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FEATURING

IR 4.0

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CONTENTS

FEATURES

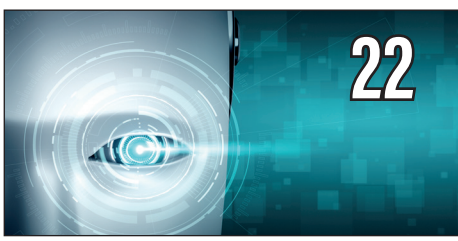
16 17 ways technology could change the world by 2027
- innovation is critical to society's future well-being

22 The Impacts of IR 4.0 on Jobs and the Future of the Third Sector
- it changes how we will live and work

32 Is Africa ready for digital transformation?
- companies and industrial processes need to adapt to this rapid change

GENERAL

6 INDUSTRY AFFAIRS
10 NEWS
48 OPINION PIECE
51 EVENTS CALENDAR



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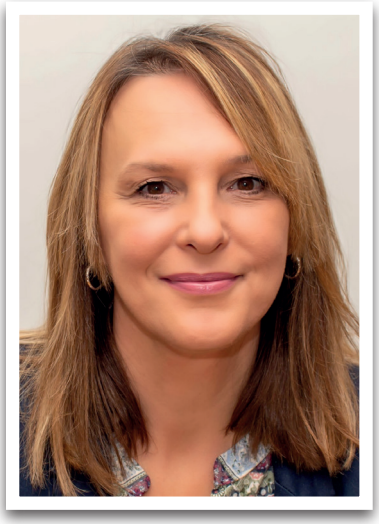

Dear **watt**now reader,

This issue brings you information on changing times.

The Fourth Industrial Revolution, 4IR, or Industry 4.0, conceptualises rapid change to technology, industries, and societal patterns and processes in the 21st century due to increasing interconnectivity and smart automation.

Our feature articles look at every aspect to understand the do's and don'ts.

The first feature article, "17 ways technology could change the world by 2027", gives a futuristic look at how innovation is critical to society's future well-being and driving economic growth. Read this on page 16.

The flipside of the coin tackles the "Impacts of the fourth industrial revolution on jobs and the future of the third sector". Many commentators are increasingly talking about the potential impact of the "4th Industrial Revolution." It will change how we live and work, how the economy works and how we are governed. For example, a Citi and Oxford University joint report in 2016 estimated that 57% of jobs across the OECD are at risk of automation.
Read this on page 22.

In our last feature article, we ask: "Is Africa ready for digital transformation?". Around the world, the traditional manufacturing industry is in the throes of a digital transformation that is accelerated by the exponential growth of smart technologies. Companies and industrial processes need to adapt to this rapid change and exponential growth if they are not to be left behind by developments in their sector and by their competitors. Read this on page 32.

The August issue features Manufacturing. Please send your articles or papers to minx@saiee.org.za. The deadline is 18 July.

Herewith the July issue; enjoy the read!

Minx

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OUR GOAL IS TO ENSURE SAFE & COMPLIANT PRODUCTS IN SOUTH AFRICA

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INDUSTRY AFFAIRS

SAIEE President visits Vaal Centre

Members and guest in attendance with Mr Prince Moyo, SAIEE President, 3rd from right.

SAIEE President Prince Moyo recently visited the SAIEE Vaal Centre to meet with members and engage in a panel discussion - still keeping to his inaugural theme: "Information Analytics and decision-making in business".

Engineers add value to society, and their trade is indeed a service to humanity. Despite massive progress, engineers are still faced with many grand challenges. Inevitably, the exercise of the engineering trade crosses paths with other necessary trades, chief among them that of making technical decisions with multiple competing priorities. In taking these technical decisions, one is expected to make the most optimal decision.

Carlisle Sampson, Vaal Centre Chairman, said: "It was a successful and engaging event, with attendees from various industries in the area, including Sasol, Proconics, Arcelor Mittal, Eskom, Emfuleni municipality, VUT, small business owners and some retired engineers as well".

"We are honoured that Proconics sponsored the evening for us - a big thank you to them!" he concluded. wn

What's a DMM?

Technology is rapidly changing our world. Electrical and electronic circuitry seems to permeate everything and continues to get more complex and smaller in size. The communication industry booms with cell phones and pagers, and Internet connections have put more pressure on electronics technicians. Servicing, repairing, and installing this complex equipment in these environments requires diagnostic tools that provide accurate information.

So what EXACTLY is a DMM? A DMM is simply an electronic tape measure for making electrical measurements. It may have any number of special features, but mainly a DMM measures volts, ohms, and amperes. DMMs measure faster, more efficiently and with greater accuracy, in almost any job in any industry. The three watchwords when selecting your DMM are SAFETY, QUALITY and PERFORMANCE. Fluke models include handheld troubleshooters to ultra-smart instruments packed with features, including the ability to log and graph data, as well as high-precision bench units.

For more info, contact COMTEST - email: sales@comtest.co.za
www.comtest.co.za

Fluke's DMM range

Danfoss to apply for Guinness World Record after E-ferry Ellen sails more than 90 kilometres on a single battery charge

Industry, government, and civil society leaders joined the International Energy Agency (IEA) for the 7th Annual Global Conference on Energy Efficiency. The islands of Ærø and Als in Southern Denmark are connected by Ellen, the longest-ranging fully electric ferry in the world. Ellen set a new world record on June 9 just outside the windows in Sønderborg, Denmark.

On her return from the conference, where participants explored how international ambition on energy efficiency can be translated into faster and stronger real-world progress, Ellen sailed 50 nautical miles – 92 kilometres – on a single battery charge.

