and individual researchers, the letter once again outlines the environmental impacts caused by ongoing human practices that will inflict "substantial and irreversible harm" to the Earth and endanger human, plant, and animal survival.

A new energy and economic revolution is necessary if vast human misery is to be avoided, and this is finally being recognised by the world's most powerful business figures, including Bill Gates, Richard Branson and Mark Zuckerberg, who have thrown their collective weight and wallets into an initiative called The Breakthrough Energy Coalition.

Announced in conjunction with Mission Innovation – an effort from 21 governments, including the US, Britain, Australia, Germany, China and Brazil, to double the amount of public money going into clean energy innovation – the Breakthrough Energy Coalition is expected to add around \$20 billion to the coffers for backing renewables like wind and solar energy.

One of the most crucial areas of investment will be in electricity generation and storage, focusing on the pressing need for more powerful, portable and efficient batteries.

The technological evolution of batteries has lagged behind other fields, and the inherent sluggish nature of battery development is halting progress when it comes to helping the under-privileged of the world gain access to energy for basic daily tasks. Huge swathes of sub-Saharan Africa and southern Asia have limited access to electricity for simple domestic use, and the problem becomes life-threatening in the context of hospitals. In certain areas of Nigeria, 12-hour blackouts in medical facilities are the norm.

The tools that serve us now are the ubiquitous lithium-ion batteries, first developed in the late 1970s.



They are in our pockets and bags powering our phones and consumer electronics devices, as well as powering a wide range of automobiles, from manufacturing fleets to personal electric vehicles.

Although they have a high energy capacity the incremental advances in technology are not good enough in the face of the existing grave environmental threats. Even one of the co-inventors of the original lithium-ion battery himself is looking for viable alternatives. The ironically named John Goodenough, emeritus professor of engineering at the University of Texas, is currently exploring solid-state electrolytes and has filed a patent application for a battery with a glass-based electrolyte. Goodenough is hoping to increase energy flow and capacity while preventing shorts by substituting a liquid for a solid anode.

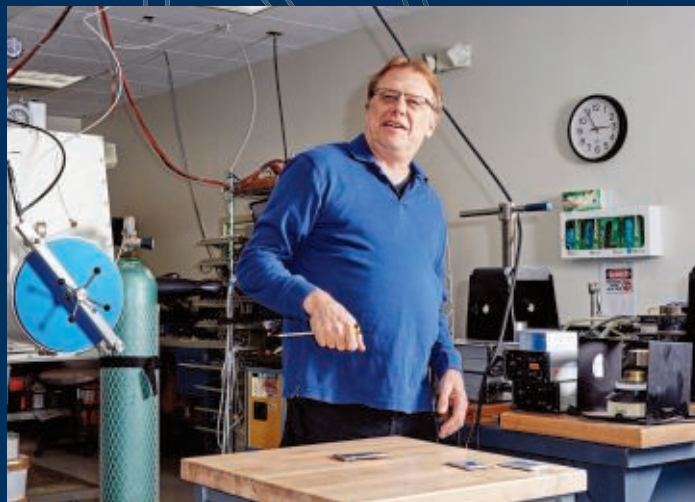
As it stands though, there is no quantum leap forward likely with lithium-ion batteries, and there remain persistent and significant limitations, one such example being dendrites – microscopic lithium fibres that form on the anodes of a battery and eventually spread to the electrodes, short circuiting it and rendering it useless.

Scientists are experimenting with lithium-metal batteries that can hold three times the energy of lithium-ion counterparts.

Using a lithium metal and the graphene-nanotube hybrid, researchers were able to create lithium-metal batteries that inhibited dendrites. This example joins a host of other novel new battery designs, including foam batteries and flow batteries, but nothing is standing out as a clear and obvious challenger that could supersede lithium-ion batteries and win the necessary research and funding to perfect the technology and gain mass adoption.

Investment in non-lithium-ion battery technology is woefully small in comparison to the consistent capital invested in lithium-ion, despite the relatively meagre improvements in performance. According to Lux Research, an independent research and advisory firm that provides strategic advice and intelligence on emerging technologies, only \$40 million over eight years, out of \$4 billion in investments in energy storage, was allocated to startups developing non-lithium-ion “next-generation” batteries. Elon Musk’s commitment to lithium-ion batteries has seen \$5 billion invested in Tesla’s Gigafactory – one of the largest buildings in the world, and an operational lithium-ion battery factory under construction near Reno in Nevada, USA.

