

#YearOfZayed

THE DNA DIET

Rise of the personalised
eating plan

BETTER READING

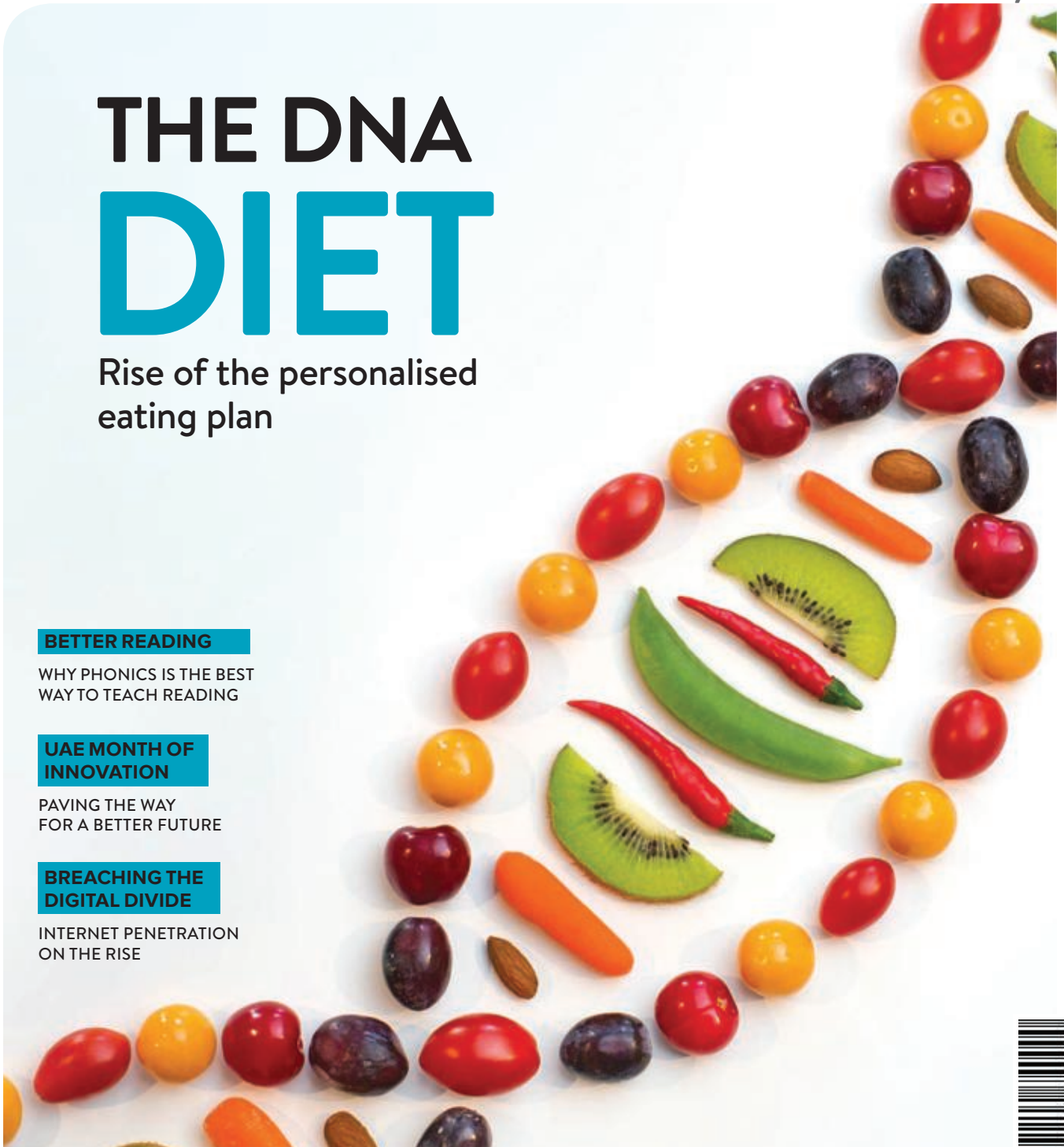
WHY PHONICS IS THE BEST
WAY TO TEACH READING

UAE MONTH OF INNOVATION

PAVING THE WAY
FOR A BETTER FUTURE

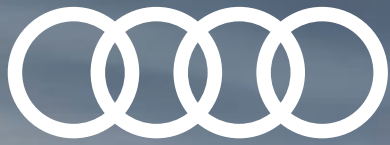
BREACHING THE DIGITAL DIVIDE

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FOREWORD

Dear readers,

The importance that the UAE places on innovation is reflected by the fact that this year the annual Innovation Week was increased to include the whole month of February. The UAE's vision of engineering a society and country powered by innovation and future applications has been steadily gathering momentum since 2014 when His Highness Sheikh Mohammad Bin Rashid Al Maktoum, Vice-President and Prime Minister of the UAE and Ruler of Dubai, launched the National Innovation Strategy.

The country's leadership has further emphasised the importance of innovation across all sectors through the UAE Vision 2021: "Innovation, research, science and technology will form the pillars of a knowledge-based, highly productive and competitive economy, driven by entrepreneurs in a business-friendly environment where public and private sectors form effective partnerships."

This focus on innovation is already bearing fruit. In the Global Innovation Index 2017 the UAE achieved a six rank increase, up from 41 in 2016 to reach 35 globally. Over the past two years, the UAE has also exhibited a consistent performance by repeatedly ranking as number 1 in the Arab world. Over the period 2014-2016, the UAE also displayed consistent performance in innovation inputs, ranking 25th. Last year, however, the UAE improved even further by achieving a rank of 23rd.

In order to lend our full support to the country's rapid transition to

a knowledge-based economy, the Mohammed bin Rashid Al Maktoum Knowledge Foundation (MBRF) launched its inaugural Arab Innovation Forum as part of the UAE's Innovation Month. The event, which was held at the Dubai World Trade Centre from February 26-28, covered innovation in six major sectors.

The Arab Innovation Forum is a logical next step for us, following MBRF's successful and highly acclaimed series of Knowledge Summits. The launch of the Arab Innovation Forum is part of our extensive efforts and overall mission to build knowledge-centred societies. We are always prepared to embrace and support any initiative that supports innovation and empowers creative thinkers to propose sustainable solutions for the challenges facing their communities.

Government initiatives such as UAE Vision 2021 and the National Innovation Strategy, Dubai Integrated Energy Strategy 2030 and 10X show the careful planning, thinking and support that is going into the country's rapid transition to a knowledge-based economy. We hope the Arab Innovation Summit, which will be held annually, will build on this year's success to aid the UAE's determination to become one of the most innovative countries in the world.

Jamal Bin Huwareb

CEO of Mohammed bin Rashid

Al Maktoum Knowledge Foundation



‘Museum of the Future’ Opened During World Government Summit

His Highness Sheikh Mohammed bin Rashid Al Maktoum, Vice President and Prime Minister of the UAE and Ruler of Dubai, opened the new temporary ‘Museum of the Future’ as part of the 2018 World Government Summit that was held 11-13 February at Madinat Jumeirah, Dubai.

The museum offers visitors an interactive experience about the future of artificial intelligence (AI) and how it will affect different aspects of life in the future, offering an exciting way to discover tomorrow’s trends and opportunities.

HH Sheikh Mohammed highlighted the fact that AI will add \$15 trillion to the world’s GDP within a period of 12 years, and said “The Museum of the Future is a unique incubator for futuristic innovations and design... We are determined to make the

UAE a major contributor to future development.”

“The UAE government sets an example to the governments of the world in adopting technological advancements as a driver for development. AI is key when we speak about tackling future challenges,” HH Sheikh Mohammed said.

The Museum of the Future is a unique incubator for futuristic innovations and design, currently under construction in Dubai. It builds on over five years of immersive exploration of the future by the Dubai Future Foundation, the organisation behind everything from the world’s first 3D printed office to the Dubai Blockchain Strategy. Opening in 2019, the museum will become the world’s largest and most exciting way to discover tomorrow’s trends and opportunities. †

Global Happiness Coalition Launched

Vice President and Prime Minister of the UAE and Ruler of Dubai, His Highness Sheikh Mohammed bin Rashid Al Maktoum, attended the launch of “The Global Happiness Coalition” on February 12, comprising the ministers of six countries including UAE, Portugal, Costa Rica, Mexico, Kazakhstan, and Slovenia.

HH Sheikh Mohammed said that the world needs new forms of coalitions that work for the wellbeing and happiness of people. “The Global Happiness Coalition reflects a message where the UAE’s aspirations meet with the ambitions of different nations around the world towards creating a better future

for everyone. It is time to join efforts as governments to come up with new approaches and mechanisms to achieve people’s happiness and improve their quality of life.”

“We perceive people’s happiness as a benchmark for government efficiency and an important indicator in assessing its policies and programmes. It is also a common objective that both government and private sectors collaborate to achieve,” HH Sheikh Mohammed said.

“This coalition is an opportunity for its members to exchange ideas and expertise, and to learn from our experiences, as well as to

showcase the UAE's vision regarding the importance of happiness as the ultimate goal for any government," His Highness explained.

HH Sheikh Mohammed said that investment in happiness promotes security, peace and coexistence between nations.

"Happiness is the opposite of hatred and extremism. We look forward that the "Global Happiness Coalition" will lay a foundation for positive transformation in the world," HH Sheikh Mohammed said.

The agreement to establish "The Global Happiness Coalition" was signed by the UAE's Minister of State for Happiness and Quality of Life, Ohoud Khalfan Al Roumi; Portugal's Minister of the Presidency and of Administrative Modernisation, HE Maria Manuel Leitão Marques; Costa Rica's Minister of National Planning and Economic Policy, HE Olga Marta

Sánchez Oviedo; Kazakhstan's Minister of Information and Communication, HE Dauren Abayev; Slovenia's Minister of Development, Strategic Projects and Cohesion, HE Alenka Smerkolj; and Head of the President's Office in Mexico, Francisco Guzmán Ortiz.

The joint declaration of "The Global Happiness Coalition" aims to ensure effective international dialogue about achieving happiness on a global level, and disseminating knowledge and exchanging information and expertise about the implementation of related policies between member countries. The Coalition will hold an annual meeting on the sideline of the World Government Summit to review achievements and exchange ideas that may help coalition members improve policies and programmes to ensure sustainability of happiness. †

Sheikh Mohammed Inspects 100 per cent UAE-made Satellite



His Highness Sheikh Mohammed bin Rashid Al Maktoum, Vice President and Prime Minister of the UAE and Ruler of Dubai, inspected the progress of the KhalifaSat project while visiting the Mohammed bin Rashid Space Centre (MBRSC).

KhalifaSat is the first satellite to be fully built by Emirati engineers, an achievement that highlights the UAE's growing expertise in satellite technology. The satellite will be launched later this year, following a series of rigorous tests.

"Emirati engineers are the first in the Arab world to construct a satellite without foreign assistance. This is a major achievement that signifies the high level of capabilities UAE youth have acquired in space technologies," Sheikh Mohammed said.

"The high level of expertise that Emirati scientists and engineers have developed creates a strong foundation for the future scientific and technological development of the UAE," he added. "We are confident

KhalifaSat is the first satellite to be fully built by Emirati engineers, an achievement that highlights the UAE's growing expertise in satellite technology. The satellite will be launched later this year, following a series of rigorous tests.

that the nation's space industry sector will continue its strong growth, and emerge as a key component of our economy. The development of KhalifaSat is not only a source of pride for Emiratis and Arabs, but also a global achievement that will benefit humanity, and offer scientific solutions for development globally," Sheikh Mohammed further said.

KhalifaSat is the first satellite to be developed in space technology laboratories in the UAE entirely by Emirati engineers. It is the third satellite owned by MBRSC following the launch of Dubai-1 and Dubai-2.

Once the manufacture and rigorous testing phases have been completed, the satellite will be transported to Japan for launch aboard the Mitsubishi Heavy Industries rocket - H-IIA.

When placed into a Low Earth Orbit of approximately 613km, the satellite will proceed to capture detailed imagery capable of competing with the highest industry standards. †

Nobel Exhibition 2018: Workshops Shed Light on Breakthroughs and Milestones in Chemistry



Major breakthroughs made by prominent chemists and Nobel laureates took centre-stage in a series of workshops at the fourth Nobel Exhibition taking place in Dubai's City Walk from February 4 until March 3, 2018.

Organised by the Mohammed Bin Rashid Al Maktoum Knowledge Foundation (MBRF) – a member of the Mohammed Bin Rashid Al Maktoum Global Initiatives – the 2018 edition's theme is "Nobel Prize in Chemistry – Connecting Elements". The first workshops drew large crowds of students from schools and universities across Dubai, in addition to chemistry experts and academics.

MBRF's CEO His Excellency Jamal bin Huwairib said: "The Nobel Exhibition 2018 allows us to showcase the inspiring experiences of prominent Arab and international scientists, stimulate creativity and innovation among students and visitors, and demonstrate the great role chemistry plays in people's lives. This, indeed, is the main objective from all our activities at the Mohammed Bin Rashid Al Maktoum Knowledge Foundation, where we strive to produce and promote knowledge across various disciplines in an effort to empower all segments of society."

One of the most notable workshops was entitled "Ahmed

Zewail: Journey to the Nobel and Realizing his Dream; Zewail City of Science and Technology". It shed light on the Zewail City of Science and Technology, conceived by world-renowned Egyptian chemist Ahmed Zewail, the Nobel Prize in Chemistry 1999 laureate. Presented by Professor Ibrahim El-Sherbiny, Zewail City's Director of the Centre for Material Science & Director of the Nanoscience Programme, and Mohamed Al-Kordi, Associate Professor at the institution, the workshop presented the vision and mission of the city, the advanced research and academic programmes it provides, and the role it will play in sparking a new era of scientific development across the entire Arab region.

In a workshop entitled "The Cryogenic Electron Microscopy", Lund University's Professor Viveka Alfredsson explored Transmission Electron Microscopy (TEM), which has been an invaluable technique for elucidating the structure of materials. With time, the technique has developed to allow for increasingly advanced studies to be performed. The session highlighted the accomplishments of German-born American biophysicist Joachim Frank, Scottish molecular biologist and biophysicist Richard Henderson, and Swiss researcher Jacques Dubochet, who together won

the Nobel Prize in Chemistry 2017 for their work on single-particle cryo-electron microscopy.

MBRF also organised a workshop on February 18, entitled “How to Get the Nobel Prize” and presented by Gustav Källstrand, Nobel Prize Historian, and Anna Sjöström Douagi, Head of Programmes at the Nobel Centre.

An additional workshop was held on February 25, bearing the title “How to select a Nobel Laureate (in Chemistry)” featuring Professor Sven Lidin, a former member of the Nobel Committee of Chemistry.

The workshops were held at the Nobel Exhibition 2018 site in Dubai’s City Walk and were open to the public for free. †

Experts, Entrepreneurs Tackled Six Major Sectors at First Arab Innovation Summit

Experts and entrepreneurs discussed innovation across all major sectors at the inaugural Arab Innovation Forum, organised by the Mohammed bin Rashid Al Maktoum Knowledge Foundation (MBRF), which was held on February 26-28, 2018, at the Dubai World Trade Centre.

The event covered innovation in six major sectors, namely: smart government, communication technologies, healthcare, renewable energy, transportation, and financial services.

MBRF CEO His Excellency Jamal bin Huwairib said: “The Foundation is committed to promoting innovation as a means to build a knowledge-centred society and maintain our economic competitiveness. This new Summit we launched reflects the UAE Government’s ambition and directives to place innovation at the core of all strategies and development plans.”

On Day One the Forum tackled Smart Government, where Daria Tataj, Chairwoman of Advisors to the European Commissioner for Research, Science and Innovation, discussed “Policy Lessons for a New Growth Model”. Next, Professor of Strategic Management at Antwerp Management School and Visiting Professor at INSEAD, Jamie Anderson, discussed “Creative Leadership & The Future of Energy”. On the same topic, Larry Siebert, Chairman, President and Co-founder of Kilowatt Labs, led a session titled “Disruptive Solutions to Global Energy Needs”.

Day One wrapped up with two sessions covering Healthcare. The first session explored “How Artificial Intelligence Can Revolutionise Healthcare” with Dr Joel Robertson, CEO of several companies under the umbrella of Robertson Health. The second session covered “The Future Democratisation of Healthcare” and featured Mohit Sagar, Group Managing Director at Singapore’s CIO Network.

The fourth topic, starting Day two, focused on Transportation. Leading global trend expert Faith Popcorn led a discussion titled “The Future in Motion: Transportation 2028”. Dr Omar Hatamleh, Executive Director of the Space Studies Program at International Space University, did a presentation on “Innovation through Rocket Science”, while Crystal Worthem, Director of Marketing for Ford Middle East and Africa, spoke of “Re-Imagining the Auto Industry”.

Financial Services commenced with a presentation on blockchain technology titled “From Babylon to Bullion to Blockchain” by J. Bradley Hall, Global Founder, Executive Chairman and Chief Executive Officer of ICON. Thierry Sanders, CEO of Mekar, tackled the topic from a different angle in the session “The New Promise of FinTech”.