Senior Lecturer, Marstal Naval Academy, Denmark, Henrik Hagbarth Mikkelsen, who helped specify the technical solutions for the ferry during its design phase, was on-board for the trip: "The 92-kilometre trip on a single battery charge is the longest planned distance for an electric ferry able to carry passengers and vehicles to date anywhere on the globe. We are talking about a clear record. On its regular, daily trips, the ferry sails 22 nautical miles, or 40 kilometres, from harbour to harbour before recharging."

Danfoss has supplied electric Editron drivetrains and propulsion motors for the ferry. Ellen does not emit carbon and operates at a 24 per cent lower cost than a new diesel ferry. She started sailing in 2019.

Kimmo Rauma, Vice President, Danfoss Editron: "Ellen is an excellent example of the future for electric transport. It's cleaner, greener, and more efficient than her fossil fuel competitors. Electrifying maritime transport is a clear-cut way to reduce greenhouse gas emissions. And Danfoss has the solutions to build new electric ferries and retrofit existing ones to electrify them with the potential to reduce carbon emissions all over the world."

Danfoss Editron plans to submit the world record to Guinness World of Records.

FACTS ABOUT MARITIME TRANSPORT:

27% of all global energy-related CO_2 emissions come from transport. With 4.27 billion passengers and 373 million vehicles transported by ferry yearly, ferries are significant carbon emitters and often sail close to cities, where they add to the already critical air pollution levels. Electric ferries such as Ellen can help solve the problem. wn

INDUSTRY AFFAIRS

Dealing with fire risk in a mining environment

Michael van Niekerk | CEO | ASP Fire

Mining vehicles such as excavators, haul trucks and even drag lines are high-value assets that operate in arduous conditions where there is a high fire risk. This means that pre-shift and weekly inspections on mining vehicles are essential to ensure that the fire prevention system is in good working order.

"We assist mining operations to mitigate any risk posed by fire, which can affect productivity and profits," says ASP Fire CEO Michael van Niekerk. The fire engineering expert designs systems to suit individual vehicles and their specific requirements. This means examining the conditions not only inside the vehicle, but also within the surrounding environment.

The design and installation of a vehicle fire-protection system requires that mining vehicles are subjected to a Hazard Identification and Risk Assessment (HIRA) of potential fires. Each vehicle needs to be assessed carefully within its specific operating environment to understand what hazards and fire risks that vehicle is exposed to.

Inherent fire risks include the turbochargers and brake system overheating, as well as high-pressure hydraulic systems and electrical equipment that may ignite a combustible or flammable component of the vehicle. Although Dry Chemical Powder (DCP) extinguishers are highly effective in firefighting, they offer minimal cooling properties. This results in re-ignition of flames, especially in liquid fuel and rubber fires, thereby increasing the risk of property damage and loss of life. The powder inside DCP extinguishers can also compact due to vibration when placed on a moving vehicle.

The compacted powder increases the risk of malfunction when activated. As a result, DCP extinguishers placed on mobile equipment need to be serviced more frequently. DCP extinguishers also pose serious operator and environmental hazards. When used in confined spaces, they can affect the fire respondents' visibility and capability to effectively suppress the fire, or to safely evacuate an area should the fire spread out of control.

A much more effective and 'greener' solution is water-mist handheld fire extinguishers. Utilising water as the main agent and nitrogen as a propellant, these can extinguish most types of fires, including rubber and plastic, diesel and petrol fires, and electrical fires rated up to 245 kV.

The atomised mist generated by the extinguisher increases the surface area of the water by more than a hundredfold. The micro-droplets rapidly turn into cold steam when meeting burning or very hot materials, further increasing the surface area by 1 600 times. The endothermic reaction effectively cools down any hot surfaces in the immediate environment. Not only is the fire extinguished, but any hot spots also cool down without any thermal shock. The thermal heat radiation barrier created allows the operator to approach the fire without sustaining burns to deploy the extinguisher. A protection mechanism eliminates any false alarms. This consists of a heat-sensitive pressurised activation tube that requires heat to rupture and open a differential valve on the main cylinder to activate the system.

Another solution offered by ASP Fire is an Aqueous Film Forming Foam (AFFF) for fire-extinguishing and vapour suppression of hydrocarbon fuel fires. The AFFF blanket blocks oxygen supply to the fuel and cools any hot flammable liquid by effectively sealing the surface. wn

Enel Green Power South Africa connects to the national grid with Karusa Wind Farm

Enel Green Power South Africa (EGP RSA) has connected to the electricity grid a 147 MW Karusa wind farm, which is located in a remote part of the Laingsburg Local Municipality in the Western Cape and will be able to generate more than 500 GWh annually, potentially averting the emission of approximately 500,000 tons of CO_2 into the atmosphere annually. Karusa features the Vestas V136-4.2MW wind turbines, the largest on the African continent to date.

Awarded to Enel Green Power in 2016 as part of round four of South Africa's Renewable Energy Independent Power Producer Procurement Programme (REIPPPP), the wind farm is supported by a 20-year Power Purchase Agreement with South African energy utility provider, Eskom.

With the Karusa wind farm operational, EGP RSA now has six wind farms up and running, including Nojoli (88 MW), Oyster Bay (148 MW), Nxuba (148 MW), Gibson Bay (111 MW) and Garob (145 MW), with its Soetwater (147 MW) wind farm also expected to achieve commercial operation during July 2022.

The company has ten operational wind and solar projects in South Africa. Once all current projects are in operation, the business will have an overall installed capacity of 1.2GW.

Manuele Battisti, Country Manager of EGP RSA, says construction of the Karusa facility commenced in 2019 and amounts to a 200-million-euro investment in South Africa.

"The COVID-19 hard lockdown and accompanying restrictions caused various delays and supply challenges for the project and limited international travels. Enel Green Power overcame these strategic problems by using South African resources and harnessing technological solutions that allowed for remote interaction with colleagues in other countries," he adds.