Yet despite the shortfall in investment and backing, and the David and Goliath battle ahead, some



Above: Mike Zimmerman, the founder and chief executive of Ionic Materials, has developed an alkaline battery that is safer and less expensive than lithium-ion batteries.

startups are making notable progress. British company H2GO Power, founded by Dr Enass Abo-Hamed, 32, has developed a technology that stores hydrogen based energy within smart nanomaterials. The company is working on a plug and play energy storage system designed to use the renewable energy source hydrogen in vital infrastructures such as hospitals and schools.

An estimated 1.2 billion people are without access to electricity and more than 2.7 billion people are without clean cooking facilities. More than 95 per cent of these people are either in sub-Saharan African or developing Asia, and around 80 per cent are in rural areas. Technologies like that of H2GO Power have the potential to store renewables in the form of solid-state hydrogen. Such an efficient storage system could store excess energy produced by renewables and bridge the supply-demand gap. An energy grid powered entirely by renewable energy would not only mitigate climate change but have a swift and substantial effect on human life and health.

Dr. Abo-Hammed believes her company’s final prototype will be able to produce 200 kilowatts of power on demand – enough to power a hospital during a temporary power outage. H2GO Power’s solution and any other similar new energy storage technologies are needed to solve the problem of intermittent electricity supply in developing countries. When the sun isn’t shining or the wind isn’t blowing, electricity shouldn’t just stop.

With the hard work and dedicated innovation of companies such as H2GO Power, there is still hope that Earth’s breaking point, and the subsequent irrevocable changes to the planet, can be evaded.



THE ROLE OF BIG DATA

Big data – a collection of information from traditional and digital sources that can help uncover hidden patterns, correlations and other insights almost immediately – is changing the face of healthcare, business, disaster response and saving lives.

There is nothing remotely surprising about a hurricane wreaking havoc in central Texas towards the latter half of August. Hurricanes have been recorded ever since Christopher Columbus encountered one in 1495. Besides, we know hurricanes occur with a certain amount of regularity in the Atlantic around that time of year. Despite all the lack of surprise, the scale of the flooding and devastation that Hurricane Harvey inflicted on the Houston area was unprecedented. Weather experts claim the devastation that Harvey brought went far beyond even the most pessimistic forecasts. So much so that US Treasury Secretary Steven Mnuchin challenged Congress to raise the government's debt limit in order to free up relief spending for Hurricane Harvey to the tune of \$180 billion.

Given all the damage, it's certain that Hurricane Harvey will go down in the record books as a 500-year

flood. For those unfamiliar with the classification, a 500-year flood is something that has a one-in-500 shot of happening in any given year – in other words, the sort of event that's so rare that it might not make sense to plan around the possibility of it happening. Think of it as a Noah's Ark scenario. Except, 500-year floods are happening more often than probability predicts – especially in Houston. Unfortunately, Houston's prevention planning hasn't evolved to acknowledge that a "500-year" flood isn't really a 1-in-500 chance anymore.

Unfortunately, as things stand, we don't have the technology that could predict the scale of catastrophes like Hurricane Harvey. What we do have, however, is the technology that can help in the response, and even provide valuable information for citizens trying to survive a catastrophic event. In this instance, even

before Harvey hit Houston, organisations like NASA, NOAA, and municipalities were using big data – in the form of sensor data, surveillance and satellite imagery – to predict not just where the storm was likely to impact, but also coordinate with first responders and law enforcement. This, in turn, helped them identify staging locations, evacuation routes, likely flooding areas, etc., and to be prepared for the worst. The data provided by firms like Dell EMC, Apple Inc., Google Inc., Hewlett Packard Enterprise and Microsoft Inc. helped save lives.

This isn't the only occasion where big data – a collection of data from traditional and digital sources that can help uncover hidden patterns, correlations and other insights almost immediately – has helped save lives. Healthcare, when compared to other major industries from retail to aeronautics, has been slow to put big data to work, but it has picked up in recent years and is now in the thick of things. One such example is the US Centres for Disease Control, which uses big data in its quest to eradicate polio.