Technology was first addressed by Rania Rostom, Chief Innovation & Communications Officer for the Middle East, North Africa & Turkey at General Electric, in the discussion “Future of Work – Meet the Microfactory”. Marc Deschamps presented “Seven Tech Trends That Will (Re)shape the World and Redefine the Entrepreneur’s Economy”. Deschamps is Managing Partner & Co-CEO of Drake Star Partners.

The Arab Innovation Summit was divided into several sessions, starting with the opening ceremony, where entrepreneurs, creative thinkers and international experts from all around the world discussed innovation within the various sectors covered in the Forum. The second part of the event was the 10,000-square-metre exhibition, where more than 200 international, Arab and local start-ups showcased their innovations to visitors. Furthermore, the event included the Arab Innovation Forum Award ceremony. †



Daria Tataj



J Bradley Hall



Mohit Sagar



Rania Rostom



Marc Joseph Deschamps



COUNTRY PROFILE: SAUDI ARABIA

GDP 646.44 BN

POPULATION 31,557,144

HDI 0.847

SECTORIAL INDICES



PRE-UNIVERSITY EDUCATION (PUE)

RANK **96**
VALUE **48.4**



TECHNICAL VOCATIONAL EDUCATION & TRAINING (TVET)

RANK **119**
VALUE **40.3**



HIGHER EDUCATION (HE)

RANK **58**
VALUE **40.3**



RESEARCH, DEVELOPMENT & INNOVATION (RDI)

RANK **36**
VALUE **30.2**



INFORMATION AND COMMUNICATIONS TECHNOLOGY (ICT)

RANK **38**
VALUE **59.2**



ECONOMY

RANK **59**
VALUE **45**

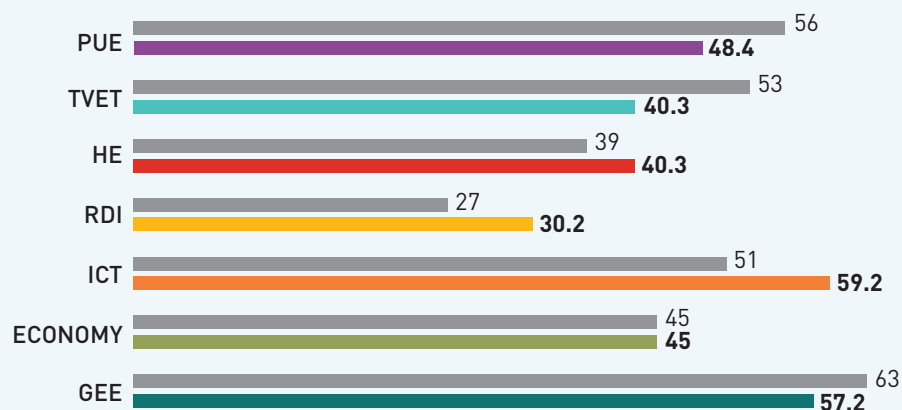


GENERAL ENABLING ENVIRONMENT (GEE)

RANK **92**
VALUE **57.2**

SECTORIAL INDICES IN COMPARISON WITH WORLD AVERAGE

● World Average ● Sectorial Indices



WORLD RANK 68/131

Georgia

65

The former
Yugoslav Republic of
Macedonia

66

Mauritius

67

Saudi Arabia

68

Turkey

69

Moldova

70

Panama

71

GENERAL ENABLING ENVIRONMENT

92 RANK 57 VALUE

POLITICAL AND INSTITUTIONAL

77 RANK 50 VALUE

SOCIO-ECONOMIC

78 RANK 55 VALUE

HEALTH AND ENVIRONMENT

111 RANK 67 VALUE

PRE-UNIVERSITY EDUCATION

96 RANK 48.4 VALUE

KNOWLEDGE CAPITAL

91 RANK 47.1 VALUE

EDUCATIONAL ENABLING ENVIRONMENT

97 RANK 50.4 VALUE

TECHNICAL VOCATIONAL EDUCATION AND TRAINING

119 RANK 40.3 VALUE

FORMATION AND PROFESSIONAL TRAINING

125 RANK 23.8 VALUE

FEATURES OF THE LABOUR MARKET

31 RANK 65.0 VALUE

HIGHER EDUCATION

58 RANK 40.3 VALUE

HIGHER EDUCATION INPUTS

40 RANK 48.0 VALUE

HIGHER EDUCATION OUTPUTS AND QUALITY

72 RANK 34.7 VALUE

RESEARCH, DEVELOPMENT AND INNOVATION

36 RANK 30.2 VALUE

RESEARCH AND DEVELOPMENT

31 RANK 33.1 VALUE

INNOVATION IN PRODUCTION

58 RANK 26.9 VALUE

SOCIAL INNOVATION

93 RANK 25.1 VALUE

INFORMATION AND COMMUNICATIONS TECHNOLOGY

38 RANK 59.2 VALUE

ICT INPUTS

40 RANK 68.1 VALUE

ICT OUTPUTS

39 RANK 55.3 VALUE

ECONOMY

59 RANK 45 VALUE

KNOWLEDGE COMPETITIVENESS

65 RANK 51.4 VALUE

ECONOMIC OPENNESS

66 RANK 33.3 VALUE

FINANCING AND VALUE ADDED

52 RANK 43.8 VALUE

INNOVATION IS THE FUTURE

Innovation Month is part of the government's strategy to make the UAE one of the world's most innovative nations.

The UAE's vision of engineering a society and country powered by innovation and future applications has been steadily gathering momentum since 2014 when His Highness Sheikh Mohammed Bin Rashid Al Maktoum, Vice-President and Prime Minister of the UAE and Ruler of Dubai, launched the National Innovation Strategy. The strategy, targeting seven crucial sectors - renewable energy, transport, education, health, technology, water and space - is committed to make the UAE among the most innovative nations in the world.

This vision is based on the social, environmental and economic reality that the countries that offer workable solutions are the ones that will shape the future of mankind. At this point in time the world needs solid solutions for numerous challenges that affect every sphere of life - from health, education, economy, technology and environment to sciences, social sciences and social engineering. The greater the proliferation of ideas and

implementations, the more positive will be the outlook for mankind's security and progress.

"The UAE is already the most innovative Arab nation. Our target is to be among the most innovative nations in the world. The competitiveness race demands a constant flow of new ideas, as well as innovative leadership using different methods and tools to direct the change," said HH Sheikh Mohammed at the launch of the National Innovation Strategy.

The country's leadership has further emphasised the importance of innovation across all sectors through the UAE Vision 2021: "Innovation, research, science and technology will form the pillars of a knowledge-based, highly productive and competitive economy, driven by entrepreneurs in a business-friendly environment where public and private sectors form effective partnerships."

Government initiatives such as UAE Vision 2021 and the National Innovation Strategy, the annual Innovation >





Above: His Highness Sheikh Mohammed Bin Rashid Al Maktoum, Vice-President and Prime Minister of the UAE and Ruler of Dubai, at the launch of the Knowledge Summit 2017 organised by the Mohammed bin Rashid Al Maktoum Knowledge Foundation (MBRF). This year MBRF launched the inaugural Arab Innovation Summit.

Right: The UAE Hackathon, part of Innovation Month, was the country's biggest data analysis challenge.

Month, Dubai Integrated Energy Strategy 2030 and 10X show the careful planning, thinking and support that is going into the country's rapid transition to a knowledge-based economy.

This focus on innovation is already bearing fruit. In the Global Innovation Index 2017 the UAE achieved a six rank increase, up from 41 in 2016 to reach 35 globally. Over the past two years, the UAE has also exhibited a consistent performance by repeatedly ranking as number 1 in the Arab world. Over the period 2014-2016, the UAE also displayed consistent performance in innovation inputs, ranking 25th. Last year, however, the UAE improved even further by achieving a rank of 23rd.

INNOVATION STARTS WITH YOU

The UAE is definitely not resting on its laurels. Following the tremendous success of the UAE Innovation Week over the past two years, HH Sheikh Mohammed Bin Rashid Al Maktoum called for celebrating February as the UAE Innovation Month, in line with the enterprising spirit of the UAE's visionary leadership.

Mohammad Abdullah Al Gergawi, Minister of Cabinet Affairs and the Future and Chairman of the Science, Technology and Innovation higher committee, said the UAE Innovation Month is an embodiment of the UAE leadership's clear directives to transform the country into an open global laboratory to experiment with avant-garde policies and programmes.

"UAE Innovation Month is the fruit of the complementarity, synergy and collaboration between the Federal Government, the Executive Councils of the



emirates, private sector companies, and various academic and social institutions," he said. "This makes it the largest national event of its kind in the UAE, underlining innovation's pivotal role in forecasting and building the future."

This year's Innovation Month, held in the 'Year of Zayed', centred on four main themes inspired by the late Sheikh Zayed Bin Sultan Al Nahyan. As such it focused on four aspects inspired by the UAE's Founding Father -- the innovative leader, the creative thinker, the change maker and the inspirational thinker.

The month-long initiative achieved grass-roots penetration of the spirit of innovation by inspiring the public and private sectors, as well as individuals to adopt innovative thinking and practices for the greater common good of the people. This was made clear by the event's slogan of "Innovation Starts with You." In





Left: HH Sheikh Sultan bin Tahnoon Al Nahyan, Member of the Executive Council, inaugurated initiatives for the Month of Innovation in Abu Dhabi.



order to engage the community, Innovation Month featured competitions and workshops, as well as exhibitions and the launching of national initiatives for innovation.

The surging participation of students via various programmes and projects in each of the seven emirates proved just how successful Innovation Month was in extending its reach.

Huda Al Hashemi, Assistant to the Director-General for Strategy and Innovation at the Ministry of Cabinet Affairs and the Future, said that this year's event had succeeded in engaging the whole community through key events held at popular spots in each emirate.

"We started with a mission of enhancing the culture of innovation and creativity among all UAE nationals, expats and visitors in the first year of the event. With that already being achieved, we now wanted to focus on expanding the events and have the public join in," she said.

Around 1,200 events of all shapes and sizes were held around the seven emirates during Innovation Month, which was organised by the Mohammed Bin Rashid Centre for Government Innovation (MBRCGI). Abu Dhabi, the UAE's capital, kicked off proceedings with events such as the Abu Dhabi Science Festival and Innovator 2018 attracting around 35,000 visitors.

Proceedings then moved to Ras Al-Kaimah and Fujairah for the week from February 8-15, followed by Sharjah, Ajman and Umm Al Quwain before ending in Dubai on February 22-28.

In Dubai the UAE Ministry of Education held the hugely successful five-day National Science, Technology and Innovation (NSTI) Festival at the Dubai Festival Arena. It consisted of segments in Conference, Awards, Science Fair, Family Festival, and Industrial Revolution X (IR-X), among others.

Jameela Salem Al Muhairi, Minister of State for Public Education, said: "The NSTI Festival allows

Below: The five-day National Science, Technology and Innovation (NSTI) Festival is part of the UAE's mission to foster a generation with outstanding scientific talents.

NSTI FESTIVAL

NATIONAL
SCIENCE
TECHNOLOGY
& INNOVATION

المهرجان
الوطني
للعلوم
والتكنولوجيا
والتكرار





Above: Dubai is a leader in innovation and a test bed for major initiatives such as driverless cars.

students and community members to stay up to date on the latest developments in science, technology, modern techniques, artificial intelligence and the latest trends in advanced educational solutions. It offers a comprehensive agenda with its various events, programmes, competitions, initiatives, sessions and workshops by experts and educational leaders from around the world."

Of particular interest was the Industrial Revolution X, launched by the UAE Ministry of Education. Its programme is designed to equip UAE nationals with the knowledge, skills and hands-on expertise required to keep pace with modern technologies and scientific advancements occurring globally.

The vision of the programme is for it to evolve with time and adapt its content to gear UAE



nationals for upcoming industrial revolutions, hence the 'X' in the name, which represents the future eras. The IR-X Program is aligned with the UAE Artificial Intelligence Strategy and the UAE Strategy for the Fourth Industrial Revolution (4IR) to boost government performance and to create a highly productive innovative environment by investing in future technologies. This marks the beginning of the UAE Centennial 2071 phase that will require Emiratis specialised in Artificial Intelligence (AI) to develop new sectors and create opportunities for the national economy.

The UAE has been one of the first countries in the world to realise the strategic importance of Artificial Intelligence (AI) and has established the first ministry and minister in the world dedicated to Artificial Intelligence in sync with the leaps of progress witnessed by the country in all spheres. The UAE government launched its Artificial Intelligence strategy as part of the country's trend to be the pioneer and best in the world in all fields.

FIRST ARAB INNOVATION SUMMIT

The Mohammed bin Rashid Al Maktoum Knowledge Foundation (MBRF) launched its inaugural Arab Innovation Forum at the Dubai World Trade Centre from February 26-28. The event covered innovation in six major sectors, namely: smart government, communication technologies, healthcare, renewable energy, transportation, and financial services.



The Arab Innovation Forum is a logical next step for the organisation, following MBRF's successful and highly acclaimed series of Knowledge Summits. Last year in November, the fourth annual Knowledge Summit was held in Dubai under the theme "Knowledge and the 4th Industrial Revolution".

MBRF CEO His Excellency Jamal bin Huwareb said: "The Mohammed Bin Rashid Al Maktoum Knowledge Foundation is inaugurating the Arab Innovation Summit to add to its extensive efforts and overall mission to build knowledge-centred societies. We are always prepared to embrace and support any initiative that supports innovation and empowers creative thinkers to propose sustainable solutions for the challenges facing their communities."

The Arab Innovation Summit featured an international line-up of thinkers, speakers, and experts such as author Gabor George Burt, Faith Popcorn, a global pioneer in the science of the future; Omar Hatamleh, Executive Director of the Space Studies Program at International Space University; Daria Tataj, author and entrepreneur; and Jamie Anderson, business thinker.

The forum also provided a platform for institutions, experts and entrepreneurs to come together and showcase their innovations, as well as discuss topics of interest and forge professional strategic ties that will in turn help strengthen the economy.

The second part of the event was a 10,000-square-metre exhibition, where more than 200 international, Arab and local start-ups showcased their innovations to visitors.

Saif Al Mansouri, Corporate Affairs Adviser to the Managing Director of MBRF, said: "My vision for this forum next year is that it will only become bigger and attract more experts and innovators from around the world."

Above: A major aim of the National Science, Technology and Innovation (NSTI) Festival is to prepare the next generation for the Fourth Industrial Revolution.

Left: His Highness Sheikh Mohammed bin Rashid Al Maktoum at the National Science, Technology and Innovation (NSTI) Festival at the Dubai Festival Arena.

Autonomous ships have the potential to increase safety, reduce costs and cut emissions.

GHOST

The skies are full of remote-controlled drones, autonomous cars are being tested around the world, automated metro systems operate in cities such as Dubai, and self-driving intra-logistics vehicles or automated guided vehicles (AGV) operate in modern container terminals. So what about maritime traffic?

“If we look at recent advances in driverless car technology, the thought of trying something similar with ships does not appear too far-fetched. After all, water has at least one great advantage: there is less traffic than on roads and reaction times are usually longer,” says Dr Pierre Sames, Director of Group Technology & Research at DNV GL, an international ship-certification organisation headquartered near Oslo, Norway.

“Advances in sensor technology, data analytics and bandwidth to shore are fundamentally changing the way shipping works,” explains Dr Sames. “And as operations are digitalized, they become more automated.”

Governments around the world are already seriously looking into autonomous shipping as a way to move more cargo to sea in order to contain spiralling road maintenance costs caused by heavy truck traffic, not to mention air pollution. As it happens, Norway is a leader when it comes to ship automation. In 2016 government agencies and industry bodies established the Norwegian Forum for Autonomous Ships (NFAS) to promote the concept of unmanned shipping. In support of these efforts, the Norwegian government turned the Trondheim Fjord into a test bed for autonomous ship trials.