EGP RSA is committed to supporting South Africa in solving its energy crises through renewable energy solutions.

It also employs local staff and hires local contractors in the construction process to promote meaningful socio-economic and enterprise development. At the peak of the construction process of Karusa and Soetwater, the business had 1,160 employees on site.

As part of its Creating Shared Value initiative, EGP RSA has assisted underserved communities close to the wind farm. One initiative involved the supply of 15 interactive smartboards and 15 laptops to the Acacia Primary School in Laingsburg as part of an educational support programme.

During the nationwide lockdown, which began in March 2020, EGP donated food relief parcels to approximately 200 families in vulnerable communities in collaboration with the Laingsburg Local Municipality.

EGP RSA is looking to empower local SMMEs through its Enterprise Development Support programme. This could include support in the form of funding, income-generating assets (equipment), skills development and market linkages, amongst others.

Battisti says while the employees at Karusa worked under extraordinary circumstances, they concluded their work with zero lost-time incidents: "Completing the project despite challenging circumstances is testimony to their hard work and resilience", he concluded. wn

SAIEE Women in Engineering Chapter introduced new leadership

Maite Sako | WiE Chairperson

Mantsie Hlakudi | WiE Vice-Chairperson

At the recent SAIEE Women in Engineering (WiE) Chapter's Annual General meeting, Ms Maite Sako was appointed as the incoming chairperson. Ms Mantsie Hlakudi was appointed as the Vice-chairperson.

A hearty congratulations to these formidable ladies, who have big shoes to fill from the outgoing chairperson, Makgola Makololo.

Join the chapter by sending an email to wie@saiee.org.za wn

VIP visit for Africa's clean cold centre shows how we can keep alive the goal of 1.5°C

COP President, the Rt. Hon. Alok Sharma MP, visited the Africa Centre of Excellence for Sustainable Cooling and Cold-chain (ACES) during his attendance at the Commonwealth Heads of Government Meeting (CHOGM) in Rwanda.

Currently 7% of the world's emissions come from cooling - from food and vaccine cold-chains to air conditioning to high-tech innovation - and demand for cooling will only grow as global temperatures increase. ACES is a first-of-kind Centre dedicated to generating ideas, technology and capacity building to support sustainable cooling that doesn't cause a spike in energy demand or exacerbate climate change further.

The COP President said, "ACES is a demonstration of how we can work together, to help tackle rising emissions and keep alive the goal of limiting average global temperature rises to 1.5°C.

"Cooling and refrigeration are the fastest-growing source of greenhouse gas emissions in the world, especially in developing countries. But this challenge gives us the opportunity to develop innovative, energy efficient technologies of the future. Spearheaded by UK experts and £16 million of DEFRA funding, ACES is dedicated to developing innovative cooling technologies and providing training to apply those technologies."

Through a "hub and spoke" model, the Centre is being developed by the Governments of Rwanda and the United Kingdom (UK), University of Rwanda, United Nations Environment Programme and the UK's Centre for Sustainable Cooling leading a consortium of UK universities.

Alongside the UK commitment, the Government of Rwanda is providing the five-hectare campus and cash for renovating existing buildings, backed by industry support to develop new bespoke facilities on-site.

ACES is the merger of key social and environmental targets. As project co-leader and ACES co-Director Professor Toby Peters from the University of Birmingham explains: "By 2050, global food demand is set to grow by between 59% and 98%. In sub-Saharan Africa, almost 50% of fruits and vegetables are lost mainly due to improper cold chain management.

"Given the economic, environmental and social impact, food saved and the food system is as important as food produced. The challenge is how to create local and global temperature controlled 'field to fork' from hundreds of millions of subsistence and small-scale farmers whose livelihoods are often dependent on only 1-2 hectares or less, whilst using

COP President, the Rt. Hon. Alok Sharma MP visits ACES

renewable energy and climate friendly technologies."

A key focus of the Centre is on clean cold-chains. Globally, 536 million tonnes (12% of total food production) are lost due to lack of cold-chain, enough to feed around 1 billion people. In Rwanda, as an example, food loss equates to 21% of its total land use, 16% of GHG emissions, and 12% loss to its annual Gross Domestic Product. Similarly, 25% of vaccines are wasted globally due to failures within cold-chains; more than 1.5 million people globally die from vaccine-preventable diseases each year.

The campus will include a state-of-the-art refrigeration training centre complementing training at IPRC (Integrated Polytechnic Regional Centre); a technology demo hall and innovation centre and quality control labs. UK funding is also supporting the development of outreach SPOKEs across Africa, the first of which is being developed in Kenya.

During his visit, the COP President joined workshops with:

- Local farmer co-operatives acting as test-beds with ACES experts and industry partners to develop new, fit-for-purpose, self-sustaining, multi-service cold-chains that can be applied and operated locally; and
- UK clinical research and Covid vaccine trial teams from University Hospital Birmingham who are using ACES to work with Rwanda's counterparts to build on the successes of their COVID-19 vaccine programmes to jointly develop better and sustainable vaccine protection to a variety of infectious pathogens. This includes investment in people and preparedness for further breakthroughs in vaccine technology that will require a robust cold-chain in order to protect everyone who needs them.
- Students from IPRC and University of Rwanda learning how to service and maintain refrigeration equipment.

ACES Founder Industry Partner (FIP) Danfoss was also present for the visit. FIPs are making multi-year commitments, with Danfoss already providing sustainable refrigeration technology for a novel demonstrator "community cooling hub", a training cold store and extensive training material for refrigeration installers. The company also used the event to open its first East Africa regional office on the campus.