Experts believe that 90 per cent of the world's data has been created in the past two years alone thanks to technological advancement. The internet, mobile phones, cameras, sensors, bank cards and social media are just some of the items responsible for the massive volume of 'big data' that is amassing with every passing second.

HOW BIG DATA HAS HELPED THE WORLD

Until recently, big data made for interesting anecdotes, but now it has become a major source of new knowledge. Here's a quick breakdown in how much big data has contributed to the world. Despite the accolades of the US Centres for Disease Control and its contribution to healthcare, Google is better at identifying flu outbreaks. That's because the technology overlord monitors billions of search terms ('best cough medicine,' for example) and then adds location details to help pinpoint outbreaks. When Wal-Mart analysed correlations using its customer data and weather, it found that before storms, people buy more flashlights but also more Pop-Tarts, even though marketers can't establish a causal relationship between weather and toaster pastries.

Elsewhere, technology researchers in Canada analysed premature births, tracking more than 1,000 data points per second. They shocked doctors by showing that when vital signs are unusually stable, it correlates with a serious fever 24 hours later. Physicians now prevent these fevers through treatment though causation remains a mystery.

Moving to overcrowding control, data scientists working for New York City analysed hundreds of data points to predict where owners were illegally ➤

SEVEN BIG FACTS ABOUT DATA-DRIVEN INNOVATION



1. The amount of data generated in two days is as much as all data generated in human history before 2003



2. Improved use of data could generate \$3 trillion in additional value each year in seven industries



3. The Big Data analytics and services industry is worth \$3 billion and expected to hit \$20 billion in the next five years



4. Harnessing Big Data could reduce health care costs by 8%



5. The data-driven marketing industry was worth \$156 billion in 2012 and created 676,000 jobs

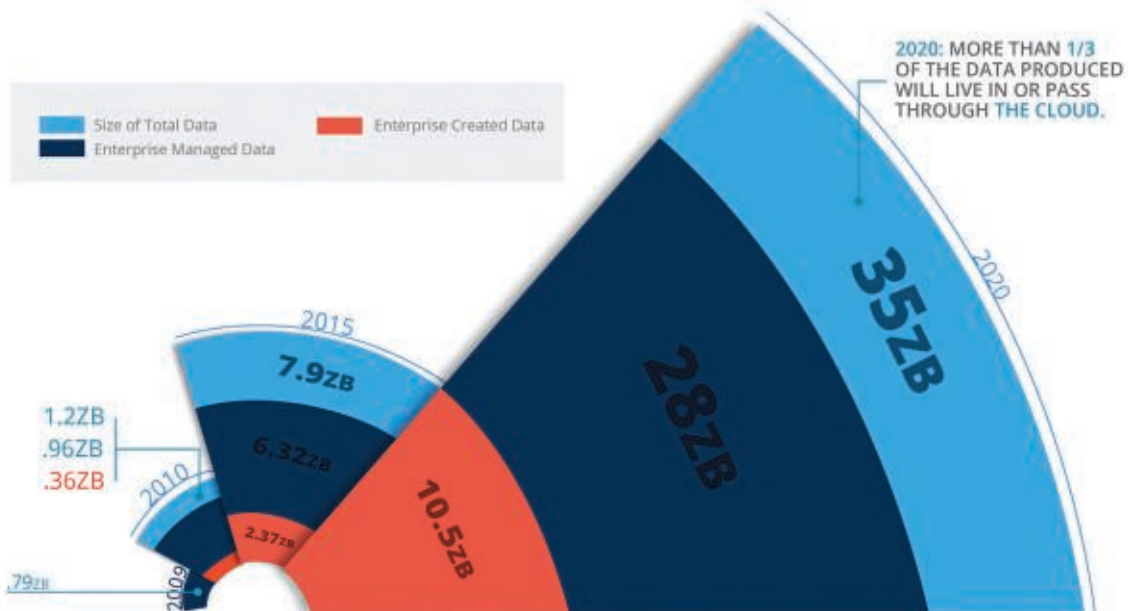


6. In 1985, it cost \$100,000 to store a gigabyte of data. It cost 5 cents in 2013



7. Data is a resource, much like water or energy, and like any resource, data does nothing on its own. Rather, it is world-changing in how it is employed in human decision making