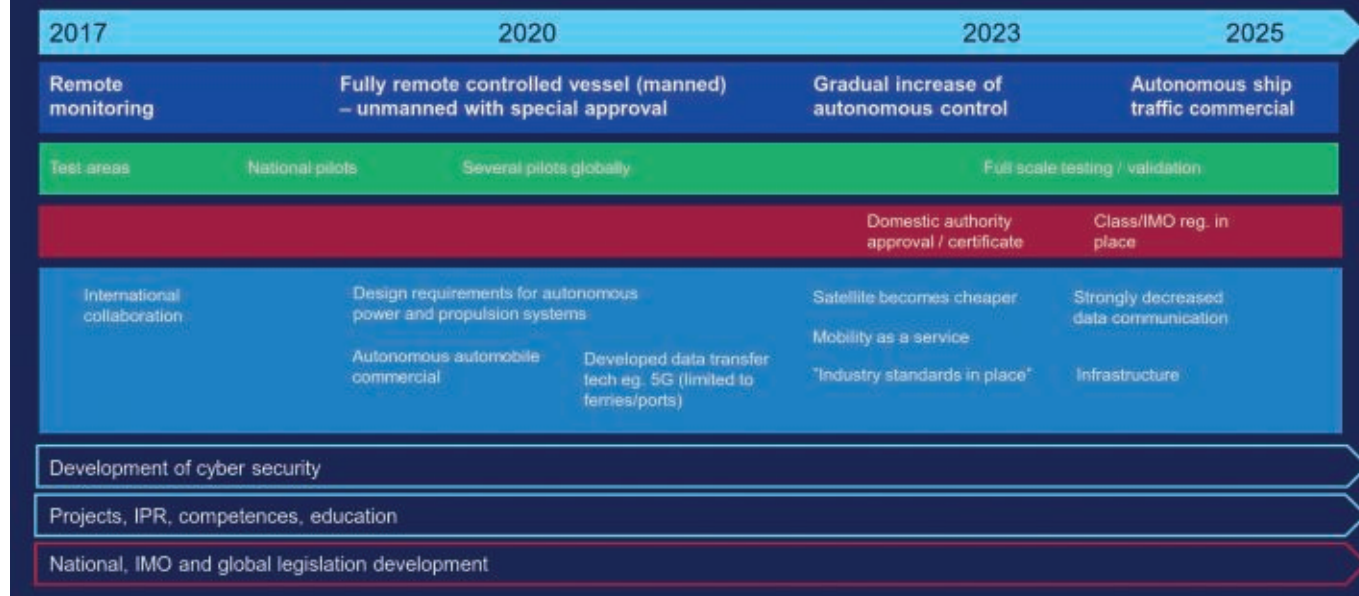
The European Union’s MUNIN (Maritime Unmanned Navigation through Intelligence in Networks) project, led by the Fraunhofer Center for Maritime Logistics and Services in Hamburg, is assessing the technical, economic, and legal feasibility of operating an uncrewed merchant vessel autonomously during an open-sea voyage. China’s Maritime Safety Administration and Wuhan University of Technology have partnered in their Uncrewed Multifunctional

SHIPS



DIMECC One Sea

Timeline for autonomous ships



Above:
Autonomous container ships are expected in international waters in 10 to 15 years.

Maritime Ships Research and Development Project. Other nations, most notably Finland and Singapore, are pursuing similar goals.

THE RATIONALE FOR AUTONOMOUS SHIPS

There are four main reasons behind the drive to develop unmanned ships: safety, commercial, environmental and social.

The safety rationale for autonomous ships has long been clear. The US Coast Guard estimates that human error accounts for up to 96 per cent of all marine casualties. A report by the Munich-based insurance company Allianz highlights that between 75 and 96 per cent of marine accidents are the results of human error, often a result of fatigue. Furthermore, a recent surge in piracy is a clear reminder that crews remain vulnerable (and valuable) targets for international criminals.

According to MUNIN, crew costs typically represent more than 30 per cent of the total ship operation costs and around 10 per cent of the average trip rates. This means autonomous or at least partly unmanned shipping has a significant potential to reduce cost. Moreover, slower sailing speeds become economically viable if crew costs can be reduced. A reduction of vessel speed from 16 to 11 knots, for example, results in fuel savings of about 50 per cent. However, a reduced speed also results in a longer voyage time, which means charter and crew costs increase per trip. This, at some

point, offsets the fuel savings. This equation will not be a factor for autonomous ships.

The above factors also have an environmental impact. Maritime shipping accounts for about 2.5 per cent of global greenhouse-gas emissions and barring a radical change, those emissions are set to surge in the decades ahead. Here too, losing the crew has an impact. Crew quarters, air-conditioning units, a bridge (which typically requires heavy ballast to ensure a ship's balance) and other amenities take up valuable weight and space that might otherwise be used for cargo. Plus they increase power requirements and wind resistance. Therefore, losing the crew allows for more streamlined, lighter and productive ships. Together with slow sailing speeds, these factors save fuel and reduce emissions.

The last factor is social. Due to piracy, time away from family and long sea voyages the maritime industry is facing a chronic shortage of skilled workers. Here, the concept of autonomous vessels can make seafaring jobs more attractive by creating and transferring new nautical and technical jobs from ship to shore. This will not have a major effect on employment as many container ships, including those carrying more than 10,000 containers, already use 30 crewmembers or less.

READY TO SET SAIL

All the technological building blocks are in place to

construct and control autonomous ships, marking the beginning of a revolution that should transform one of the world's oldest and most conservative industries – and make global shipping safer, faster and cleaner than it's ever been.

Already two commercial projects are nearing completion: Rolls-Royce is supplying automatic crossing systems for two DNV GL-classed double-ended, battery-powered ferries the Norwegian operator Fjord1 plans to commission this year. Both vessels will navigate autonomously under the captain's supervision, and he has the option to take control at any time. The first ferry will still require human-controlled berthing, while the second will be able to perform this task automatically as well.

The unmanned offshore vessel *Hrønn*, under construction at Fjellstrand shipyard for a Norwegian and UK consortium led by Automated Ships and global maritime technology firm Kongsberg, will also be delivered in 2018. The light-duty, fully automated utility ship will be deployed in a shuttle service for offshore installations but could be used for many other purposes, ranging from research to fish farming operations.

In May 2017 Norwegian agricultural company Yara International and Kongsberg agreed to build the world's first autonomous and zero-emission container ship. The electric-powered *Yara Birkeland* will be miniscule by modern standards, with the capacity for 100 to 150 shipping containers. But its arrival could be a huge turning point for the global shipping industry.

The *Yara Birkeland*, according to the *Wall Street Journal*, will cost \$25 million, about three times as much as a conventional ship of similar size, but will save up to 90 per cent in annual operating costs by eliminating both fuel and crew. When it launches next year, the ship will transport fertilizer from Yara's factory to ports about 16 miles away, thereby replacing 40,000 shipments a year that had once been carried by polluting diesel trucks. That short route will give the ship's owners – along with regulators and other autonomous shipping aspirants – a first chance to see such a vessel in operation.

The plan is that the *Yara Birkeland* will transition to fully autonomous operation only in stages. For the first phase of the project a detachable bridge with equipment for maneuvering and navigation by an onboard crew will be implemented. The ship will then progress to remote control, before becoming fully self-guided by 2020. That is around the time rules governing autonomous ships are expected to be in place.

THE LEGAL CHALLENGE

What seemed impossible three years ago is quickly becoming reality. Most of the sensor technology for autonomous ships




Above: Autonomous ships will see a transfer of maritime jobs from ship to shore.

Below: Norway's Trondheim Fjord has become a test bed for autonomous ship trials.

is now commercially available, and crucial collision-avoidance tools have been around in various forms since the early 1990s.

What could prove to be more challenging though, are the regulatory changes required to allow such ships to operate. Currently, global shipping regulations are unclear about whether these ships would be permitted, how they could be insured, and who would be legally liable in the event of an accident. For example, the International Maritime Organization, the United Nations agency that oversees shipping, prohibits crewless operations.

Despite this, Rolls-Royce expects autonomous container ships in international waters within 10 to 15 years. Other groups are working to do it sooner: One UK organisation plans to have a solar-powered autonomous research vessel cross the Atlantic in 2019. Lloyd's Register, the 250-year-old ship-classification group, has already issued guidance for crewless operations. At least two other groups in Europe are looking at changes to regulations that would clarify these questions. A group called SARUMS (Safety and Regulations for European Unmanned Maritime Systems), led by Sweden with six other participating countries, is one. In the United Kingdom, the Maritime Autonomous Systems Regulatory Working Group has been carrying out similar efforts. The ultimate aim is to ensure that the next substantial iteration of the International Convention on Safety of Life at Sea – the rules that govern international shipping – reflects these technological developments.

Just as in the case of self-driving cars there are still some hurdles to overcome, but autonomous ships will take to water sooner rather than later. 





THE BETTER WAY TO READ

New research shows that phonics beats the whole word approach when it comes to better reading ability.

For years, researchers have debated over the right technique to teach children how to read. Researchers from Royal Holloway, University of London and the MRC Cognition and Brain Sciences Unit have finally put the argument to rest. In new research they showed that phonics – or learning to read by sounding out words – is more effective than focusing on whole-word meanings. The experiment proved that phonics has a dramatic impact on the accuracy of reading aloud and comprehension.

The research involved training adults to read in a new language, printed in unfamiliar symbols, in two ways: through phonics and through understanding the meaning of words. Researchers then measured their learning with reading tests and brain scans. Participants who had focused on the meanings of the new words were much less accurate than their phonics using counterparts. MRI scans revealed that their brains had to work harder to decipher what they were reading.

The research, funded by the Economic and Social Research Council, also showed that the participants who were taught the meanings of whole words did not have better reading comprehension skills than those who were primarily taught using phonics. In fact, those using phonics were just as good at comprehension and significantly better at reading aloud. The lab results helped researchers understand that phonics works better as it enables reading comprehension by relating visual symbols to spoken language.

REAL LIFE RESULTS

Long before the research was conducted,

phonics had already demonstrated its success in enhancing reading ability. So much so, that in 2010, the UK parliament made it a legal requirement for state-funded schools to use phonics. The systematic use of phonics instruction has shown year-on-year gains in the percentage of children reaching an expected standard – from 58 per cent in 2012 to 81 per cent in 2016.

A focus on phonics has seen the reading standards of Britain's schoolchildren rise to the best in a generation. The *2016 Progress in International Reading Literacy Study* tested the reading skills of 9-10 year olds from 50 different countries. UK's youngsters came in at the eighth position for their reading ability, which is the country's highest ranking since 2001.

Researchers at the London School of Economics (LSE) also found teaching reading by using sounds far more effective than teaching reading through individual letters. Their research showed that young people from impoverished backgrounds and those whose first language was not English, both advanced quicker in reading using synthetic phonics. An assessment of more than 270,000 children by LSE's Centre for Economic Performance, last year, discovered that those who were learning phonetically had developed far better by age seven than those using traditional methods.

Across the globe in Australia, the 2005 National Inquiry into Teaching Reading recommended that “teachers provide systematic, direct and explicit phonics instruction so that children master the essential alphabetic code-breaking skills required for foundational reading proficiency”.

The Holloway research is also being seconded ➤



Above: According to research by the London School of Economics teaching reading by using phonics is far more effective than teaching reading by using individual letters.

by the UK government. “This research highlights the potential benefits of learning to decode using phonics. Thanks to the hard work of teachers, our continued focus on raising standards and our increased emphasis on phonics, there are now 147,000 more six-year-olds on track to becoming fluent readers than in 2012,” said Schools Standards Minister Nick Gibb.

Although phonics has traditionally shown better reading results, it does have some disadvantages. Some practitioners argue that while it may assist reading aloud, it does not promote reading comprehension. They recommend a mix of phonics- and meaning-based skills. The research team disagrees.

“Some people continue to advocate using a variety of meaning-based cues, such as pictures and sentence context, to guess the meanings of words. However,

our research is clear that reading instruction that focuses on teaching the relationship between spelling and sound is most effective. Phonics works,” said Professor Kathy Rastle from the Department of Psychology at Royal Holloway.

BETTER WIRED FOR PHONICS

A 2015 Stanford study – co-authored by Stanford Professor Bruce McCandliss of the Graduate School of Education and the Stanford Neuroscience Institute, offers the answer to why phonics works. The research recorded how the brain responded to different types of reading instruction. Beginning readers who focused on phonics, instead of trying to learn whole words, showed increased activity in the area of their brains best wired for reading. Spelling words using

“If children are struggling, even if they’re receiving phonics instruction, perhaps it’s because of the way they are being asked to focus their attention on the sounds within spoken words and links between those sounds and the letters within visual words.”

– Professor Bruce McCandliss

phonics sparked more optimal brain circuitry than memorising them. In fact, these teaching-induced differences showed up each time the participant used the word – even after the trial. The study also showed that phonics does help readers to faster decipher words they have never seen before, provided they followed the same letter-sound patterns they were taught to focus on.

The phonics technique of learning words sparked off neural activity towards the left side of the brain, which encompasses visual and language skills regions, while words learned via whole-word association induced activity towards the right hemisphere. Previous studies have shown that skilled readers display strong left hemisphere engagement during word recognition. Children and adults who struggle with reading show a lack of this engagement.

Although many schools and teachers emphasize using phonics, there is disparity in the results. The Stanford researchers attribute this to the technique by which phonics is taught.

“If children are struggling, even if they’re receiving phonics instruction, perhaps it’s because of the way they are being asked to focus their attention on the sounds within spoken words and links between those sounds and the letters within visual words,” said Professor Bruce McCandliss.

He said the results underscore the idea that the way a learner focuses their attention during learning has a profound impact on what is learned. It also highlights the importance of skilled teachers in helping children focus their attention on precisely the most useful information.

The Stanford trial provides some of the first evidence that a specific teaching strategy for reading has direct and long lasting neural impact. The researchers believe the results will help teachers design better techniques for struggling readers. †

Below: Brain scans have shown that the phonics technique of learning words sparks off neural activity towards the left side of the brain, which encompasses visual and language skills.



THE DICK AND JANE CONTROVERSY

If ever there was a poster child for the whole word or ‘look say’ approach it was the *Dick and Jane* books. Once a beloved teaching tool, *Dick and Jane* was later denounced as dull, counterproductive, and even misogynistic.

Zerna Sharpe, a former elementary school teacher, approached education theorist William S. Gray with the idea of a collection of short stories that would each introduce a handful of new words. They’d feature average kids that any elementary scholar could identify with. And – critically – these characters would appear in simple illustrations designed to help connect a given word with its definition. In 1934

the first *Dick and Jane* book was released.

Editions that were intended for first-graders contained about 300 words apiece. Third-graders were given 1,000 and, in 6th grade, kids followed similar escapades in 4,000-word volumes. *Dick and Jane* primers came with guides that championed the ‘look-say’ approach. This method – which became popular during the 1930s – calls for largely ignoring phonics. In the classroom, phonics drills of letter sounds were replaced by word flashcards. By 1950, an estimated 80 per cent of American first graders were reading *Dick and Jane* texts.



When the look-say strategy began falling out of favour, its poster kids were vilified. In 1955, the educational manifesto *Why Johnny Can’t Read* championed a return to phonics-based teaching. Over the next decade, the backlash grew. In 1961, English professor Arthur S. Trace released *What Ivan Knows and Johnny Doesn’t*, which claimed that average Russian fourth-graders commanded a vocabulary that was nearly 10,000 words strong. Half a world away, their American counterparts were mastering less than 1,800 at that level. In 1965, *Dick and Jane* was retired. Today, authentic first-edition copies of *Elson Basic Readers: Pre-Primer* can now command a \$4,275 price tag.

TALL STOREY

More skyscrapers were built in 2017 than during any other year in history. Skylines around the world are reaching ever higher as “supertall” and “megatall” buildings change the face and the function of our cities.

The image of a dramatic city skyline is heavily charged with emotion and symbolism. Think of the looming sentinels of New York City, all lined up and sliding into shade at sundown. Aspirations, progress and the unceasing march of civilization are all evoked by the cloud-skimming alliance of steel and glass.

The skylines of cities all over the world are rapidly changing as the silhouettes steadily rise higher and higher. If cities are the world's economic engines, the skyscraper is the acceleration pedal. Potent symbols of power, self-image and global status, we are racing into an age where skyscrapers proliferate and push boundaries.

More skyscrapers were built in 2017 than during any other year in history. Last year was also the fourth consecutive record-breaking year in tall-building construction. Rem Koolhaas, the Dutch architect, former journalist, screenwriter and co-founder of the Office for Metropolitan Architecture said, “Only the skyscraper offers business the wide-open spaces of a man-made Wild West – a frontier in the sky.”

The most prominent buildings in this new frontier are not found in the USA, which used to lead the world in architectural achievements. Five of the 10 tallest buildings standing in New York City in 2009, the Empire State Building included, were completed between 1930 and 1933. The dominance in constructing both supertall (200+ metres) and megatall (600+ metres) skyscrapers has migrated to Asia and the Middle East.

Founded in 1969 and headquartered in Chicago, USA, The Council on Tall Buildings and Urban Habitat (CTBUH) is a not-for-profit organization and the world's leading resource for professionals focused on the inception, design, construction, and operation of tall buildings and future cities. According to CTBUH's 2017 annual report, “144 skyscrapers were finished in 2017, across 23 different countries.” This figure is up on 2016's record by more than 13 per cent.

Antony Wood, Executive Director of CTBUH says, “The data from 2017 shows a continuation of the trend towards a greater global proliferation of skyscraper construction. High-rise construction is no longer confined to a select few financial and business centres, but rather is becoming the accepted global model for densification, as more than one million people on our planet urbanise each week.”



Right: The gleaming skyline of Dubai has become one of the world's most recognized.

Developers in cities all over the world often face a daunting challenge in securing permits and permissions to construct supertalls, but with such a colossal influx from rural to urban dwelling, the case for building more skyscrapers is increasingly strong. In the present day, skyscrapers are overtly symbolic of status and power – “A boast in glass and steel” in the words of American literary academic and aphorist Mason Cooley – but this image may alter as more skyscrapers make sensible use of the environment, cramming a large amount of facilities and people into a relatively small footprint of land.

In economic terms, skyscrapers will also increasingly tick the right budget boxes, as advances in technology and materials improve the most crucial and cost-reducing element of a skyscraper – the load-bearing steel skeleton – allowing for ever greater amounts of floor space to be made available using the same amount of ground area.