Ziad Al Bawaliz, regional President for Turkey, Middle East, and Africa at Danfoss: comments: "At Danfoss, we are committed to supporting the expansion of a sustainable cold chain, to decarbonise from farm to fork with energy-efficient, climate-friendly technologies and training support for installers." wn

Study throws new light on Revenue Losses

With stable electricity supplies under constant threat and local government revenues dwindling across South Africa, a recent study offers hope to address the challenges of getting power to the people – and collecting the revenue to deliver other services.

The study investigated the causes of technical and non-technical losses in two KwaZulu-Natal municipalities that are losing up to 10% of their power and a similar percentage of their revenue from supplying electricity. The study was done by the Vuthela iLembe Local Economic Development (LED) programme, a joint initiative of the State Secretariat of Economic Affairs of the Swiss Confederation, the KwaZulu-Natal Department of Economic Development, Tourism and Environmental Affairs and the iLembe District Municipality, and KwaDukuza and Mandeni Municipalities.

The Vuthela Programme is a five-year comprehensive local economic development programme in the iLembe District to promote sustainable, inclusive economic growth and job creation through initiatives to improve municipal finances, municipal infrastructure planning and delivery, support private sector development through business environment reforms and SMME development, support sector initiatives promoting inclusive growth, and partnerships and co-ordination.

The electricity study, as part of the Vuthela Municipal Infrastructure component, provided valuable insights into how local government officials throughout the country can identify the causes of such losses and reverse the alarming downward trend.

The loss of revenue contributes to municipalities' poor financial performance and gravely impacts service delivery. It also means that many municipalities cannot fund new infrastructure developments due to the high cost of maintaining distribution equipment which has deteriorated.

The probe into Non-Revenue Electricity in KwaDukuza and Mandeni Local Municipalities was undertaken by the Vuthela iLembe Local Economic Development Programme. It assessed the local electrical infrastructure and its performance, public participation and awareness campaigns, installed metering and meter reading and the effectiveness of financial systems, customer databases and tariffs.

The report identified the gaps in energy and revenue losses in the two municipalities.

At KwaDukuza, the ageing electricity distribution network is exhibiting signs of degradation in reliability, performance, and functionality.

A municipal report on Energy Losses Reduction noted that there might be a disparity between the bulk cost of electricity and the set tariffs the municipality charged to their customers, leading to revenue losses. This indicates that there may be a need for a comprehensive tariff study in the district.

An assessment of the billing system found that over 14 000 of about 50 000 prepaid meters (about 28%) had no consumption record for a lengthy period. Some accounts had been duplicated and had more than one meter linked to them.

KwaDukuza District Municipality (KDM) experienced technical losses in the distribution of electricity of up to eight per cent, according to Electrical Engineering Services estimates.

The study confirmed that proper controls were in place for sound financial management in the district municipality. Still, steps should be considered to ensure the integrity of data entering the financial system.

The report found that the KwaDukuza municipality used compliant management systems, but integrating these systems remained a challenge.

An analysis of the prepaid meters revealed that about 54% of the meters showed zero electricity purchases.

"KDM is bleeding revenue in this regard," warned the report.

It was suggested that all electricity meters should be read at least once every 90 days, as customers were more willing to pay for services when they knew their actual consumption. Customers were billed according to estimates when their meters had not been read for 90 days or more, leading to audit queries.

This was a huge challenge for all municipalities, as over 50% of their customers were billed according to estimates.

Credit control systems could not be implemented because of the high number of accounts billed by estimates.

The municipality's policy on indigent customers aims to provide and regulate access to free basic services for all registered indigents. The utility has a standard operating procedure in place for indigent support.

But no systems were in place to assess indigent applications and ensure that everyone who qualified for indigent concessions was registered accordingly. The report recommended establishing a centralised, secure, web-based repository for indigent management.

The report concluded that a regional Customer Care Centre would help improve service delivery to the residents of iLembe and its member municipalities.

The study found that no initiatives were in place in the KwaDukuza District Municipality to promote community awareness of the dangers of electricity theft and illegal connections.

The second municipality in the study, Mandeni Local Municipality (MLM), received its bulk electricity supply through a single overhead line, which meant there was no firm and reliable capacity.

Like the KwaDukuza network, the Mandeni distribution network has aged, and its performance has deteriorated. The network was designed in the early 1980s and had an expected life of 25 years.

Substantial portions of the network were approaching or have exceeded useful life, requiring ongoing maintenance and the replacement of obsolete equipment.

Umgeni Water used more than double the electricity used by the entire Mandeni Local Municipality. Still, the municipality relied solely on the accuracy of Eskom metering to bill this large customer.

The technical losses for the MLM electrical network were estimated at 8.5%. The losses were similar to the factors at KwaDukuza and largely due to the ageing network.

Another similarity with KwaDukuza was that Mandeni also used compliant financial management systems, but there was no integration between the various systems being used.

As with KwaDukuza, the study found weaknesses in the assessment and registration of indigent customers and recommended establishing a centralised repository for indigent management.

The report highlights that indigents are not flagged in the system and, as a result, run the risk of being billed as normal debtors.

Once again, no community awareness programmes about electricity were evident, and the need to create a Customer Care Centre was highlighted.

The findings of this study will allow each of the two municipalities to implement strategies to address electricity revenue losses.

Many issues uncovered in the study around the bulk electricity supply were common to both districts and are likely to be shared by many other municipalities facing similar network and systems challenges throughout South Africa.

While this second phase of the study illuminated the challenges on the ground and offered pointers to resolve them, the third phase will recommend strategies and initiatives to reduce the loss of revenue.

The LED initiative will equip local government leaders responsible for service delivery, consumers and large corporate users with information that could spell a reversal in their financial performance and their plans for development in the years ahead. wn

Zest WEG poised for African Growth

After a decade-long expansion of its manufacturing capabilities in South Africa, Zest WEG, the South African subsidiary of Brazil's WEG Group, is well placed to extend its already extensive footprint in the African market.