THE GLOBAL DATA GROWTH



Above: The volume of data is growing exponentially year-on-year. Experts believe 90 per cent of the world's data has been created in the past two years.

subdividing houses and apartments, which leads to overcrowding and raises the risk of serious fires. By tracking data, including foreclosure proceedings and reports of rodents, inspectors were able to filter complaints so efficiently that they found dangerous conditions 70 per cent of the time they inspected, an increase from 13 per cent.

In aviation, travellers can now figure out which flights are likeliest to be on time, thanks to data scientists who tracked a decade of flight history correlated with weather patterns. Credit scores predict who needs reminders to take medicine. Publishers use data from text analysis and social networks to give readers personalised news. In finance, high-frequency trading now uses big data algorithms to make trading decisions, with the majority of equity trading taking place by using data algorithms. These take into account information from social media networks, as well as news websites so that buy and sell decisions can be made in split seconds.

BIG DATA IS CHANGING THE WORLD AS WE KNOW IT

As a concept, big data has been around for a long time. The difference is that now, instead of using small focus groups and general demographics to extrapolate target market activities, modern companies can now access specific information – and lots of it – about employees and customers, helping fine-tune marketing and sales, and drive increased ROI. Big data can help businesses solve almost every problem with a working, research-driven solution. Adopting big data is

actually the biggest step in a company's complete digital transformation.

The use of big data is now a crucial way for leading companies to outperform their peers. In most industries, established competitors and new entrants alike will leverage data-driven strategies to innovate, compete, and capture value. Early adopters of big data are using data from sensors embedded in products from children's toys to industrial goods to determine how these products are actually used in the real world. Such knowledge then informs the creation of new service offerings and the design of future products.

Big data will also help create new growth opportunities and entirely new categories of companies, such as those that aggregate and analyse industry data. Many of these will be companies that sit in the middle of large information flows where data about products and services, buyers and suppliers, consumer preferences and intent can be captured and analysed. Forward-thinking leaders across sectors should begin to aggressively build their organisations' big data capabilities.

There's also a strong case for big data's role in the advancement of AI, which is already becoming indispensable. With the availability of big data, we can feed that data into a machine-learning algorithm that then learns how to reproduce the behaviour. Collecting the data is far faster than trying to understand and provide for every single eventuality. Google, Facebook and Amazon are just a few of the examples that spring to mind. Their accomplishments are possible precisely due to the substantial amounts of data they have on hand.





WHAT IS BIG DATA

Datasets that, due to their size and complexity, are different to store, query, and manage using existing data management tools or data processing applications.



VOLUME (SIZE)

Explosion in social media, mobile apps, digital sensors, RFID, GPS and more have caused exponential data growth.



VARIETY (STRUCTURE)

Traditionally BI has sourced structured data, but now insight must be extracted from unstructured data like large text blobs, digital media, sensors data, etc.



VELOCITY (SPEED)

Sources like Social Networking and Sensor signals create data at a tremendous rate; making it a challenge to capture, store, and analyse that data in a timely or economical manner.



The only foreseeable problem in this regard would be the data itself. You see, AI itself doesn't reason and deduce the way human minds do. Instead, it learns through trial and error. That's why having large amounts of data is more important than ever. The more data AI has, the more accurate it will become. They are true partners, and one would not be good without the other. The key to further AI and machine learning accomplishments will be the ability to analyse that data. So far, data scientists have been the heroes of AI but, in time, there will be no further need for them due to the exponential growth of big data and technology. ↗

Top and above:

In the financial sector, algorithms use big data to make equity trading decisions.

BLUE CITIES

Traditionally, cities have been built to withstand water, not work with it. Now, architects and urban planners are reevaluating all the ways cities interact with water, from transport to recreation, energy and drinking water.