The CTBUH report expects the trend for skyscraper construction to continue to rise and predicts another record-breaking year in 2018. In the case of the UAE, home of the Burj Khalifa – the world's tallest building – 2018 began with yet another record notched up.

On New Year's Eve, the ‘Light Up 2018’ event at the Burj Khalifa claimed a Guinness World Record as the largest light and sound show on a single building. Dubai is also home to three out of the five tallest buildings completed in 2017, ranking the Emirate fourth in the world for the tallest skyscrapers.

The tallest completed skyscraper in the city last year was Marina 101, a 101-storey hotel and residential development scaling 425 metres. Developed by Emaar Properties, it is now the second tallest building in Dubai after the 830 metre Burj Khalifa.

The 144 buildings completed in 2017 beat every previous year on record, including the former record high of 127 completions in 2016. This brings the total number of 200 metre-plus buildings in the world to 1,319. This represents a 12.3 per cent increase from 2016, and a staggering 402 per cent increase from the year 2000, when only 263 existed. China dominates the list accounting for more than half of the global total, with 77 of the structures located in 36 different cities.



A total of 15 supertalls were completed in 2017, bringing the worldwide total to 126. When it comes to megatalls, the CTBUH report revealed that the number of 600-metre-plus buildings in the world is set to rise from three to seven in the next five years. This includes the completion of the 1,000-metre-high Jeddah Tower, formerly known as the Kingdom Tower, in Jeddah, Saudi Arabia, which is on track to become the world's next tallest building. The tower, which broke ground in 2013, will be at the heart of Jeddah Economic City, a commercial and residential project of 5.3 million square metres, featuring homes, hotels and offices, as well as tourist attractions. The Jeddah Economic Company, the developer behind the skyscraper, confirms the completion date will be 2020.

While Asia, China in particular, and the Middle East are leading the way in building completions of 200 metres and above, the CTBUH report says, “the region may start to lose its dramatic lead as other regions, such as Africa and India, pick up the pace.”

A concerted shift towards building more skyscrapers in developing countries such as India is desperately needed according to Edward Glaeser, a Professor of Economics at Harvard University since 1992. In an article for the *Atlantic* magazine titled, “How Skyscrapers Can Save the City” Glaeser writes, “Concrete canyons, such as those along New York's Fifth Avenue, aren't an urban problem – they are a perfectly reasonable way to fit a large number of people and businesses on a small amount of land. Only bad policy prevents a long row of 50-storey buildings from lining Mumbai's seafront, much as high-rises adorn Chicago's lakefront.”

Those bodies enforcing building height restrictions, supported by urban planners and preservationists, will





have to fend off the prevailing argument supporting the boom in skyscrapers, which is that besides enhancing skylines and fostering social capital and creativity, they may ultimately make cities more affordable, and tall buildings can be more environmentally beneficial than sprawl.

Glaeser makes the case that, “A city of 20 million people occupying a tiny landmass could be housed in corridors of skyscrapers. An abundance of close and connected vertical real estate would decrease the pressure on roads, ease the connections that are the lifeblood of a 21st-century city, and reduce Mumbai’s extraordinarily high cost of space. Yet instead of encouraging compact development, Mumbai is pushing people out. Only six buildings in Mumbai rise above 490 feet (149 metres), and three of them were built last year, with more on the way as some of the height restrictions have been slightly eased, especially outside the traditional downtown.”

Glaeser adds, “If Mumbai wants to promote affordability and ease congestion, it should make developers use their land area to the fullest, requiring any new downtown building to have at least 40 storeys. By requiring developers to create more, not less, floor space, the government would encourage more housing, less sprawl, and lower prices. The magic of cities comes from their people, but those people must be well served by the bricks and mortar that surround them. Cities need roads and buildings that enable people to live well and to connect easily with one another... In the most desirable cities, whether they’re on the Hudson River or the Arabian Sea, height is the best way to keep prices affordable and living standards high.”

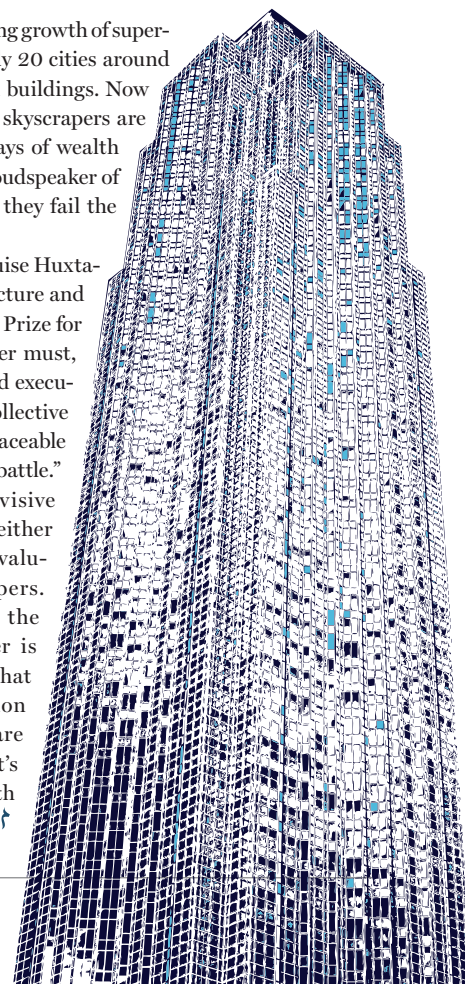
While skyscrapers have not historically been used for residential purposes, this is rapidly changing.

Current projections indicate over a third of all super-tall completions will be comprised of all-residential buildings by the end of this year. All-residential high-rise construction, which was significantly affected by the 2008 financial downturn, could even represent the largest proportion of 200 metre-plus buildings completed in 2018.

It’s astonishing to track the soaring growth of super-tall skyscrapers. Ten years ago, only 20 cities around the world had completed supertall buildings. Now that number is over 60. But while skyscrapers are the ultimate in conspicuous displays of wealth and prosperity, bellowed over the loudspeaker of architecture, they are worthless if they fail the residents and people that use them.

The late revered author, Ada Louise Huxtable, who wrote 11 books on architecture and was awarded the first-ever Pulitzer Prize for criticism, insisted that a skyscraper must, “illuminate principles of design and execution useful and essential to the collective spirit that we call society. For irreplaceable examples of that spirit I will do real battle.”

Huxtable recognised how divisive skyscrapers can be and she was either scathing or plauditory in her evaluations of the world’s skyscrapers. She unswervingly drove home the importance of how a skyscraper is experienced, always looking for that all-important human connection with any building. Skyscrapers are undoubtedly on the rise, but let’s hope they have been conceived with people rather than profit in mind. ↑



SUITED FOR

The current generation of spacesuits has been in use for almost three decades of obsolescence, the next generation of spacesuit is needed to protect and

Imagine floating 500 kilometres above our pale blue Earth in the inconceivable vastness of space. Now that is perhaps the ultimate separation.

Alexey Leonov experienced it on March 18, 1965, when he became the first person to walk in space. The Soviet/Russian cosmonaut and classmate of Yuri Gagarin stepped out of the Voskhod-2 into the unforgiving void to float for 12 minutes and 9 seconds, and in so doing, opened a new frontier in space exploration.

However, what remained concealed for decades was that it almost ended in disaster. Leonov's spacesuit presented unpredictable dangers, drastically inflating and lethally heating up. In a BBC report Leonov said, "My suit was becoming deformed. My hands had slipped out of the gloves [and] my feet came out of the boots. The suit felt loose around my body. I had to do something. I couldn't pull myself back using the cord. And what's more, with this misshapen suit, it would be impossible to fit through the airlock."

Thankfully, Leonov was a quick thinker and he depressurized the suit to re-enter his spacecraft, risking the bends but surviving to tell the tale.

North America's National Aeronautics and Space Administration (NASA) was swift in following the milestone and two months after Leonov's spacewalk, on June 3, 1965, Edward White stepped out of Gemini 4 to become the world's second spacewalker.

The correct term for spacewalking is Extra Vehicular Activity (EVA) and NASA has conducted hundreds of EVAs since White's leap of faith. One of the most famous of all came on July 20, 1969, when "one giant leap" was taken by Neil Armstrong in the Apollo 11 Moon landing.



What kept Armstrong alive on his iconic outing was his Extravehicular Mobility Unit (EMU) – his spacesuit. Extravehicular Mobility Units sound more like miniature spaceships than specialised clothing, which is entirely appropriate as that is precisely what spacesuits are – mobile, human body-shaped spacecraft.

EMUs are technological marvels that protect astronauts and enable them to live and work in outer space. They regulate an astronaut's temperature as he or she endures the extreme heat of 120°C in the sun and -120°C in the shadows, and also protect them from micrometeoroids (small particles of rock in space, usually weighing less than a gram, which could strike them and pierce the suit). EMUs essentially cater for every possibility concerning the mission at hand, incorporating temperature control, radiation levels, pressures, mobility requirements and more.

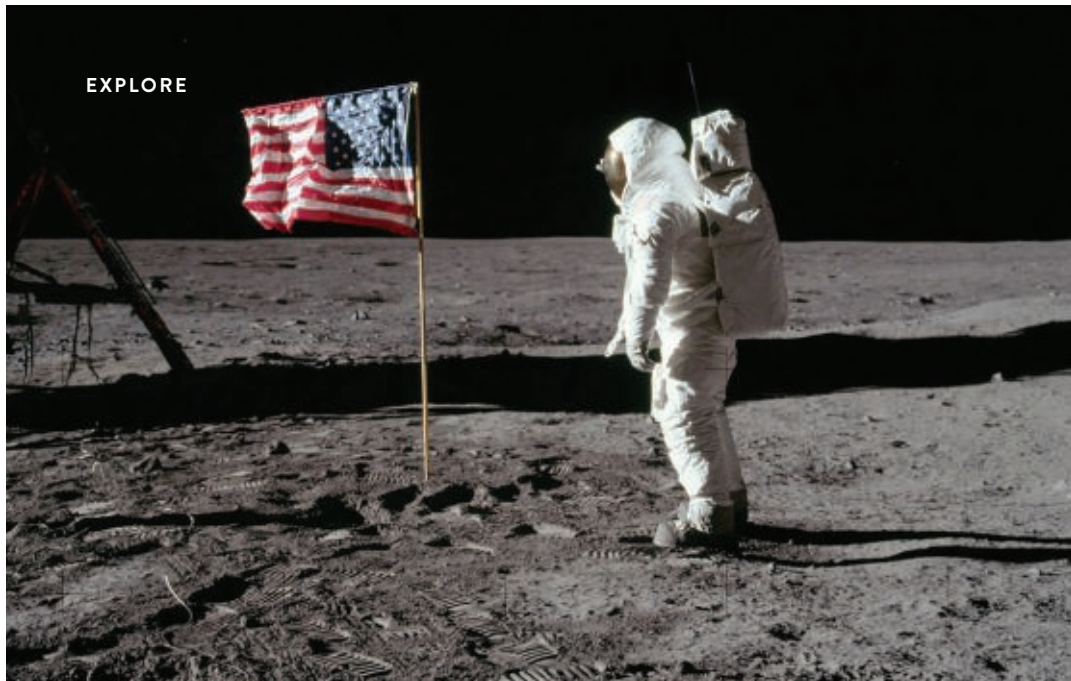
Armstrong's custom-made EMU, model A7L, serial number 056, cost around \$100,000 at the time – approximately \$675,000 today. Twenty-five years after his unforgettable journey Armstrong posted a thank you letter for the suit to NASA. "It turned out to be one of the most widely photographed spacecraft in history," Armstrong wrote. "That was no doubt due to the fact that it was so photogenic. Equally responsible for its success was its characteristic of hiding from view its ugly occupant," he joked. "Its true beauty, however," wrote Armstrong, "was that it worked."

NASA's spacesuits have actually been working for much longer than originally intended. The EMUs still used >

DISCOVERY

*longer than initially designed for. Whilst admirably defying
enable astronauts to undertake new intergalactic journeys.*





Above: Neil Armstrong became the first man to walk on the moon on July 20, 1969. His spacesuit cost around \$100,000 at the time.

Right: In 1965 Russian cosmonaut Alexey Leonov became the first person to perform an Extra Vehicular Activity (EVA).



on the International Space Station (ISS) today were designed to last for 15 years, but over 40 years later they are still in service. So much for technological obsolescence! When it comes to spacesuits, the product development cycle has turned at a glacial pace.

Suits that were developed not so long after Armstrong's – in 1974, and actually first flown in 1981 – are still in active use on the ISS today. Designed for the \$196 billion Space Shuttle Programme, which flew 135 missions between the first launch on April 12, 1981, and the final landing on July 21, 2011, and helped construct the ISS, each EMU has been partially modified and repeatedly refurbished over the decades. NASA added glove heaters and an

emergency rescue propulsion module in the 1990s for example, plus camera and light technology on the EMUs has been consistently updated.

A total of 18 suits were originally built but seven have been lost. Four in the Challenger and Columbia disasters, one in the SpaceX explosion of 2015, another was lost during testing and one was a prototype never intended for use. Out of the remaining 11, seven are on Earth being repaired or modified, leaving just four working spacesuits on board the ISS.

This situation is far from optimal and in April 2017, NASA's Office of Inspector General (OIG) conducted a full audit and released a report entitled NASA's Management and Development of Spacesuits, in which some severe shortfalls were highlighted and recommendations for progress made.

Despite spending 10 years and \$200 million to create new spacesuits, the OIG report revealed that NASA was still "years away" from finishing work on a replacement for the current EMUs. The ISS, in orbit since 1998, is not due for decommission until 2024, so the seven remaining suits need to last until then at least. With 17 spacewalks for ISS maintenance planned between now and March 2020, the astronauts are placing immense faith in the team's refurbishing and monitoring the EMUs – which only happens every six years, sometimes even longer. An independent technical review team commissioned by the ISS programme found that EMUs regularly exceed the six-year cycle, including one that saw nine years of use.

Although NASA concedes that the old EMUs are not up to the task of the agency's deep space exploration plans, it does maintain that the current suits are still adequate for ISS use and NASA also explained that robotic maintenance would reduce the number of EVAs. The agency gave predictions that the suits will be





Above left: Astronauts test the new Orion Crew Survival System to be used on the Orion spacecraft and its planned journey to Mars.

Left: Researchers at the University of North Dakota test the NDX-1, a spacesuit concept for Mars.

Below: The PXS suit is a technology demonstrator focused on long-duration missions to low-Earth orbit and beyond.



used eight times in 2018, 11 times in 2019 and subsequently eight times per year between 2020 and 2024 – a total of 59 more spacewalks for the old EMUs.

Part of the reason for the delay in creating a new generation of EMU is the lack of a formal plan with specific mission criteria. EMU technology is optimally created with targets clearly defined. The type of future missions dictate the kind of suit required – will the wearer be floating in microgravity or walking upon the surface of another planet?

Since 2007, NASA's Human Exploration and Operations Mission Directorate has invested in three different spacesuit development programmes, ploughing \$136 million toward the Constellation Space Suit System, \$52 million toward the Advanced Space Suit Project, and \$12 million to the Orion Crew Survival System for a suit to be used on the Orion spacecraft and its planned journey to Mars. The latter is the only suit with a very specific set of criteria.

The OIG report stated, “In the past, NASA linked spacesuit development efforts to specific programmes like Mercury, Apollo, and the Space Shuttle. However, with the exception of the OCSS spacesuit, recent spacesuit development efforts have not followed this practice. Instead, the spacesuits have been developed separately without a specific mission in mind.”

As NASA currently has plans to start building a manned space station near the Moon in the 2020s, which will serve as a platform for further deep space exploration, including missions to Mars, two new prototype spacesuits have seen extensive development and could be ready by 2025 – the Z-2 and the PXS.

The Z-2 suit is a planetary surface suit and the astronauts will use this for exploring, collecting samples, and manoeuvring around another planet in space rovers. The Z-2 features advanced composites meaning it will be light-weight, durable, and up to the task of long-duration missions in the harsh environments found on the Red Planet.

The PXS suit is intended for long-duration missions to low-Earth orbit and beyond and focuses on improving suit fit and performance. The PXS is planned to allow for 3-D printing in orbit, in transit, or on Mars, to achieve a customised fit for any crew member or to optimise EVA mobility for different mission phases.