"We now have six manufacturing facilities in Gauteng and Cape Town, producing a wide range of equipment including gensets, transformers, electrical panels, E-Houses, MCCs and mini sub-stations," says Zest WEG's outgoing CEO, Juliano Vargas. "This ability to manufacture locally gives us a huge advantage in the African market, as we can produce economically and deliver promptly to countries throughout the sub-Saharan region."

According to Vargas, who is taking up an appointment at another operation of WEG Group, Zest WEG's drive on local manufacture and local sourcing is consistent with WEG's global approach of maximising local content and procurement wherever possible. It has also contributed to Zest WEG earning coveted Level 1 B-BBEE status.

"WEG now manufactures in 12 countries outside of Brazil with these facilities accounting for more than a third of the Group's global production," he says. He adds that Zest WEG is amongst the largest WEG operations outside of Brazil, including USA, Germany, and China

Vargas's successor as CEO of Zest WEG is Eduardo Werninghaus, who has been with WEG for more than 15 years and who comes to South Africa from WEG's USA subsidiary. "I've been briefed to build on the very firm base created by Juliano and his predecessors," he says. "WEG is not a company that is fixated on next quarter results only. It thinks and acts long term and considers Zest WEG as being crucial to its future, given Africa's enormous growth prospects which include a need for massive investments in energy infrastructure."

Zest WEG is responsible for the entire sub-Saharan region and works through an extensive network of branches and Value-Added Resellers (VARs) throughout the continent.

"Being local in Africa is a key part of our strategy," says Werninghaus. "We need to be close to the countries and communities we serve. There is a perception that all African countries are the same. This is not so. Each as its own unique culture, its own challenges and its own strengths. Having a presence on the ground in so many countries across the continent allows us to address this diversity."

Most of Zest WEG's product offering will be on display at the Electra Mining Africa 2022 exhibition. "Our theme, as always, will be how to change energy into solutions," says Werninghaus. "There will, however, be a particular emphasis on efficiency and sustainability. One of the products that we'll be highlighting is our range of WEG IE4-rated super-premium efficiency electric motors which were launched locally last year and which cost no more than their IE3 predecessors. These are the most energy efficient motors in the market and offer major operating cost advantages to users."

Werninghaus says that the WEG IE4 motors have already received a warm reception from the mining industry, which is struggling with constantly rising electricity costs. "A medium-sized mine typically has between 2 000 and 3 000 electric motors on site – powering everything from fans and pumps to conveyor belts and screens – so the potential for very significant energy and cost savings is huge."

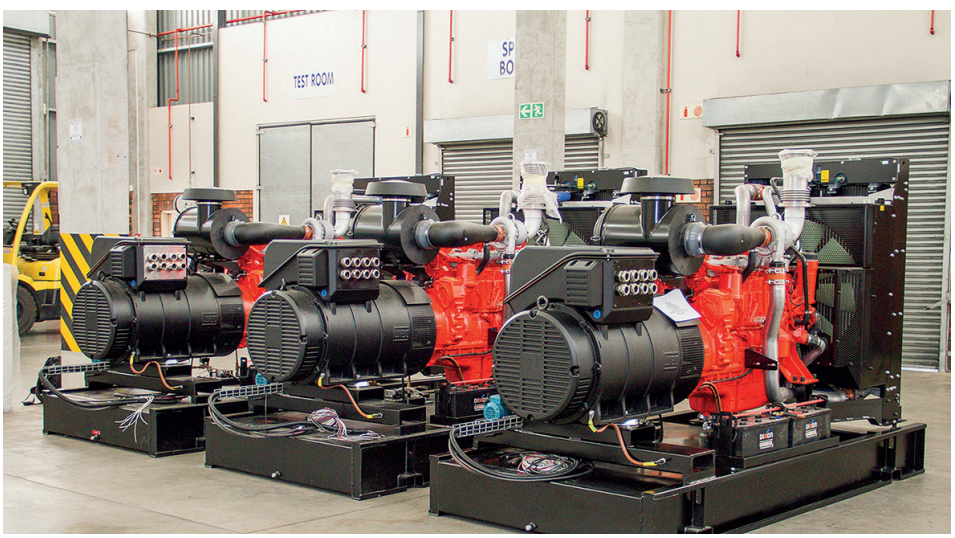
He points out that electric motors account for about 40 % of all industrial

Zest WEG will showcase its mobile substation capabilities at Electra Mining Africa 2022.

electricity consumption and that around two-thirds of these motors are on mines.

Werninghaus adds that Zest WEG will also be showcasing many high-tech products and systems at Electra Mining Africa 2022. These include the already available WEG Motor Scan, which allows the continuous monitoring of electric motors and other rotating machines; and Pump Genius, a software package that enables a standard VSD to be dedicated to specific pumping systems with various motor and pump combinations, thereby providing improved control and monitoring capability.

Also on show will be WEG's new Motion Fleet Management system, which uses artificial intelligence and machine learning to diagnose and monitor rotating equipment such as motors, VSDs, gearboxes and compressors. Based on cloud computing technology, the performance of assets can be monitored at any time from any part of the world. This approach reduces unplanned downtime and optimises repair actions.



Generators at the Zest WEG manufacturing facility in Cape Town.

According to Werninghaus, WEG has fully embraced the world of Industry 4.0 (also known as the Internet of Things). "Keeping abreast of digital developments is a priority for us and Electra Mining Africa will give us an opportunity to show just how far we've come on our digital journey," he concludes. wn

17 ways technology could change the world by 2027

Innovation is critical to society's future well-being and driving economic growth, both of which are key priority areas for the World Economic Forum. To support these two pillars, the Forum launched its Technology Pioneer community in 2000.