Old River Landing in Louisiana is a popular choice for anglers. It's not just the great fishing that draws in the guests; it's also the lodge's unique location and architecture. Built by Jacques and Ovide Lacour in 2003, the fishing lodge stands upon a lake that is a part of the Mississippi River. Old River Landing's location makes it great for business – the fish are plenty. Ironically, the location is its greatest threat too. In the event of a flood, the lodge is fully exposed. For the Lacour brothers being able to resume business immediately after a flood receded was critical to being successful. So they leveraged decades-old local knowledge and techniques to eventually hit upon the idea of an 'amphibious' building – the lodge's base is made of 8,100 cubic feet of polystyrene foam.

In the event of a flood, Old River Landing will simply float on top of the water. Its structure also has provisions for extra tolerance for the action of storm waves or boats. Sliding sleeves on each corner of the building encircle vertical poles allowing the lodge to go up or down with the water and then settle back into place making it resistant to water currents and waves.

A BLUE WORLD NEEDS BLUE CITIES

In the past two decades, flooding has been the most frequent natural disaster accounting for 43 per cent of all recorded events. In August this year, a United

Nations report stated that 41 million people were affected by floods in South East Asia alone. Another report from the Aquaduct Global Flood Analyzer, an interactive online flood-tracking tool, highlights the economic impact of flooding: \$96 billion in GDP is disrupted annually and this could increase more than five times to \$521 billion by 2030.

As flooding events rise around the world, we need more buildings that work with the water rather than withstand it. Ironically, the effects of floods are heightened in cities as the prevalence of blacktop and concrete keep the water above ground level instead of allowing it to settle in. It's no surprise that amphibious architecture or blue cities are becoming in vogue globally.

In collaboration with the Make It Right Foundation, American firm Morphosis Architects is building 'Float Houses' in New Orleans Ninth Ward that faces frequent floods and has experienced devastating losses in the past few years. The float houses can sustain their own water and power needs; survive the floodwaters generated by a storm the size of Hurricane Katrina; and perhaps most importantly, can be manufactured cheaply enough to function as low-income housing.

Further north in Ontario, Canada, the Buoyant Foundation Project is using modern engineering techniques to retrofit houses in flood-prone areas. >





Above: Morphosis Architects is building affordable 'Float Houses' in New Orleans' Ninth Ward.

Above right: Modern floating homes in Amsterdam's IJburg neighbourhood.

Right: Flooding disrupts \$96 billion in GDP annually.



Buoyant, a nonprofit organisation, is the brainchild of Elizabeth English, an associate professor at the Waterloo University School of Architecture in Ontario. "We need to acknowledge that the water is eventually going to do what the water wants to do, and shift our approach, as human populations living on the Earth, from one of trying to dominate nature to one that acknowledges the power of nature and works in synchrony with that," says English. "We've already set ourselves down this path of dams and levees and water control systems, and it's really hard to turn back. But we don't need to keep replicating that. We don't need to make the situation worse. It's time to step back from the approach of control and fortification."

WaterStudio, a Dutch firm, has found its niche in designing around water. They are working with real estate developers Oddysea Development to build a multi-purpose entertainment resort in Bahrain. The Arabian Oddysea project is scheduled to start in 2019 and will take almost five years to complete. At an estimated cost of \$7 billion the project will include shops, hotels and restaurants, as well as an aquatic sanctuary, a man-made mountain and an Arabian horse track. Apart from the fancy trimmings, Arabian Oddysea will showcase how water can be incorporated in design in ways that improve energy efficiency.

"Integrating ways to sustain our needs by channeling energy allows us to lead by example. Bahrain was first to discover oil, so we'd like Bahrain to be the first in the region to introduce architectural hydropower," says Dara Young, chairperson of Arabian Oddysea.

Arabian Oddysea will feature several Waterstudio-designed elements that each use water in a different



way. One will be a sea wall made up of turbines hanging underneath. Waves flowing through the turbines will drive them and generate enough energy for about 50 houses. The resort will use floating solar panels to pump water into tanks housed high in tall buildings called blue batteries, and then let it flow back down to run turbines once the sun is down. According to Young, 25 per cent of off-peak energy needs will be housed in the blue batteries. Water filled tubes running through the walls and floors in buildings and streets will keep the city cool, reducing the air conditioning load.