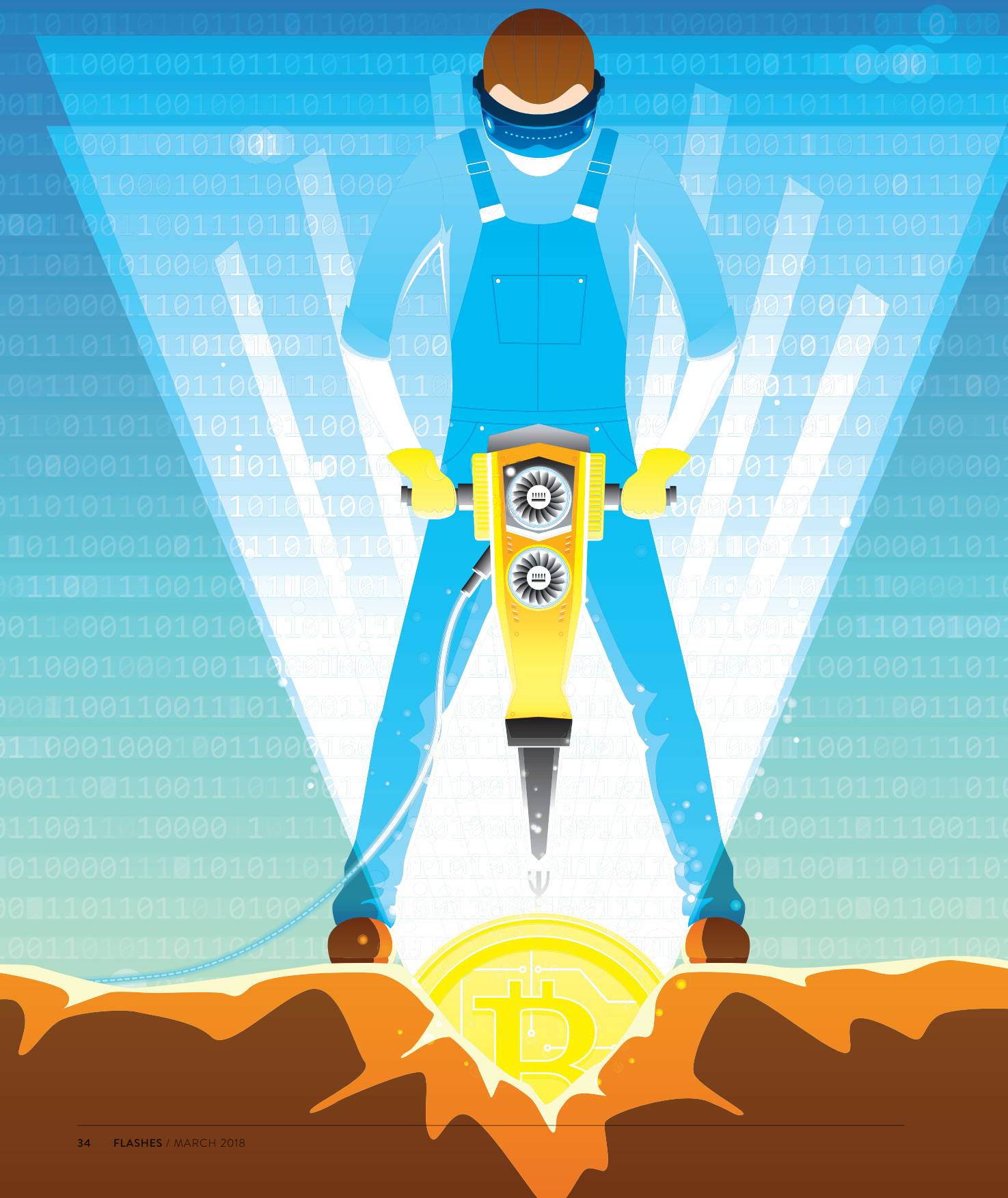
Before these suits arrive the workhorse EMUs on the ISS will continue to perform and earn their retirement. And before the ISS itself is closed down and sunk at the Oceanic Pole of Inaccessibility in the Pacific Ocean, it will be home for a short while to four Emirati astronauts. The four Emiratis are being selected from over 1,000 applicants to the UAE's newly established Astronaut Programme. The Mohammed bin Rashid Space Centre (MBRSC) revealed the four selected candidates will pass a three-year long intensive training programme before boarding the ISS.

The Chairman of the MBRSC, Hamad Obaid Al Mansouri, says, “The UAE Astronaut Programme is a boundless ambition that showcases the UAE's ongoing investment in science programmes to help serve national interests in the future, actively participating in global space exploration and exploring the prospects of human life in space, including the possibility of inhabiting other planets.”

Whether in the long serving old suits or the hotly anticipated new EMUs, the symbolic power of the EVA is undimmed. †



FLASHBACK



MINING GOES GREEN

Cryptocurrency miners are heading to colder climates as they search for cheap, renewable energy.

Experts will tell you 2017 was an anomaly for cryptocurrencies. Bitcoin, the biggest of the many peer-to-peer cash systems that currently dominates internet transactions, witnessed its largest boom. In August last year, Bitcoin was trading at a record high of \$2,200, but it hadn't reached its ceiling. By December, Bitcoin was trading at a staggering \$19,000 – a 9,000 per cent increase from its initial trading price of \$120. Today, the cryptocurrency market isn't as inviting, although at \$8,500 it's not doom and gloom either. For the umpteenth time, experts are predicting a nosedive in its value. Yet despite early signs of the cryptocurrency market plummeting, it's still holding its own.

Those familiar with the idea of cryptocurrency know that while trading is the easier option, mining is far cheaper. Bitcoin, the world's first cryptocurrency, doesn't rely on a central monetary authority and allows for – encourages, actually – anonymous, untraceable and untaxable transactions. While that sounds supremely shady, its origins were noble. Bitcoin gained momentum a little after the Occupy Wall Street movement accused big banks of misusing borrowers' money, duping clients, rigging the system, and charging mind-numbing fees. The pioneers of the cryptocurrency wanted to put the seller in charge, eliminate the middleman, cancel interest fees, and make transactions transparent to prevent corruption and cut fees. They created a decentralized system, where you could control your funds and know what was going on.

Obviously, its characteristics made it ideal for carrying out unethical activities, which is why it is actually the de facto currency of the Dark Web – the underbelly of the World Wide Web notorious for hosting highly illegal content including pirated music and films, drugs, hitmen for hire and sites where credit card details are bought and sold.

Mining is one of the ways a person can get his virtual hands on Bitcoins. This involves running the Bitcoin software on your computer and processing complex mathematical equations. If your computer solves one of these equations, you get paid in Bitcoins. The issue, however, is that your computer is up against other large groups of computers that will likely solve the problem before you. That means your machine may end up doing a bunch of work and you may never get paid. The solution, in this case, is joining a mining group. This makes it much more likely you'll get paid, but you'll also receive only your small share.

Then there are companies who specialise in Bitcoin mining by setting up huge computer farms. Bitfarms, a company near Quebec in Canada, has 5,000 computers mining cryptocurrencies. Bitfarms says it's earning





Above: Bitfarms has 5,000 computers mining cryptocurrencies in Quebec, Canada. It plans to expand its mining capacity nearly seven fold to 187 megawatts.

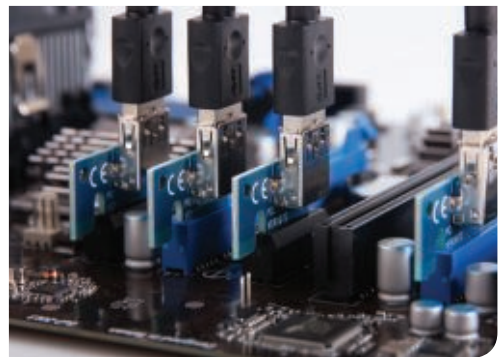
Right: Companies such as Samsung are cashing in on the cryptocurrency boom by making crypto-mining chips.

more than \$250,000 a day from mining Bitcoin and other virtual currencies at four sites in the province.

The problem with these computer farms is that they use large amounts of electricity to both run and cool the machines. According to Morgan Stanley, blockchain diggers could require as much as 140 terawatt-hours of electricity by the end of 2018. That's nearly one per cent of global demand. In November last year, UK-based PowerCompare issued a report that said the average electricity used to mine Bitcoin has surpassed the annual energy usage of some 159 countries. Specifically, the global average energy spent on Bitcoin mining has far exceeded the electricity consumption of Ireland and most African nations.

Long-term, this trend could lead to serious problems. According to the Washington DC-based Semiconductor Industry Association and the Semiconductor Research Corporation, we could be running short of electricity to power these machines by 2040. The environmental impact of this activity can't be overlooked as more energy requires more fossil fuels.

If cryptocurrency mining is here to stay, it's important that environmentally friendly, sustainable methods are put into place to help carry it out. China – home to about three-quarters of the machines plumbing the blockchain – dominated the scene until the government halted trading of virtual currency,



banned initial coin offerings and shut down mining in recent months. Some of the most influential companies in the new crypto economy, whose roughly 1,500 digital currencies were worth about \$405 billion last month, are looking for greener pastures.

Canada, where Bitfarms is located, has become a popular location due to its cold climate and cheap, clean electricity from hydropower. Hydro-Quebec has a surplus for provincial needs alone of 10 terawatt-hours or enough to power 600,000 homes for a decade. The company envisions demand from crypto miners in the province could rise to as much as five terawatt-hours of electricity. By the end of the year, Bitfarms plans to expand its mining capacity nearly seven fold to 187 megawatts.





“Google, Facebook and Apple have set their sights on Denmark, and Sweden’s attractive energy prices have seen companies buying land, signing deals and building data centres to benefit from the cost savings directly – including a 35MW Bitcoin mining facility in Northern Sweden.”

However, Canada isn’t the only player. Nadine Damblon, co-founder of a startup called HydroMiner, also plans to tap into renewable energy. The Austrian-based company raised \$2.8 million to install high-powered computers at hydroelectric plants to reduce the overall cost and environmental impact of mining cryptocurrencies.

Elsewhere, the Moonlight Project is building a data centre in Iceland that will operate several industrial-scale data centres in the cryptocurrency mining industry, and “plans to begin by mining predominantly Bitcoin, DASH, Litecoin, and Ethereum using 100 per cent sustainable, green energy”. According to the Icelandic energy firm HS Orka the electricity use

Above: Iceland’s geothermal power and Canada’s hydroelectric dams produce cheap electricity that is attracting crypto currency miners.



at Bitcoin mining data centres is likely to exceed that of all Iceland’s homes this year.

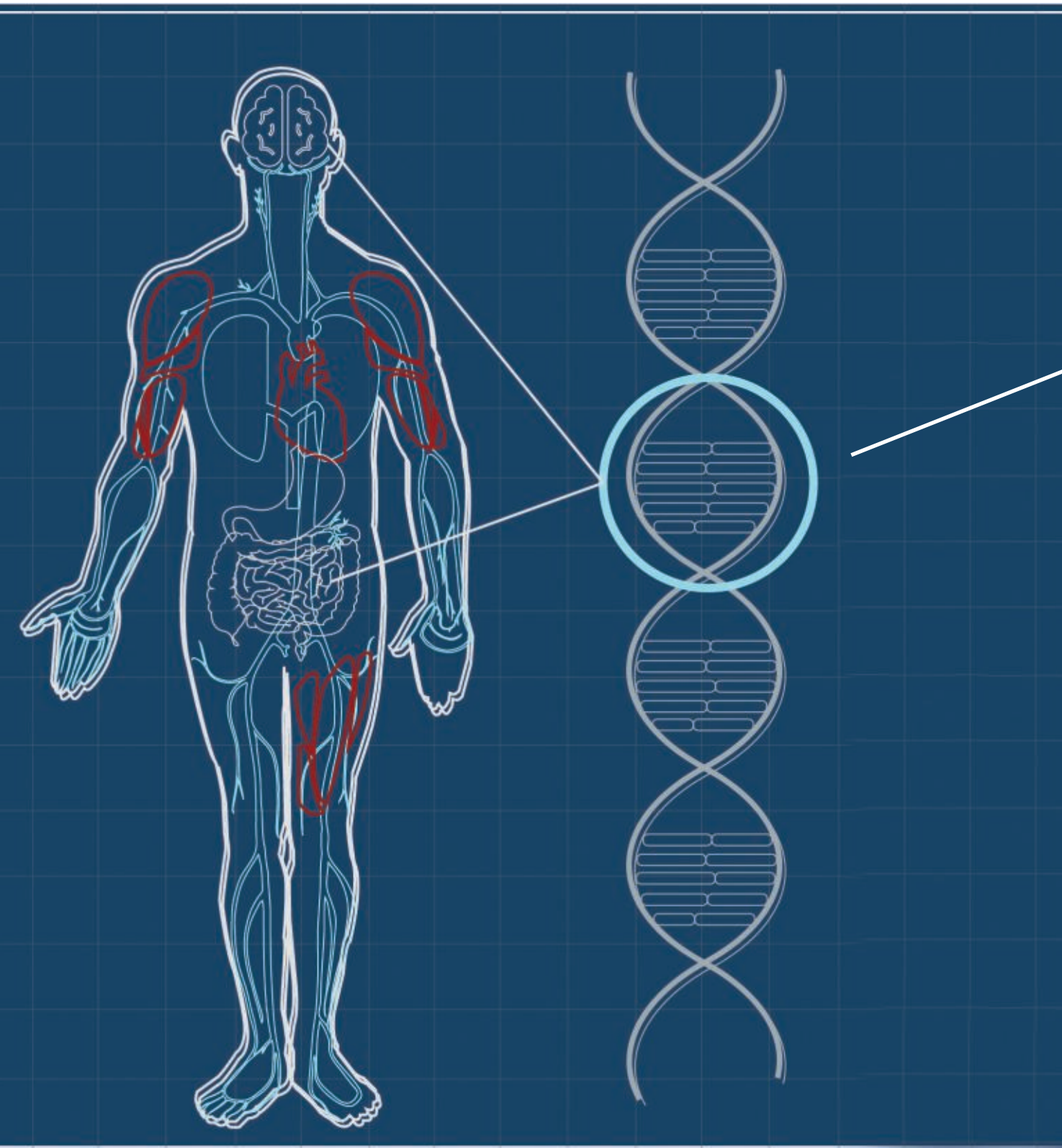
Norway, Denmark and Sweden are also attracting their fair share of companies. Norway recently announced it had signed its largest ever data centre deal with an unknown, international customer in a \$48.1 million deal. Google, Facebook and Apple have set their sights on Denmark, and Sweden’s attractive energy prices have seen companies buying land, signing deals and building data centres to benefit from the cost savings directly – including a 35MW Bitcoin mining facility in Northern Sweden.

The bigger corporations are catching up too – albeit not being as environmentally responsible – with Samsung joining the fray in February this year. Samsung recently became the world’s largest chip maker by revenue, ending Intel’s 25-year dream run after reporting revenues of \$69 billion for 2017. In a move to increase its lead over competitors even further, Samsung has started making crypto-mining chips – better known as ASICs or application-specific integrated circuits.

Just how lucrative is the crypto chip mining business? Last year, Taiwanese company TSMC added between \$350-\$400 million in revenues in Q4 alone from selling crypto-mining chips. As one analyst pointed out, ASICs could account for less than one per cent of its total revenues, but when you consider that Samsung had revenues of \$224 billion in 2017, that’s still a billion-plus opportunity for Samsung.

With Samsung already committing to investing \$27.6 billion in its Pyeongtaek factory by 2021, Samsung’s trajectory in the semiconductor business hopes to see the same meteoric rise in overall revenue as the cryptocurrency market continues to grow.

That also applies to countries in the northern latitudes who hope that their cooler climate and excess of sustainable electricity will continue to attract the crypto miners. †



THE DNA DIET

Looking for a fool-proof, personalised diet plan? Take a DNA test.

DNA tests can now tell you what not to eat. The days of seeking a nutritionist's advice to formulate fitness plans seem numbered with more and more health conscious people resorting to genetic tests to help them devise diet plans specific to their body type.

So, how can a DNA test help achieve weight loss or fitness goals?

Well, just as DNA holds the secret to our ancestry and susceptibility or resistance to certain diseases, it also dictates how we respond to different food and exercise. Nutrigenomics, or the study of how one's genes interact with food and drink, is a field that has taken off since the conclusion of the Human Genome Project in 2003. Clinical and randomized trials across the globe are examining how diet impacts genes and how genes respond to diet.

The DNA fitness test usually consists of a simple kit through which users have to conduct a mouth swab. The test scans 45 gene variants that offer valuable insight into how our body responds to food and exercise. This includes factors such as genes that affect muscle mass; sensitivity to carbohydrates, salt and saturated fat; lactose and gluten intolerance risk; individual anti-oxidant and vitamin needs; and caffeine and alcohol metabolism. The test further helps determine if the taker has the natural makeup for endurance sports or power sports; their aerobic potential and how quickly their body is likely to recover between workouts. Once this is done, the user is then offered personalised diet and training plans.

DNA testing is becoming the fitness trend of the

year. Previously, genetic profiling for fitness was available only to elite athletes. But with a host of companies, such as DNAFit, FitnessGenes and Nutrigenomix offering the service, anyone can now access it. The home testing kit is available online and fitness enthusiasts can buy theirs for prices starting from \$200. People who have taken the test claim it has helped them make more meaningful lifestyle changes to help them get stronger, fitter, faster and healthier.

Genetic testing service 23andMe has genotyped more than two million customers to determine ancestry and genetic health risks, and Nutrigenomix offers tests designed to help medical professionals make recommendations for a person's intake of sodium, omega-3 fatty acids, vitamin C, and — yes, caffeine. People with a variation of the CYP1A2 gene metabolize caffeine more slowly, and are at an increased risk of heart attack and hypertension if they drink more than a couple of cups of coffee a day.