The community comprises early- to growth-stage companies from around the world that are involved in designing, developing and deploying new technologies and innovations and are poised to impact business and society significantly.

The programme aims to give next-generation innovators a voice in solving global issues and the opportunity to contribute to the exploration of future trends.

The Forum recognises a new cohort of Technology Pioneers each year and incorporates them into its initiatives, activities, and events.

We asked our 2022 cohort for their views on how technology will change the world in the next five years. From maturing advanced technologies such as Web3 and quantum to managing flexible grids and on-demand manufacturing, here are their predictions for our near-term future.

CREDIT WILL BECOME ACCESSIBLE TO THOSE IGNORED BY TRADITIONAL FINANCIAL INSTITUTIONS

MADHAV KRISHNA, FOUNDER AND CHIEF EXECUTIVE OFFICER, VAHAN

With an explosion in internet penetration worldwide accompanied by the proliferation of digital labour marketplaces or platforms, 'gig-work' will become the predominant mode of work.

This shift has enormous ramifications for low-skilled/blue-collar workers, who usually comprise more than 80% of the workforce in developing countries. Internet platforms in e-commerce, food delivery, ride-sharing, logistics and so on have low barriers to entry and are creating a wealth of earning opportunities in countries where there

aren't enough jobs for low-skilled populations. Workers can engage with many platforms in parallel and maximise their earnings.

Soon, digital labour marketplaces will embed financial services into their products, making credit accessible for many people who traditional financial institutions ignore. Over time, technology will enable financial stability and discipline without needing people to gain relevant knowledge.

AI and machine learning advisors will become ubiquitous, constantly recommending the next gig, next investment or next online class to us, genuinely democratising growth and financial well-being.

WEB3 TECHNOLOGIES WILL REVOLUTIONISE THE WORLD OF COMMERCE

JUSTIN BANON, CO-FOUNDER, BOSON PROTOCOL

By 2025, Web3 technologies will have revolutionised the world of commerce in the same way that Web2 transformed access to information. Physical and digital (phygital?) 'things' will be listed and traded on an open, liquid, digital market. In the early days of the internet, information mainly was siloed within proprietary online networks. However, the zero marginal cost of distribution and consumer demand led to the single, searchable, open internet of information we enjoy today. Understandably, commerce has taken longer to leap. With the exchange of physical assets, managing counterparties' risk, mediating disputes and ensuring settlement require trust. This trust is vested in either trusted intermediaries or trusted sellers. Consequently, e-commerce transactions are mostly siloed within one of many closed, proprietary systems.

The advent of Web3 technology enables the automation of settlement by smart contracts and the tokenisation of physical asset commerce transactions into a universal standard such as NFTs. Just as decentralised finance's 'money lego' applications have begun to unbundle traditional finance, an ecosystem of decentralised 'commerce lego' protocols and applications will evolve to create an open marketplace for things, where everyone can share the value they create.

THE DATA INDUSTRY WILL BECOME MORE INCLUSIVE AND AFFORDABLE

CHRISTINE QI, CHIEF EXECUTIVE OFFICER, DATABENTO

The amount of information - or data - about our universe and ourselves has grown exponentially over the past decade. But with enormous growth comes an array of issues: data privacy, management, access, and affordability are some of the most significant areas of debate amongst citizens and leaders alike. Who owns my data? Is my phone spying on me? How much money are companies making from it? Why am I paying a fortune for market data?

These questions are becoming increasingly pertinent as companies continue to collect our data, whether we pay them or not, with or without our permission. Issues also persist in industries like finance. In the next few years, so long as governments allow it, we'll see technology in the data industry become more inclusive and affordable as startups enter the space.

IN THE FUTURE, OUR FOCUS WILL BE ON THE HUMAN EXPERIENCE

ISAAC CASTRO, CO-FOUNDER AND CO-CEO, EMERGE

By 2027, we'll look back at our digital interactions the same way we see our carbon emissions today. Social media has exposed the perils of technology designed without humans at the centre and its harmful effects on our mental health and emotional wellness. We're missing what we removed from our interactions a decade ago: humanity, intimacy, depth, and empathy. Honest conversations instead of mass influence.

Interactions that make us feel closer to each other. In the future, our focus will be on the human experience. The transition to the Metaverse will be not a technological but a sociological paradigm shift. The Metaverse will be shaped by the communication of our emotions, enabled by technologies such as virtual and augmented reality and brain-computer interfaces. New hardware, platforms, disciplines, and senses will come into play. We'll redefine social contracts in the virtual world, where emotion, trust, and safety become our most important currencies. We'll decentralise the platform experience in favour of the human being. We'll give our daughter a soothing caress from across the ocean. We'll hold the hand of our grandmother, who has passed away. We'll treasure those meaningful moments. Our interactions with others will be centred on our human experience.

BATTERY-POWERED CONSTRUCTION WILL UNDERPIN SUSTAINABILITY EFFORTS

BRANDON NG, CO-FOUNDER AND CHIEF EXECUTIVE OFFICER, AMPD ENERGY

The construction industry accounts for almost 40% of global CO2 emissions, and much of this is driven by the urbanisation of humanity. Fossil fuels continue to power construction projects, producing around half a billion tonnes of CO2 each year. Noise and exhaust fumes from fossil fuel use also negatively affect worker health and local air quality. This is rapidly changing. The industry is adopting battery energy storage systems (ESSs) tailored for construction sites that reduce carbon emissions by 80%–the remaining 20% is the carbon of electricity used to recharge the ESSs.