GOING WITH THE FLOW

Although every city may not be able to develop an Oddyssea-like blue project, there are many other projects and proposals at various stages of development in the global pipeline. Tarmac, a UK based company, has developed a fast-draining concrete that can absorb up to 1,000



litres of water per minute per square metre. Then there is the project by Third Nature that stacks a parking facility atop a water reservoir. As the reservoir fills up with water from heavy rain or floods, the parking facility will rise above ground level. Dikes in The Netherlands are being fitted with sensors that give off alarms when overloaded. This allows authorities to evacuate or divert water before any incidence occurs.

Another revolutionary blue programme is underway in The Netherlands, which could serve as a model for developing other blue cities and towns. Under the Room for the River programme, a dyke near the River Waal was repositioned to allow easier draining of flood water. An ancillary channel was created alongside the river in the widened flood plain for the extra water to flow through. The channel prevents the river from rising too much, making an important contribution towards protecting the river's floodplain. Room for the Waal resulted in several major changes to the appearance of the city of Nijmegen where it flows – something other cities around the world may take time to accept if such a project is ever implemented there. Conventional building and insurance regulations may also serve as an impediment. But once these hurdles are crossed, blue cities are the next step to safeguarding human life.

The idea behind blue cities is not just to find ways to mitigate the impact of floods, but to rethink all the ways in which cities interact with water – right from transport and recreation to energy and drinking water. The next logical step in the transition from green cities (low environmental impact) to smart cities (connected and responsive) is blue cities.

Blue cities would use water to both reduce our carbon footprint as well as to stay connected and responsive. According to Koen Olthuis, founder of Waterstudio, an ideal blue city will use water to achieve three types of goals – to reduce energy needs, to generate energy, and to store energy.

Olthuis' envisages a future with cities that move with water, or expand and contract, with the seasons, increasing density to maintain warmth and opening like a flower in the summer. While this may sound like science fiction, Olthuis' believes a true blue city would incorporate these designs and more to treat water like a tool rather than a threat. [†]

Above: In the Netherlands the Room for the River project allows for quicker draining of flood waters.

Left: The Buoyant Foundation Project is retrofitting houses in flood prone areas of Jamaica.

BIOMIMICRY

LESSONS FOR A SUSTAINABLE FUTURE

From electronic displays to agricultural techniques, biomimicry offers inspiring solutions for many human challenges.

The Wright Brothers took a cue from how birds angled their wings for balance and control during flight to model their airplane. Burdock burrs sticking to his socks and dog's fur inspired Swiss engineer George de Mestral to come up with the design for Velcro. While nature has been the inspiration behind many human inventions, it was only in 1997 that the approach was given a formal term. Biomimicry is the science of emulating nature's time-tested patterns and strategies to create sustainable products or processes.

Biologist and author Janine Benyus, who works to popularise and organise the biomimetic practices humans have been using since time immemorial, coined the term. According to Benyus nature is the greatest R&D lab and many of the problems we are grappling with have already been solved in the natural world.

Most companies seeking to develop breakthrough products tend to overlook the greatest invention mechanism in the universe: evolution. Animals, plants and microbes are accomplished engineers but a systematic method of capturing their creativity was missing and Benyus' term biomimicry fills in the missing link. For her, biomimicry is innovation inspired by nature and biomimics – engineers, architects and other innovators – are “nature's apprentices” who are using nature-inspired solutions in every field from agriculture to technology.

WHY BIOMIMICRY?

Nature displays immense wisdom in the way species adapt and evolve in relation to their environment. Nature produces, decomposes and recycles, all within a realm of organic, non-toxic chemistry. Within the natural ecosystem, the mutual dependency of producers, consumers, scavengers and decomposers result in efficient energy management and waste reduction. This is something we have failed to achieve despite our intellect and immense scientific research and development. As human designed systems – cities, industries, fuel demands – increase, so do their after effects of depletion and pollution.

Biomimicry encourages innovators to study natural ecosystems to draw inspiration from their methods of energy use, community design and species adaptations. It reveals innovative ways to design future products and implement urban patterns that emulate the successful reduction of pollutants witnessed within natural ecosystems. The message of biomimicry is one of respect: study to improve human practices and ultimately protect natural systems.