"There is so much information out there about how to lose weight or get fit," says Dan Reardon, the CEO and co-founder of Fitness Genes. To actually get the results you want, he continues, "You have to be able to know what will work for you."

HEALTH IS WEALTH TOO

Apart from a healthier lifestyle, DNA fitness testing is also spawning off a market that will generate \$340 million by 2022 predicts Credence Research Inc. In 2015, it stood at just \$70.2 million. A report by Euromonitor International ranks genetic profiling >



Above & opposite page: A mouth swab is used to obtain a person's DNA. The average test kits scans for 45 gene variants out of the human body's 10 million .

Right: Although DNA tests give a small window into our genetic profile, they can't account for environmental factors such as lifestyle, diet and stress.

among 2018's top 10 global consumer trends. Its growing popularity can be credited to falling prices, better marketing and distribution, and positive regulatory changes.

Singapore's Imogene Labs Pte Ltd., which offers DNA-based, personalised recommendations on skin care, nutritional supplements and fitness in packages, aims to raise \$15 million in a round of venture-capital financing by June this year. They further expect at least a 20-fold increase in sales through new partnerships with spa and fitness chains in 2018. Hong Kong-based biotechnology company Prenetics Inc sold over 100,000 DNA test kits in 2017 – five times more than 2016. They predict sales will double this year when they start marketing the kits not only to consumers but also to insurers. “We’ve seen a lot of demand from individual consumers who want our test,” Chief Executive Officer Danny Yeung said in an interview. “We want to democratise genetic testing.”

ELEMENT OF RISK

It cost as much as \$1 billion to generate the first human genome sequence in 2003. Since then, technological advances have slashed the time and cost of deciphering the body's genetic code. However, experts bemoan the negligence of public education. A layman may not be able to fully comprehend the finer points or technicalities of the 20- to 40- page reports DNA-testing companies offer. It's also worth remembering that the DNA tests give only a small window into our genetic profile – the human body has 10 million gene variants; these tests look at only 45 of them.

“At the moment, I think a lot of the clinical information is not very good, and the potential to scare people is quite high,” said Nina McCarthy, a research fellow at the University of Western Australia's Centre for Genetic Origins of Health and Disease in Perth.

“With home testing kits, consumers may not receive the right guidance in selecting test kits or counseling on how to convey potentially important information to their family. There’s also the risk of breach of privacy since there are grey areas in the agreement on how the companies will use the acquired data.”

“Genetic tests for common disorders, such as cardiovascular disease, will never be completely predictive because such conditions aren’t determined by genetics alone.”

Then there is the question of quality control. Traditional genetic tests were conducted in clinical settings under the guidance of an expert doctor and only if it





was warranted. With home testing kits, consumers can easily bypass doctors removing an essential set of checks and balances. For instance, consumers may not receive the right guidance in selecting test kits or counseling on how to convey potentially important information to their family. There's also the risk of breach of privacy since there are grey areas in the agreement on how the companies will use the acquired data.

"It is important to recognise that while the allure of genetics and the weight of scientific authority that comes with it is promising, results still need to be made sense of in light of each person's life," said Jacqueline Savard, a postdoctoral research fellow in health ethics at the University of Sydney.

The nature-vs-nurture debate remains to the fore: how much of our health is governed by environmental factors? Lifestyle, diet, stress, even pollution can play key roles. The US FDA says it supports tests "that may provide consumers with direct genetic information that can inform health related decisions."

The Academy of Nutrition and Dietetics agrees, writing in a 2014 opinion paper that, "...the use of nutrigenetic testing to provide dietary advice is not ready for routine dietetics practice." In the same paper, the Academy did also characterise nutritional genomics as insightful into how diet and genes impact our phenotypes.

However much a technology may evolve, its success or failure is eventually dependent on the human factor. Genetic testing may be gaining popularity but has it actually made a lasting difference in the lifestyle of the people who have taken it? The answer is a surprising no.

A 2016 study by the University of Cambridge, England, found that "when people had personalised genetic information about their disease risk, plus knowledge about how to lower that risk (quit smoking, eat less, move more, etc.), they were no more likely than the general public to make those changes." †

DNA FIT DIET

SATURATED FAT SENSITIVITY



Long-term overconsumption of saturated fat is associated with many health problems, and limits are advised. However, the way saturated fats are handled varies according to genetic variation – some of us are more efficient at getting fats from food, so in these cases a lower intake is advisable.

LACTOSE INTOLERANCE



Lactose is a sugar present in milk and most dairy products, and it is digested by an enzyme called Lactase. In many people the presence of this enzyme decreases significantly with age – determined by the lactase gene variant. This results in a reduced ability to digest lactose itself, which can cause symptoms of bloating, pain and discomfort for those affected.

CAFFEINE SENSITIVITY



Caffeine is the most common stimulant we ingest on regular basis. Primarily, we get our caffeine from coffee, but also from energy drinks, tea and even certain medicines. While a moderate amount of caffeine is usually harmless, in some people excessive caffeine intake can cause anxiety, insomnia headaches and stomach irritation. Individuals can be classed as slow or fast caffeine metabolisers, determined by personal genetic variation.

SALT SENSITIVITY

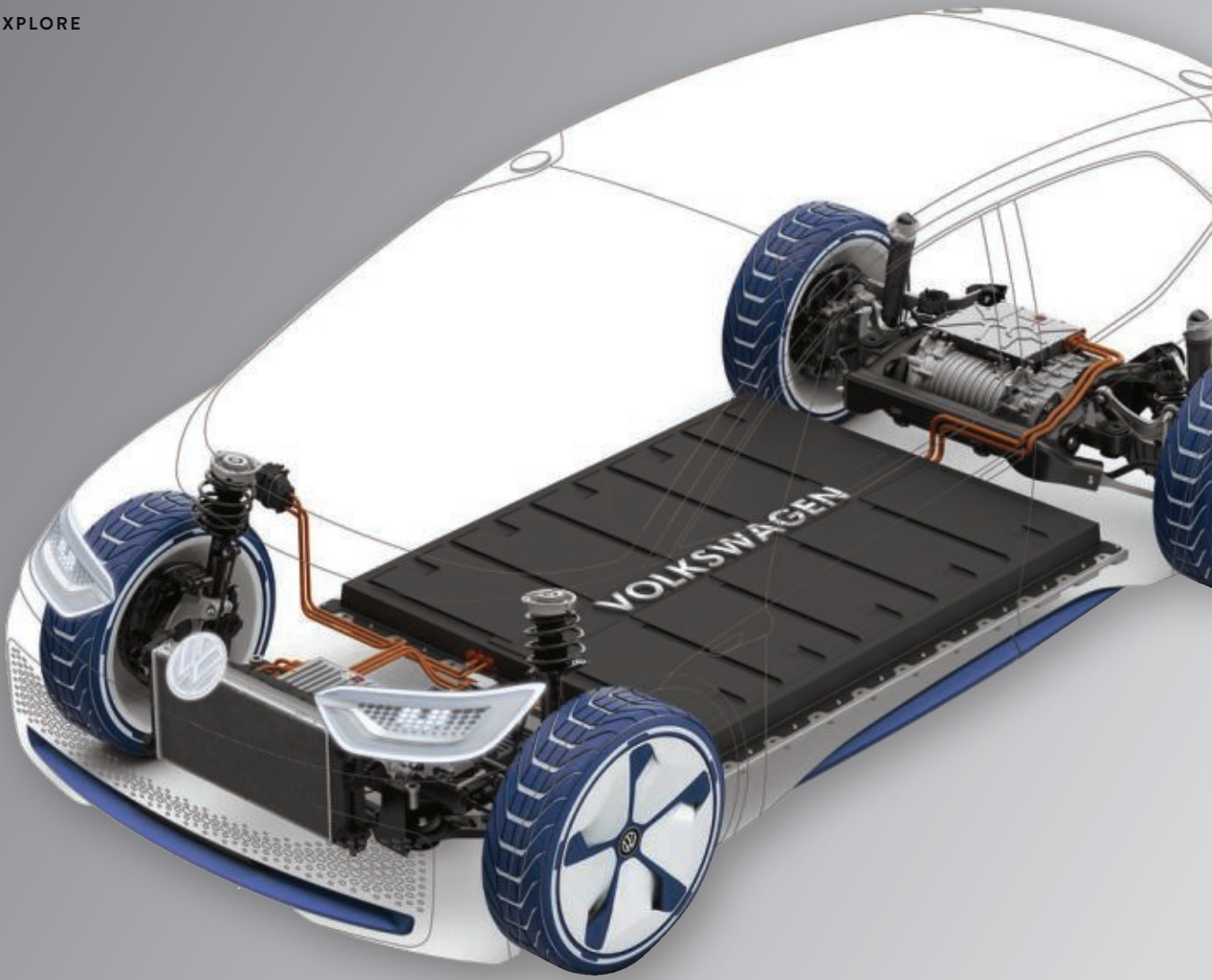


Salt is made up of Sodium and Chloride. For health reasons we are mostly concerned with sodium intake as it can cause high blood pressure in those who are genetically susceptible. Commercial food that we buy from supermarkets often include large amounts of hidden sodium, before we even add salt to cook ourselves. Some individuals appear to be more susceptible than others to hypertension associated with sodium intake.

VITAMIN D NEED



Vitamin D helps us maintain normal blood levels of calcium and strengthens our bone structure. Although it is found in certain foods, our skin can also create Vitamin D when we are exposed to sunlight. Lack of enough vitamin D, over the long term, is associated with increased risks of osteoporosis and other health problems.



POWERING INNOVATION

Professor Rachid Yazami is credited as one of the four co-inventors of the lithium battery, as well as numerous other breakthroughs.



Below: Professor Yazami has invented a chip that monitors the health of lithium batteries, which allows for faster charging.

In 2016, Samsung had to recall their Galaxy Note 7 as their lithium-ion batteries had a tendency to burst into flames. This wasn't the only battery-related scare of 2016, as the CPSC recalled a half-million 'hoverboards' due to similar conflagratory problems. In both cases, after lengthy studies, it was determined that bad manufacturing techniques had led to the faults.

Despite the above extreme examples, lithium-ion batteries are one of the most popular types of rechargeable batteries for portable electronics thanks to a high energy density, tiny memory effect and low self-discharge. When they are properly manufactured they are also extremely safe, but it wasn't always like that. It is thanks to a breakthrough by Moroccan-born Professor Rachid Yazami that we happily carry our mobile phones in our pockets.

"Prior to the 1980s, the use of lithium batteries was

largely uncommon," Professor Yazami explains. "Anode materials in use were then inherently unstable and susceptible to explosions. In 1979-1980, I pioneered the use of the graphite anode as a safer alternative. Today, this technology is used in most commercial lithium batteries."

There are four people directly credited as the co-inventors of lithium batteries: John Goodenough, Yoshio Nishi, Akira Yoshino and Professor Yazami. It was the latter who solved a vexing problem that prevented the commercialisation of lithium batteries.

Professor Yazami's specific contribution was the physical invention of the graphite anode (or, the negative electrode) that allowed the battery to recharge multiple times. Before his breakthrough, the organic electrolytes available at the time would decompose during charging, slowing the development of a rechargeable lithium/graphite battery. Professor Yazami used a solid electrolyte to demonstrate that lithium could be reversibly intercalated in graphite through an electrochemical mechanism. As of 2011, the graphite electrode discovered by Professor Yazami is the most commonly used electrode in commercial lithium-ion batteries.

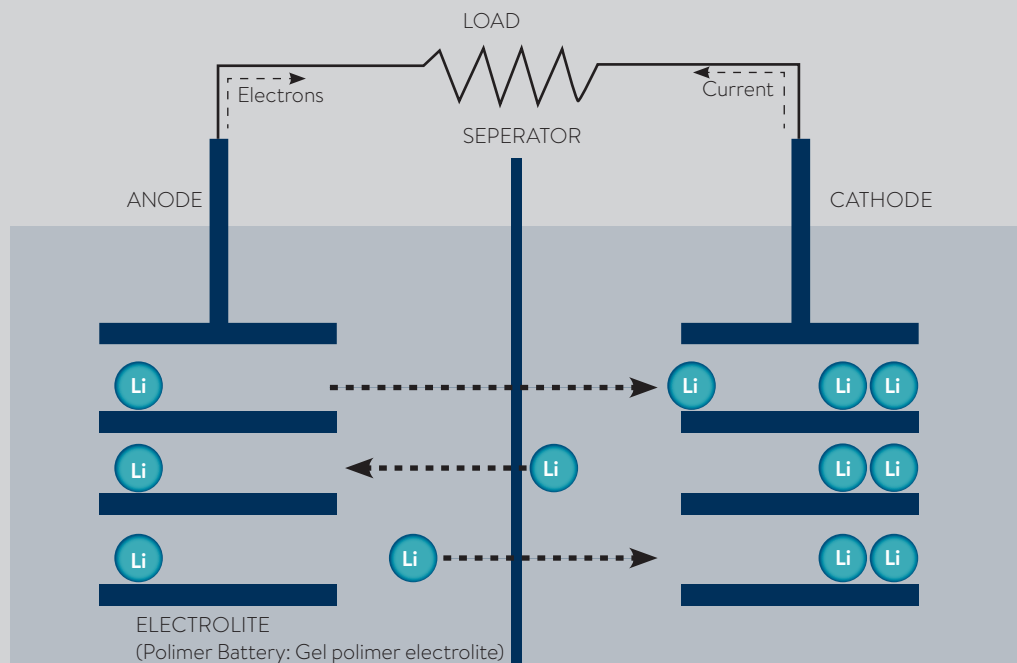
In 2012, Yazami, Goodenough and Yoshino received the 2012 IEEE Medal for Environmental and Safety Technologies for developing the lithium ion battery. Two years later, the American National Academy of Engineering bestowed the Draper Award on Yazami, Goodenough, Nishi and Yoshino for their pioneering efforts in the field. To put it into context, the Draper Award is the equivalent of winning a Nobel Prize in the technology and engineering fields.

However, that's not the only contribution Professor Yazami made. In 2015, he also invented a smart chip that can charge cell phone batteries quicker by using sensors. He is listed as inventor on more than 70 patents related to battery technology and has co-authored more than 250 papers on batteries and their materials and systems.

This begs the question what makes him so inventive. "The answer to that question isn't clear-cut," he says. "It's a desire that started out in a curiosity of what surrounds me. But it was also nurtured by a number of teachers who encouraged this curiosity, which seemed



LITHIUM-ION RECHARGEABLE BATTERY CHARGING MECHANISM



Right: Professor Yazami's latest invention can restore an old lithium battery pack up to 95 per cent capacity in as little as 10 hours.

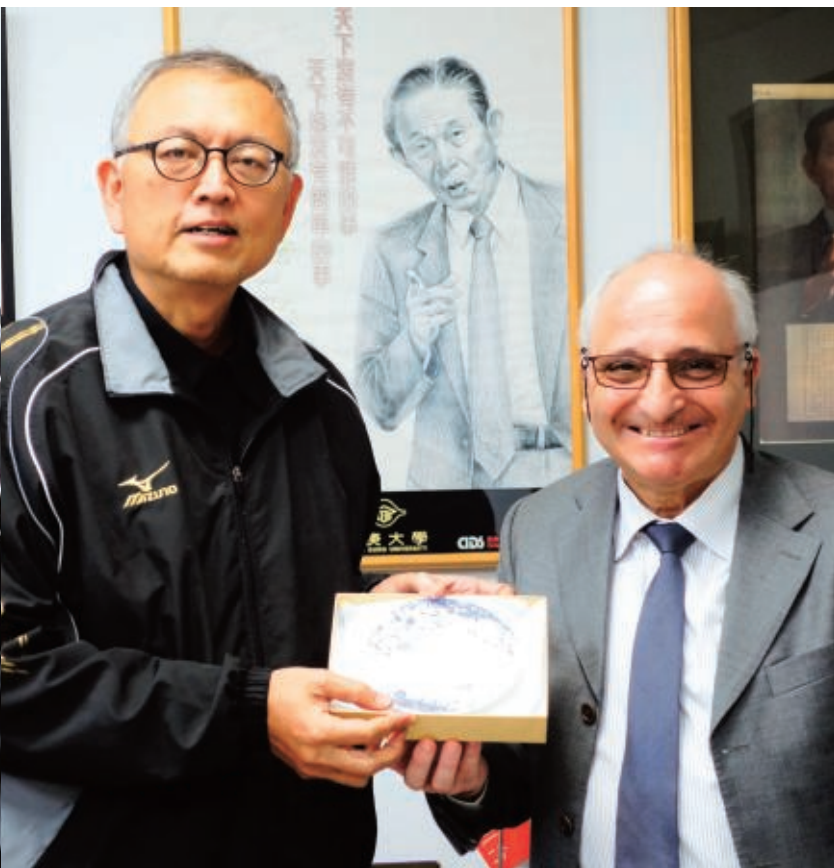


unusual when I was barely eight years old. Before I was passionate about batteries, I became interested in geology. I went into the suburbs of Fez (his home town), I broke the rocks and brought them to the Professor of Natural Sciences who gave me details of what I had collected. Then, there is also the 'I want to invent' component, which is essentially similar to everyone's creativity."

According to Professor Yazami, it was this creativity that guided his choice of studies and specialization.