The electrification of mobile construction machinery is also making giant strides towards commercialisation. All of this is driven by advances in lithium-ion battery technology. Looking into the future, long-duration ESSs–which only need recharging weekly, monthly or longer–make off-site recharging from solar or wind farms a real possibility. The world is still figuring out a suitable technology base for long-duration ESSs. Still, there are multiple options: flow batteries, non-lithium-ion non-flow batteries, gravity-based ESSs, heat-based ESSs and hydrogen–and a winner or winners are sure to emerge. In short, the future for how we build cities is charged with potential.

BUILDING WILL DYNAMICALLY RESPOND AND ADJUST TO SUPPORT HUMAN WELLNESS AND COMFORT

FRANCOIS AMMAN, CO-PRESIDENT AND CO-FOUNDER, AKILA

90% of life is spent indoors, and buildings create 50% of carbon emissions. Their impact is massive; so is the volume of building data that could be harnessed for better outcomes for people and the planet. Today, buildings are becoming smart and automated through increasingly cost-effective sensors and control points. Properly connected smart buildings can react to dynamics like equipment status, space occupancy, weather and more, using AI to optimise for the best impact.

Most building systems are manually controlled, but we'll see this status quo upended in coming years. Buildings will dynamically respond and adjust to support human wellness and comfort, minimise carbon emissions, and include building-to-building interoperability enabling accurate metaverse applications for the built environment. Driving this change will be a fundamental transformation in the construction industry.

The emergence of digital twin and 5G/6G technology as critical tools enabling new ways of assessing and optimising value over the building lifecycle from design to construction into operations and a growing understanding of energy is not just a direct cost to portfolio holders but also a liability for those who cannot keep up with new regulatory and ESG frameworks.

GRID FLEXIBILITY WILL PHASE OUT FOSSIL FUELS AND JUMPSTART THE CLEAN ENERGY TRANSITION

THOMAS FOLKER, CO-FOUNDER AND CHIEF EXECUTIVE OFFICER, LEAP

One pressing challenge on the road to a clean-energy future is grid flexibility and the need for more dynamic interaction between energy supply and demand. As we incorporate more intermittent renewable energy sources such as wind and solar into the power mix, the flexible load will be crucial to ensure that the grid can always meet demand.

Unlocking a significantly more digitised, decarbonised and resource-efficient future by 2025 will be made possible by market-driven software solutions that allow smart energy technologies, such as EV chargers and heat pumps, to respond to real-time grid requirements in targeted areas, optimising the asset owner's earnings as well as supporting the electric grid when it needs it most. When aggregated together, these distributed energy resources can collectively offer the flexibility needed to phase out polluting fossil fuel-powered peaker plants and jumpstart the transition to the clean energy future.

PEOPLE WILL EAT MORE NOURISHING FOOD

EDWIN O. ROGERS, CHIEF EXECUTIVE OFFICER AND CO-FOUNDER, BONUMOSE

Though nourishing, tasty food should be available to wealthy and poor alike, too often, there is a great gulf between the "is" and the "should." But there is nothing inherent in capitalism or the profit motive that demands the divergence.

Good news is in the wind: thanks partly to new processing methods for healthy sugar or salt alternatives, good food will become an accessible, ubiquitous option for all consumers. People will eat more nourishing food even if, in some cases, they do not realise it – because cost and taste will be at par with less healthy, legacy foods. In the best cases, production assets for questionable food ingredients (e.g., high-fructose corn syrup) will be redeployed for healthy counterparts. Finally, in a virtuous circle, global reductions in diet-related healthcare costs will deflate food prices. Global alleviation of health-related suffering will free individuals from inspired innovations that benefit humankind and the earth.

CENTRAL BANK DIGITAL CURRENCY WILL REVOLUTIONISE THE FINANCIAL SYSTEM

INGA MULLINS, FOUNDER AND CHIEF EXECUTIVE OFFICER, FLUENCY

A new digital form of a country's fiat currency issued directly by a nation's monetary authority or central bank is predicted to have one of the most significant disruptive impacts over the next 3-5 years. This form is referred to as a central bank digital currency (CBDC).

When underpinned with blockchain technology, a CBDC has the potential to revolutionise the financial system and pave the way to increasing financial inclusion and improving the lives of billions of people globally by providing access to cheap and affordable financial services.

Due primarily to its architecture, a well-constructed CBDC can support offline payments, shielded transfers, automation throughout the programmability layer, and possess cash-like properties. All these features, when taken together, will foster the financial inclusion of the user by providing them with a digital alternative to physical cash, enhancing access to their money even in remote areas, and providing options for those currently unbanked. Innovative payment platforms will provide an on-ramp for building CBDC and bridging them to existing payment networks, including traditional banking and alternative finance. Banks and issuers can integrate their existing infrastructure, provide a broad spectrum of CBDC-linked payment-related services, and exercise cross-chain interoperability protocols for universal payment access to digital national currencies stablecoins NFTs, the Metaverse and much more.

SUPPLY CHAIN INTELLIGENCE WILL SOLVE THE FOOD CRISIS

JULIE GERDEMAN, CHIEF EXECUTIVE OFFICER, EVERSTREAM

Several decades of accelerating climate change, a global pandemic, conflict, and fragmented supply chains impacted food production and distribution, driving the global food crisis to catastrophic levels. By 2027, primary food, beverage, and consumer packaged goods manufacturers will use AI-driven supply chain technology to see future disruption and act before weather, labour issues, and other incidents can harm the global food supply.

Contingency plans will be needed far less often because companies will have advanced insights exposing how future weather events will impact their suppliers, giving them ample time to find alternatives. They will predict spikes in commodity availability, change their purchasing habits and reformulate their products, so shelves remain stocked.

Food spoilage and waste during transit will no longer be a problem because manufacturers and shippers can spot unusual weather, labour issues, and other stoppages well in advance. Food distribution to remote locations that need it the most will no longer be delayed due to port and road closures.