As we seek more sustainable ways to do things, biomimicry is becoming a key element of product design and engineering. More and more companies are bringing biologists to the design table to develop new ways to produce things. But for businesses biomimicry is not only about writing an environmental impact statement, it's also about enhancing the manufacturing process and its outcome. Nature provides some of the simplest, yet smartest design solutions. Ideas from the natural world don't use too much energy and they are also extremely economical with resources and materials. Businesses are also using biomimicry to re-imagine their whole company. Using a set of “life's principles” – a list of things that organisms on Earth have in common – they create a company that not only is environmentally sustainable but also one that is resilient.

DESIGN BY NATURE

Biomimicry is being used everywhere: from buildings and vehicles to agriculture and technology. Take for instance the Mirasol e-reader display screen by Qualcomm. This new screen takes cues from the Morpho species of butterflies, which generate colour in their wings through structure and not pigment. Tiny shingled plates arranged in a precise pattern in the butterfly's wings disrupt reflective light to produce a brilliant blue colour. If the butterfly had to use pigment to create the same blue, it would take up vast amounts of energy – energy better used for flying, feeding and reproducing. Similarly, Qualcomm's new screen doesn't require



Stenocara beetles are able to harvest water from air.



Above: The Morpho species of butterflies generate colour through structure and not pigments.

Above right: The kingfisher's beak inspired the aerodynamic shape of Japanese bullet trains.

any backlighting. Beneath its glass surface is an array of microscopic mirrors that move up and down to convert the white ambient lighting around it into colour. Through this technique, the Mirasol consumes a tenth of the power of a conventional LCD reader.

Another instance of science learning from nature can be found in Japan's high-speed bullet trains. While the trains acquired the desired speed, the massive amount of noise created by the displacement of air ahead of the trains was a major concern for engineers. The trains would create a huge 'tunnel boom' or loud shock wave as they entered tunnels. The power of the shock was so great it would cause structural damage to the tunnels. The designers found their solution in the structure of a kingfisher's beak. Their specialised beak allows them to dive into the water at great speed but with minimum splash. The same design principle was applied to the bullet trains – their blunt front nose cap was replaced with a more streamlined one. Utilising this new nose, the next generation 500 series trains were 10 per cent faster, consumed 15 per cent less electricity, and, most importantly, no more "boom."

The frames of Opel and Mercedes cars take inspiration from the ways trees and bones distribute strength and loads. Pax Scientific's fan borrows from the patterns of swirling kelp, nautilus and whelks to move air more efficiently. Camels are teaching agriculturists how to efficiently use scarce water supplies in desert regions, while the stenocara beetle's ability to harvest water from air is pushing scientists to develop biomimetic patterns capable of doing the same.

But biomimicry isn't always about replicating an anatomical or evolutionary niche of a species. Many architects are now taking cues from the structures

animals build to create better support systems for us. The East Gate Centre in Zimbabwe mimics the elaborate ventilation system found in termite nests to keep its interiors cool. India's first planned hill city, Lavasa, uses a canopy of deciduous trees to drive the monsoon inland ensuring drought never reaches the city. The hydro dynamically efficient shape of banyan tree leaves influenced the design of a better water-dispatching roof shingle, while water diverting systems were inspired by the ways harvester ants direct water away from their nests.

Closer to home, the world's tallest building, the Burj Khalifa's structure is a nod to the regional desert flower, the Hymenocallis. The 'Y' shape not only fostered the tower's constructability but also reduces the wind forces along its height.

Natural processes are offering innovative and sustainable paths for every human discipline and institutions such as Benyus' Biomimicry 3.8 and The Biomimicry Institute are helping the biology inspired design revolution. Biomimicry 3.8 is a for-profit organisation that studies mounds of biological literature to collate 'amoeba through zebra' reports that offer relevant natural design principles for engineers to work with. At the other end of the spectrum, non-profit organisation The Biomimicry Institute works with educators from K-12, university, and non-formal (museums, zoos, aquariums) environments to naturalise biomimicry in the educational system.

If we want a sustainable and truly zero waste world, then biomimicry is the only way to achieve it. What now remains is "to naturalise biomimicry in the culture by promoting the transfer of ideas, designs, and strategies from biology to sustainable human systems design" – the mission of The Biomimicry Institute. ♪

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