"My first motivation was the use of creativity to solve the scientific and technological problems of our society. The choice of the field of lithium batteries was taken in 1978, when I decided to embark on a doctoral dissertation at the National Polytechnic Institute of Grenoble (now Grenoble INP). Several research projects were offered to me and they were all equally interesting. However, I chose the one on lithium batteries as I intuitively felt that it was a subject of the future."

Professor Yazami's intuition couldn't have been more correct. By 2020 the handset lithium-ion battery market is expected to be \$7 billion, and the automobile battery market around 10.3 billion dollar. Then there is the growth in battery storage linked to renewable energy. By 2024 it is estimated that the total lithium-ion battery market will reach \$77 billion, with the consumer electronics market taking up the majority of this growth.



These are figures that Professor Yazami is very familiar with.

"The lithium ion battery market is expanding exponentially as new applications emerge on a regular basis," he explains. "This will be particularly in energy storage, including homes, buildings, residences, factories and hospitals, not to mention large renewable energy facilities. The other important area is electromobility, such as cars, trucks and buses. I think our grandchildren will continue to use this battery right across the 21st century."

However, Professor Yazami is clear that there will be more breakthroughs in battery technology and that by 2020-2025 lithium batteries could face a serious challenge. However, until that happens lithium-ion batteries will remain the most powerful on the market.

This brings us to the question of what has happened to his chip that allows for the more rapid charging of a lithium battery. From experience we know it still takes at least 45 minutes to charge your average smartphone battery.

According to Professor Yazami, there has been a lot of misinterpretation around the chip. He explains that current lithium-ion batteries have chips that monitor voltage and temperature – but they don't measure the

Above: Professor Yazami is currently a Principal Scientist and Energy Storage Program Director at the Energy Research Institute at Nanyang Technological University in Singapore.

health of the battery, which degrades over time. Due to this lack of data, batteries have to be charged at a standard, relatively slow speed, to avoid accidentally damaging them. However, his chip monitors potential faults in batteries, thereby increasing safety and allowing for faster charging times.

Professor Yazami stresses that electric batteries aren't at a particularly high risk of failure, but he believes the risks will increase as they are used in more and more products. "Although the risk of a battery failing and catching fire is very low, with the billions of lithium-ion batteries being produced yearly, even a one-in-a-million chance would mean over a thousand failures. In the field of electronics, the technological cycle of an innovation is a decade. So the chip is reaching the market gradually."

A major problem of lithium-ion batteries is that as they are charged and drained, the cells that store electricity slowly begin to deteriorate. Lithium-ion batteries are typically good for between 300 and 500 full recharge cycles before capacity drops to 80-85 per cent, and degradation continues from there.

Here too, Professor Yazami believes he has the answer. Late last year he presented an invention at the International Battery Seminar that is capable of restoring an old lithium battery back up to 95 per cent capacity in as little as 10 hours. The invention works by adding a third electrode to the two poles already present in every lithium-ion battery. This third electrode then drains residual lithium-ions from one of the poles, thus removing "rock content" that prevents battery cells from storing more electricity. "It's like having a chicken with three legs," Professor Yazami explains. "It's a simple enough concept but first you have to come up with the idea."

With the UAE having designated February as the Month of Innovation, we ask what innovation means to him and how young people can persevere and be able to reach the summits in the field of scientific research.

"Innovation equals to an almost natural response to a question posed by a problem," he says. "Curiosity is essential. The essential element of success is work, belief, self-confidence and teamwork. Passion, as well as the art of asking the right questions is needed. Throughout the world, young people will face problems related to the fundamentals of life: water, air, energy and food, the quality of which is crucial to the future of humanity. The awareness that these issues will have to be addressed for future generations should inspire young people to choose science and technology as a vocation to find effective and sustainable solutions to save our planet. It is not too late, but we must act quickly." †

BUILDING A SUSTAINABLE FUTURE

With its unwavering focus on sustainability, the UAE has become a pioneer in exploring ways to build a cleaner and more energy-efficient future – not just for itself, but for the region and beyond.

The annual UAE National Environment Day on February 4th was more fitting than ever this year, on its 21st iteration, as its central theme was 'Sustainable Consumption and Production' (SCP) and it coincided with the Year of Zayed, which celebrates and honours the centenary of the birth of the UAE's Founding Father – Sheikh Zayed bin Sultan Al Nayhan.

Sheikh Zayed was respected all over the world not only as a great national leader but also as a

tireless supporter of the environment with a passionate mission to forge and bequeath a country that promotes social, economic and environmental sustainability. The UAE's Founding Father was a staunch defender of the country's heritage and so deeply committed to protecting its environment and natural resources that he would most certainly approve of the great steps the UAE is taking towards a long term sustainable future.

Speaking on National Environment Day, His

Highness President Sheikh Khalifa bin Zayed bin Sultan Al Nahyan, President of the United Arab Emirates and the Ruler of Abu Dhabi, said it was a chance for everyone to be mindful of consumption levels.

"We have adopted many ambitious national strategies to transform our national economy into a green economy that pays great attention to the environment and the preservation of its resources," HH Sheikh Khalifa stated, adding, "We still have a busy future ahead, and we are all hopeful that our efforts will be met with significant and substantial changes, not only to the awareness level of members of society but also to their patterns of resource consumption."

The SCP theme is critical in supporting the UAE's Vision 2021 National Agenda, which focuses on improving environmental quality, increasing the contribution of clean energy and implementing green growth plans.

His Highness Sheikh Mohammed bin Rashid Al Maktoum, Vice President and Prime Minister of the UAE and Ruler of Dubai, launched the UAE Vision 2021 National Agenda in 2010.

The achievement of this sound government strategy, which will coincide with the UAE's 50th National Day, is based on four pillars. That the country is: United in responsibility – an ambitious and confident nation grounded in its

heritage; United in destiny – a strong union bonded by a common destiny; United in knowledge – a competitive economy driven by knowledgeable and innovative Emiratis; United in prosperity – a nurturing and sustainable environment for quality living.

HH Sheikh Mohammed stated, "Our goal is to establish the UAE as a successful global model combining economic growth, energy sustainability and a clean, safe environment."

HH Sheikh Mohammed's UAE Vision 2021 National Agenda will successfully improve the nation's quality of air, preserve precious water resources, crucially and efficiently increase the contribution of clean energy and consistently implement new and innovative green growth plans. This will ensure sustainable development while preserving the environment, thereby achieving a perfect balance between economic and social development.

The UAE embraces its continual economic growth, but it is deftly transitioning from an oil-based economy to a knowledge-based one, and SCP elevates social and environmental considerations in its value-based growth. In fact, these values are intrinsic to the culture and religion of the region – the Islamic faith takes a very dim view of any form of unsustainable consumption.

In his lifetime, Sheikh Zayed created official institutions such as the Federal Environment Agency and Abu Dhabi's Environmental Research and Wildlife Development Agency, and the present government honours his legacy by maintaining the responsibility of conserving the natural environment.

His dedication was recognised on the world stage in 1995, when the World Wildlife Federation (WWF)





Above and above right: In January HH Sheikh Mohammed bin Rashid Al Maktoum, Vice President and Prime Minister of the UAE and Ruler of Dubai, launched a conservation reserve that spans 10 per cent of the Dubai emirate's total area.

presented Sheikh Zayed with its highest conservation award – the Golden Panda.

Going back from the 21st to the first ever Environment Day in February 1998, Sheikh Zayed said, “We cherish our environment because it is an integral part of our country, our history and our heritage. On land and in the sea, our forefathers lived and survived in this environment. They were able to do so only because they recognised the need to conserve it, to take from it only what they needed to live, and to preserve it for succeeding generations.”

Today, the value of a strong green economy is reflected in the architecture of the country's social, political and economic plans, and infrastructure development and pioneering new technologies in the renewable energy sector abound.

One recent innovation will see the conversion of plastic waste into usable fuel, creating energy from environmentally harmful waste and at the same time raising public awareness about sustainable waste management.

The new partnership between Masdar (Abu Dhabi Future Energy Company) and Envyron Energy is working on upscaling plastic-derived fuel into a transportation grade fuel. The partners are looking at ways to advance the existing plastic-to-fuel technology through new research and development programmes. Following the signing of an agreement between the two parties in December, a plastic-to-fuel demonstration facility is being established at Masdar City in Abu Dhabi. The final goal is to convert the capital city's plastic waste into usable fuel.

There are numerous other developments in the renewable sector including the world's largest Concentrated Solar Power (CSP) project – a AED14.2 billion (\$3.9 billion) project that will be executed by Dubai Water and Electricity Authority (DEWA).

DEWA announced that contracts for the construction of the CSP project, which uses the

Independent Power Producer (IPP) model, have been awarded to a consortium that includes Saudi Arabia's ACWA Power and China Shanghai Electric. HE Saeed Mohammad Al Tayer, Managing Director and CEO of DEWA, said: “Awarding these strategic projects come in line with Sheikh Mohammed's vision... boosting sustainability and turning Dubai into a global hub for clean energy and a green economy through Dubai Clean Energy Strategy 2050, which aims to provide seven per cent of Dubai's power through clean energy by 2020, 25 per cent by 2030 and 75 per cent by 2050.”

The Dubai Clean Energy Strategy 2050 complements and extends the scope of the UAE Vision 2021. It was launched by HH Sheikh Mohammed in November 2015 and it lays out how Dubai aims to produce 75 per cent of its energy requirements from clean sources by 2050. The strategy also aims to make Dubai a global centre of clean energy and green economy. It consists of five main pillars: infrastructure, legislation, funding, building capacities and skills, and an environment friendly energy mix.

Commenting on the CSP project, HH Sheikh Mohammed said, “The UAE has succeeded in building a global green economy model based on environmental sustainability and clean energy and supported by clear plans. These plans will contribute to strengthening the foundations of such a model, developing it according to the world's finest standards so as to make the most of this field and invest in enhancing infrastructure, building capabilities and training competent national cadres.”

HH Sheikh Mohammed added, “Implementing the world's largest concentrated solar power (CSP) project reaffirms the UAE's leadership in renewable clean energy all over the world and enhances our status at the forefront of the most advanced countries in this field. We are pressing ahead with carrying out projects that support the UAE's comprehensive development



WASTE-TO-ENERGY PROCESS



and our aspirations that we have set for the future and are being implemented today.”

The UAE’s wise rulers and government are continuing down the path laid by Sheikh Zayed by building on his legacy and ensuring the country embraces sustainable development while preserving the environment. The Year of Zayed will be filled with numerous events and special awards across the UAE, all of which will elevate the ideas of the great leader and uphold the values he lived by, especially tolerance, charity and environmentalism.

Beyond the landmark date of 2030, the UAE Centennial 2071 aims to cement the UAE as one of the most environmentally progressive countries in the world within the next 50 years. Executing the current strategies will allow the UAE’s future generations to inherit a system with high-quality education, a productive and sustainable green economy, a more community-based integrated society and a healthier environment.

Sheikh Zayed’s vision had its foundations in a passionate belief in social, economic and environmental sustainability. He was dedicated to the needs not only of the present generation, but to the unborn generations who will inherit the land. His closing words are as crucial today as ever before:

“With God’s will, we shall continue to work to protect our environment and our wildlife, as did our forefathers before us. It is a duty, and if we fail, our children, rightly, will reproach us for squandering an essential part of their inheritance, and of our heritage.”†

Above: Dubai is building the world’s largest Concentrated Solar Power project. By 2020, the emirate plans to get 25 per cent of its electricity from clean energy sources.

Left: Dubai Municipality announced the launch of a AED2.5 billion solid waste-to-energy (WET) plant in January that will power 120,000 homes in Dubai by 2020.

BREACHING THE DIGITAL

Internet penetration and mobile phone access has risen dramatically in the world's least developed countries, yet challenges remain.



According to data provided by the International Monetary Fund, India is the world's leading cash-based economy. Imagine the country's state of affairs when its Prime Minister, Narendra Modi, together with the upper echelons of the country's government decided to suddenly remove 86 per cent of its currency circulation without having an adequate supply of new notes ready to take their place. Overnight, hundreds of millions of people were left without the means to engage economically, to buy the things they wanted and needed, and myriad businesses were left without a readily available mechanism to receive payments, buy supplies, or even pay their staff.

President Modi and his supporters hoped demonetization would fight corruption by catching India's black market off guard. In order to do that, President Modi's government nullified all 500 and 1,000 currency denominations, and then

eventually replaced them with newly designed, more secure 500 and 2,000 rupee notes. This endeavour instantaneously became policy when the Prime Minister announced it via a surprise television address at 10:15 PM on November 8, 2016.

Up until India's demonetisation, cash accounted for upwards of 95 per cent of all transactions, 90 per cent of vendors didn't have card readers or the means of accepting electronic payments, 85 per cent of workers were paid in cash, and almost half of the population didn't even have bank accounts. The government's action was the push India desperately needed in order to keep pace with the rest of the world. While developed markets have been using plastic money for a while, India was also sitting behind a few third-world countries in terms of volumes of e-transactions. As Indians stuck to their adage of hoarding cash, Kenyans were paying for goods through mobile phones for the better



DIVIDE

part of a decade and homeless people in Sweden have been given card readers by Situation Stockholm to sell freely distributed newspapers and to receive alms since potential donors no longer carry cash.

It's not just the developed markets that are experiencing this digital boom. According to reports compiled by the International Telecommunication Union (ITU), even the world's poorest countries now have access to the internet and mobile devices. The report comes as a sigh of relief for the United Nations agency considering that just two years ago, many believed that it would certainly miss the mark on its plan to bring the world online by 2020. In fact, an Alliance for Affordable Internet report at the time suggested that the ITU would miss its mark by more than 20 years. However, per its new report – released in January – the ITU claims that 47 of the world's Least Developed Countries (LDCs) are making huge strides in increasing their internet access, with more than 60 per cent of LDC populations covered by a 3G network, referring to a third generation or advanced wireless mobile telecommunication technology. The report, titled *Achieving Universal and Affordable Internet in Least Developed Countries*, also states that four in five people in said LDCs have access to a mobile cellular network.

The benefit of being wired is already having a positive impact on a slew of areas including financial inclusion, poverty reduction and better health services. Per the report, by the end of last year, the number of mobile subscriptions among these countries had

increased to about 700 million with a penetration of 70 per cent. The report added that the LDCs are also on track to reach on average 97 per cent mobile broadband coverage and to make internet prices relatively affordable by 2020.

Despite moving so far forward in such a short span of time, it is estimated that about 800 million people – about 12 per cent of the world's population – in these countries still remain offline. Moreover, the expected rise is not likely to impact favourably on the widespread use of the internet by 2020 among the population of the LDCs. The report states that the ability to use the internet will not match that of coverage and affordability due to the underdeveloped human skillset among many people. The key recommendation coming out of the ITU is for governments to make the link between strategic information and communication technologies (ICTs) sector plans and educational policies.

A few from the 47 LDCs – 33 of which are from Africa – have recently progressed to developing country status. Cosmas Zavazava, Chief of Department, Projects and Knowledge Management at the ITU said, "There is a correlation between the development of these countries and access to the internet. Now the service needs to be made more affordable, to further unlock value. As technology becomes cheaper, and demand increases, the ITU is now looking at how it can help countries reach the Sustainable Development Goals."

The Government of India is fully aware of the importance of technology, especially in agriculture. ➤



Above: Being online is an important part of poverty reduction, yet about 800 million people in the world's Least Developed Countries have no internet access.

Right: M-Pesa, a mobile banking network launched in Kenya in 2006, now has 30 million users in 10 countries and a range of services including international transfers, loans, and health provision.

Through its Digital India programme, the government is working to transform the country's rural economy and create skilled jobs in rural areas. For the estimated 156 million Indian rural households, most living in poverty according to India's National Sample Survey Organisation (NSSO), there is need for investment in transportation, power, and internet access to create more employment for women and youth in rural areas.

In April 2016, President Modi launched eNAM (National Agriculture Market), a platform for farmers that integrates agricultural markets online, allowing farmers and traders alike to view all Agriculture Produce Market Committee-related information and services, commodity arrivals and prices, and buy and sell trade offers, thus helping farmers bid for the best prices across markets. The government of India also launched a crop insurance scheme, the Pradhan Mantri Fasal Bima Yojana (PMFBY) in 2016, which now covers 37 million farmers.

Digitised land registration, mobile phones and 'Uberised' tractor services all are contributing to improved farm management. Digital India Land Records Modernisation Programme (DILRMP) is updating millions of land records, providing title guarantees and increased security of land tenure to farmers while stimulating land rentals by nonviable smallholders and land consolidation.

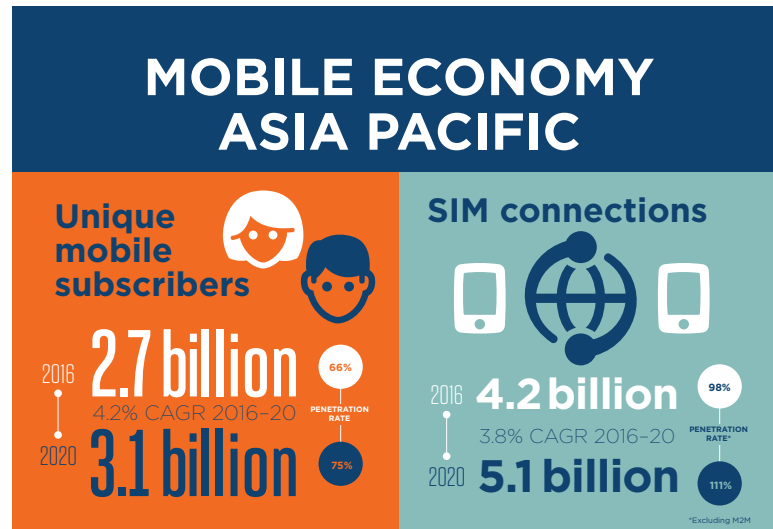
Health is also benefiting from the spread of technology. Rwanda recently introduced the use of drones to deliver blood across the country. The drones use GPS





navigational data and the cellular network to transmit information to air traffic control and the base station, and for health workers to send text messages when blood is needed. Although the cost per trip is roughly the same as the current method by motorbike or ambulance, it is much faster and demonstrates where least developed countries are ahead of the technological curve.

Technology can also accelerate learning of basic and advanced skills. Eneza Education, based in Nairobi, Kenya, delivers tailored and original educational content created by Kenyan school teachers to students via three platforms: regular web, mobile web via Android,



ACCELERATING MOVES TO MOBILE BROADBAND NETWORKS AND SMARTPHONE ADOPTION

Mobile broadband connections to increase from 53% of total in 2016 to

72%
by 2020

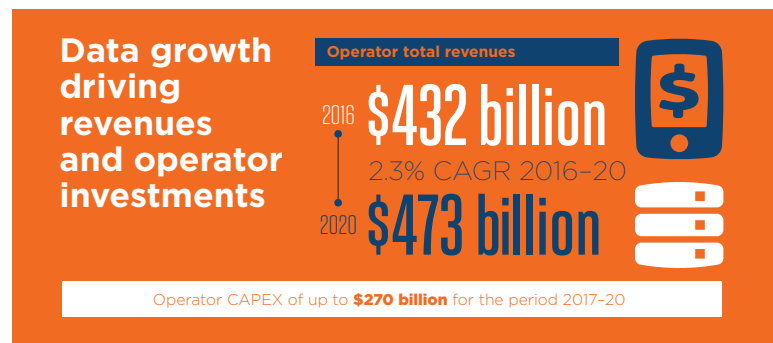
By 2020, there will be

3bn
smartphones, growth of
1 billion from the end of 2016

Mobile data traffic to grow by a CAGR of

4.2%
over the period 2016-2020

Source: Ericsson



or simple SMS via a basic mobile phone. The service has surpassed one million users and has expanded to Ghana and Tanzania.

While the future is, as always, uncertain to see, this we know: The next billion people who are coming online will do so from cheap, mobile phones. While the cost of phone service is falling globally, fixed broadband – typically more reliable and faster than cellular connections – is actually becoming more expensive in the poorest countries. That is unfortunate, as McKinsey & Company estimates that if internet access reaches the same level of penetration as mobile phones in Africa, the continent's GDP could get a boost of up to \$300 billion.

The ITU report also shed light on the large gender gap in who uses the internet. In the least developed countries, only 8 per cent of females used the internet in contrast to 11 per cent of males. Those statistics echo a separate UN report that found that women in low- and middle-income countries are 21 per cent less likely to own a mobile phone, helping perpetuate inequality between men and women. The ITU also hopes to achieve gender equality among internet users by 2020. ↑

Left: In 2016 the Indian government launched eNAM (National Agriculture Market), an online platform for farmers that integrates agricultural markets online.

DECIPHERING HUMANITY'S BLUEPRINT

Fifteen years ago the \$2.7 billion Human Genome Project successfully concluded after mapping around 23,500 genes.



“At a really basic level our DNA is a unique recipe, a list of both ingredients and instructions, that controls every aspect of us as individuals,” says Dave Coplin, Chief Envisioning Officer at The Envisioners. “Found in every cell in our bodies, this recipe controls everything that makes each human being unique. From the colour of our eyes and hair, to whether and when we may go bald, right through to the diseases we may be most at risk of, our DNA is essentially a blueprint for humanity.”

Almost 30 years ago, the Human Genome Project set out to try and decipher this blueprint. To understand both the list of ingredients and the sequence in which they are implemented. An international research project, it has subsequently been described as one of the great feats of exploration in human history – an inward voyage of discovery rather than an outward exploration of the stars.

Co-ordinated by the National Institutes of Health and the US Department of Energy, it was launched in 1990 and sought to sequence and map all of the genes – together known as the genome – of members of our species. A sequence that not only encodes the genetic instructions for human physiology, but also holds rich information about human evolution.

“By breaking DNA’s genetic code, we could prevent and potentially eradicate diseases like cancer, as well as helping us to create new forms of medication,” says Coplin of the thinking behind the project. “It would also have other benefits in helping us understand and unlock the DNA in other organisms around us, leading to new opportunities in almost every area from farming to energy and beyond.”

The project was designed to be completed over 15 years but concluded two years ahead of schedule in 2003. The main goal of the project – to sequence the DNA nucleotide sequence of the entire human genome and map all human genes (about 23,500 genes) – gave scientists the ability, for the first time, to read nature's genetic blueprint for building a human being.

"The significance of this project cannot be understated," says Coplin. "Understanding the human genome will have a profound effect on humanity. It will offer us the chance to beat diseases and conditions that have threatened our quality of life since time began. Crucially, this power will also present one of our society's most difficult ethical challenges as unlocking the mystery of DNA will enable those who crack the key to play God and to decide what attributes we will allow in our society and which we will eradicate. For the first time in human existence

we will have extended beyond the laws of evolution and natural selection."

Amin F. Majdalawieh, Professor of Biochemistry and Molecular Biology at the American University of Sharjah, agrees. "Determination of such DNA sequences and understanding the functions of gene products is very critical for our understanding of how non-infectious diseases (such as epilepsy, autism, cystic fibrosis, cancer) arise," he says. "Knowing the nucleotide sequences of genes and their map features allows researchers to identify the molecular basis of genetic abnormalities caused by mutations (alterations in the nucleotide sequences of genes). This information aids in the diagnosis, treatment, and even prevention of various diseases that affect humans."

The Human Genome Project, however, has not only been significant in the field of medicine. It has also impacted other fields, such as biotechnology, nutrition and genetic engineering. "Although the main advantage of the Human Genome Project is to accurately diagnose and treat diseases, it has been an asset in improving forensic investigation, genetic fingerprinting, pharmaceuticals >



"By breaking DNA's genetic code, we could prevent and potentially eradicate diseases like cancer, as well as helping us to create new forms of medication. It would also have other benefits in helping us understand and unlock the DNA in other organisms around us, leading to new opportunities in almost every area from farming to energy and beyond."

Right: Recently developed techniques to easily modify DNA, known as “genome editing,” are bringing many new possibilities as well as dilemmas to the forefront of medicine, ethics, religion and society at large.



production, and gene therapy,” says Majdalawieh.

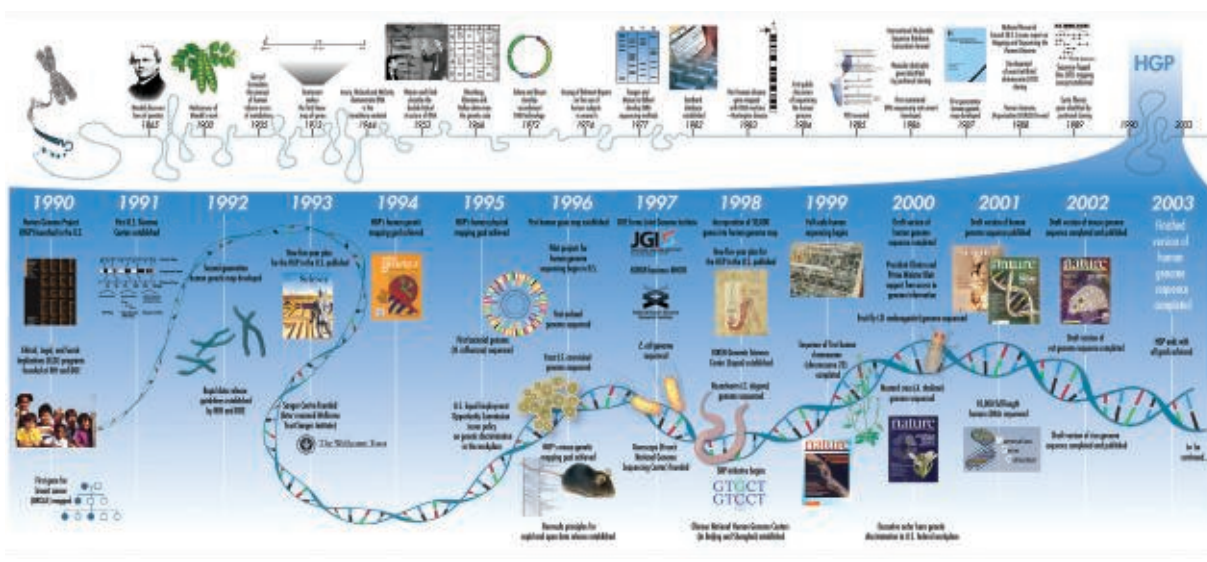
The enormity of the project’s achievement cannot be overstated. Human DNA is incredibly complex, consisting of 3.3 billion chromosome pairs with each pair controlling a different aspect of any given human. And while researchers from around the world, including from the United Kingdom, France, Australia and China, were able to correctly decipher and sequence just over 90 per cent of human DNA, gaps in understanding nevertheless persist.

In a 2004 article for *Nature* magazine, the International Human Genome Sequencing Consortium reported that there were 341 gaps in the sequence, most of which are associated with “segmental

duplications and will require new methods for resolution”. The majority of these gaps – 250 – are in the main part of each chromosome, where genes make the proteins that life runs on.

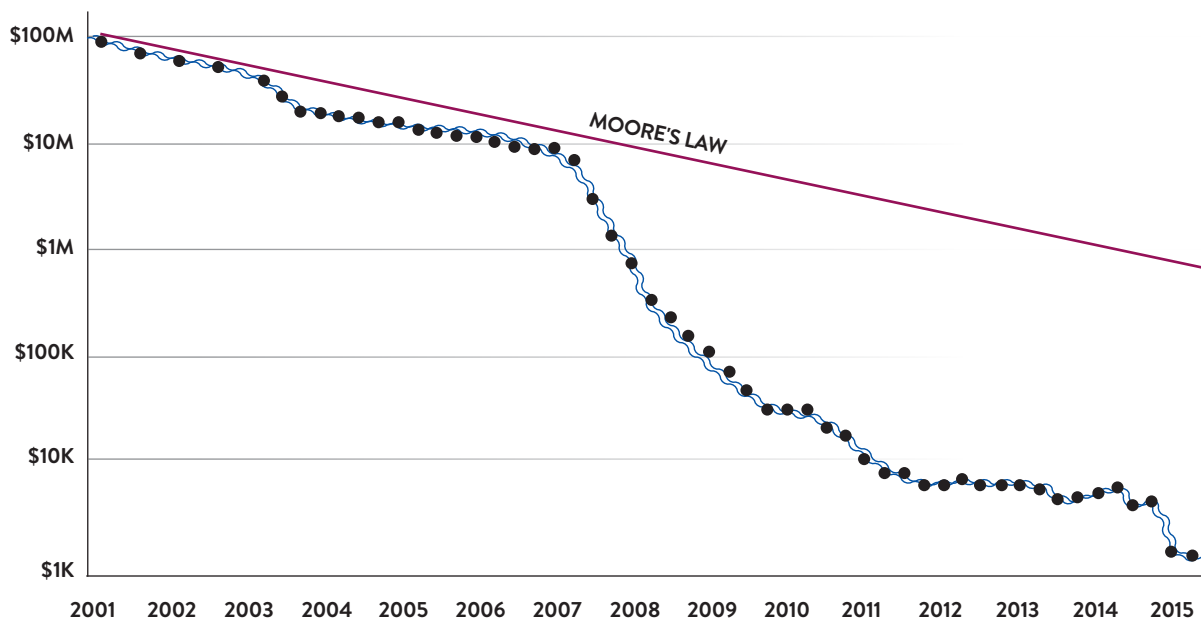
“The euchromatic portion of the human genome is still not complete,” the consortium admitted. “The issue is no longer scale, but rather the need for new approaches to understand and resolve these recalcitrant segments. Continuing efforts should be devoted towards the eventual goal of complete closure. Nonetheless, the euchromatic human genome can now be regarded as effectively known.”

“Whilst we still don’t truly understand all of the ingredients and the way in which they interact, we at



COST PER GENOME

Source: www.genome.gov/sequencingcosts



least have a more or less complete list of what they are and in which order they appear,” adds Coplin.

Deciphering the human genome, however, was just the beginning. Sequencing the human genome has paved the way for many more research goals.

“Researchers are currently working on identifying the various genetic and non-genetic elements that control the expression of genes,” explains Majdalawieh. “As proteins are the molecular manifestations of gene expression, understanding the folded structures of such proteins is a major objective.

“New technologies are currently being developed in an attempt to store a tremendous amount of genetic data and to create gene banks. In addition, given that the genomes of other organisms have also been determined, scientists are pursuing comparative genetic analyses to draw some evolutionary relationships between humans and other organisms.

“Moreover, although the human genome has been sequenced, scientists are also interested in finding variations in the genomes of different people as each individual has their own genetic blueprint. Such variations, which could be very minute, could help us better predict one’s risk of developing

HUMAN GENOME

Who owns the human genome?

Every part of the genome sequenced by the Human Genome Project was made public immediately – in fact, new data on the genome was posted every 24 hours. It is true that private companies have filed thousands of patents on human genes over the past several years.

Is the human genome completely sequenced?

Yes – within the limits of today’s technology, the human genome is as complete as it can be. Small gaps that are unrecoverable in any current sequencing method remain, amounting for about one per cent of the gene-containing portion of the genome, or euchromatin. New technologies will have to be invented to obtain the sequence of these regions.

How much did the Human Genome Project cost US taxpayers?

In 1990, Congress established funding for the Human Genome Project and set a target completion date of 2005. Although estimates suggested that the project would cost a total of \$3 billion over this period, the project ended up costing less than expected, about \$2.7 billion in FY 1991 dollars. Additionally, the project was completed more than two years ahead of schedule.

It is also important to consider that the Human Genome Project will likely pay for itself many times over on an economic basis – if one considers that genome-based research will play an important role in seeding biotechnology and drug development industries, not to mention improvements in human health.

What will the next 50 years of medical science look like?

Having the essentially complete sequence of the human genome is similar to having all the pages of a manual needed to make the human body. The challenge to researchers and scientists now is to determine how to read the contents of all these pages and then understand how the parts work together and to discover the genetic basis for health and the pathology of human disease. In this respect, genome-based research will eventually enable medical science to develop highly effective diagnostic tools, to better understand the health needs of people based on their individual genetic make-ups, and to design new and highly effective treatments for disease. ➤

specific diseases. In addition, genomic variations among different ethnic groups may provide plausible explanations as to why certain diseases are more common among individuals of specific groups or denominations.”

It is the new technologies associated with genome research, however, that excite Coplin the most. Amongst them is Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR).

“CRISPR is a simple yet powerful technology that can be used for ‘editing’ DNA,” says Coplin. “Researchers are hoping that through its use we might be able to edit out parts of our DNA that cause disease or alter the DNA of viruses to prevent them from being harmful to humans.

“As you can imagine, editing DNA is incredibly complex, but through the application of modern computing technologies like machine learning, computer scientists working with the researchers are able to do in weeks what would have taken traditional methods and computers 200 years. The net effect of this is to dramatically improve the success rates of the technique whilst at the same time accelerating further research in this space.

“This is just one example from many thousands of others that show how advances in technology will massively accelerate advances in DNA science. Our key challenge now will be more about whether we can keep up with the developments and ensure that the ethical debates and necessary regulation stays relevant.”

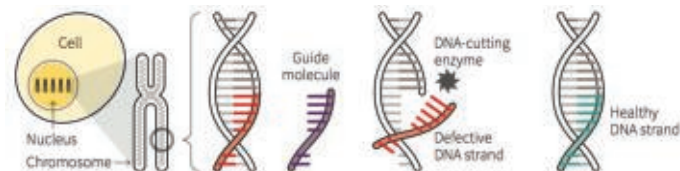
Right: Type 2 diabetes affects 10 per cent of the world’s population, but the underlying genetics of the disease are poorly understood.

DNA EDITING

Source: Reuters; Nature; MIT

A DNA editing technique, called CRISPR/Cas9, works like a biological version of a word-processing programme’s “find and replace” function.

HOW THE TECHNIQUE WORKS



A cell is transfected with an enzyme complex containing:

- Guide molecule
- Healthy DNA copy
- DNA-cutting enzyme

A specially designed synthetic guide molecule finds the target DNA stand

An enzyme cuts off the target DNA strand.

The defective DNA strand is replaced with a healthy copy.





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