Predictive supply chain technology will enable companies to shift from reactive response to proactive action, keeping store shelves stocked and food flowing worldwide.

AI WILL REINVENT HOW WE THINK ABOUT EDUCATION

ASUDE ALTINTAS, CO-FOUNDER AND CHIEF EXECUTIVE OFFICER, TWIN SCIENCE

The traditional education system was invented nearly 200 years ago to meet the needs of the industrial revolution – it is not functional today. Today, the needs of our world have been gathered under the United Nation's Sustainable Development Goals. On the other hand, 21st-century skills that will serve these needs are listed by the World Economic Forum.

The younger generation already desires to co-create solutions to the world's biggest problems and create a more compassionate world. Technological progress is a great chance to help every child develop skills and competencies to solve these problems and build a better future. AI will be used to understand children's interests to suggest the next step in their learning journey. AI will also generate insights for their parents and teachers and turn them into mentors. The internet is already connecting children with the best experts, improving the quality of education and reducing inequalities. Every child will be able to ideate, prototype, test and iterate cost-effectively. In this way, they will innovate and improve the world's well-being.

TECHNOLOGY WILL BRING THE BEST OPPORTUNITIES TO THE BEST TALENT

PROJJAL GHATAK, CHIEF EXECUTIVE OFFICER AND FOUNDER, ONLOOP

The one sector that has gone through a breakneck change in the last two years is the workplace. Office work has been the default for knowledge workers for decades and did not warrant a complete re-think until the pandemic. The pandemic tested it to its fullest, but although we saw flat to increased productivity, the loss in cultural connectivity and an increase in anxiety, fatigue, apathy and burnout are also some of the effects being felt. In a pace of rapid change, it is hard to parse out each piece independently. The pandemic also lasted long enough to truly change the talent landscape for many companies to a permanent global and hybrid one. Companies can seize the day in thinking about a global talent market to tap into realistically. So, if I had to be provocative, I would say that technology would be a true leveller. It will bring the best opportunities to the best talent irrespective of where they live, thereby truly unlocking the full potential of a billion knowledge workers.

ADVANCED MANUFACTURING AND FASHION TECHNOLOGY COULD DIGITALLY TRANSFORM THE APPAREL INDUSTRY

MATTHEW WALLACE, CHIEF EXECUTIVE OFFICER, DXM

Transforming the apparel industry with localised, on-demand manufacturing. The apparel industry is riddled with excessive waste and supply chain challenges. Today, most brands and retailers are forced to mass-produce goods with limited consumer input, resulting in high merchandise return rates, waste from overproduction, and lower profit margins due to discounts on unwanted merchandise. And while on-demand apparel and footwear are believed to be a solution, traditional manufacturing models still require months of lead time and hundreds of miles of travel between order and delivery - a problem which has only been exacerbated by global supply chain instability.

Advanced manufacturing and fashion technology can digitally transform the apparel industry by bridging the gap between creators, consumers, and local manufacturers. It can play an essential role in producing custom goods locally, resulting in dramatically reduced turnaround times – days, not months. This innovative model can reduce the fashion industry's environmental footprint and improve supply chain security on a global scale. It's a promising solution that can be achieved with an open platform that unites best-in-class partners for the greater good of the apparel industry and the world.

THE QUANTUM INTERNET IS COMING

JIM RICOTTA, CHIEF EXECUTIVE OFFICER AND CHAIRMAN, ALIRO QUANTUM

The quantum internet is expected to profoundly impact how we live our lives by enabling breakthroughs in energy, medicine, material sciences and more. The quantum internet is coming and will revolutionise the world just as the classical internet has. And just as classical networks enabled today's internet, quantum networks are required to build the quantum internet of tomorrow. In the next five years, we will see quantum networks emerge from local area networks and clusters into continent-scale area networks using quantum repeaters, which are the foundations of the quantum internet.

As a result, we'll see more and more use cases emerge for quantum networks. For example, quantum-secure communications leverage the power of physics to enable unhackable security. Distributed quantum sensing will enable ultra-high-resolution telescopes, ultra-precise clocks and GPS. And to make the power of quantum computing useful, clustered quantum computing and ultimately distributed quantum computing will enable the quantum internet.

AI WILL POWER CLINICAL DECISION MAKING IN FERTILITY CLINICS AROUND THE GLOBE

PAXTON MAEDER-YORK, CHIEF EXECUTIVE OFFICER AND FOUNDER, ALIFE HEALTH

Between now and 2030, over one billion people will suffer from infertility. As global population growth slows

and drops below the replacement rate, utilising AI-enhanced fertility treatments will help support the creation of new families and future generations.

The most common infertility treatment today, in-vitro fertilisation (IVF), is expensive, often requires multiple attempts, and is physically and emotionally onerous. Successful pregnancies from IVF rely on a complex set of clinical decisions made by physicians to deliver the optimal care for each patient.

The use of technology and advanced analytics to support this decision-making will improve care efficiency, clinical success rates, and the personalisation of treatment methods. By 2027, AI will power clinical decision-making in fertility clinics around the globe, enabling physicians to deliver a new level of precision medicine to improve outcomes and expand patient access.

HUMAN POTENTIAL WILL BE RE-DIRECTED TOWARDS MORE MEANINGFUL OBJECTIVES

GABRIEL SAFAR, CO-FOUNDER AND CHIEF EXECUTIVE OFFICER, LEASEPILOT

Documents as technology have served businesses well for centuries. In modern times, email may have replaced the need for a courier, and documents may be stored electronically, but the underlying technology hasn't changed. That's a problem since documents are fundamentally an analogue technology and today's world is digital.

Computers aren't very good at manipulating natural language (analogue), but they are excellent at manipulating information in a database (digital). So, taking a data-first approach to constructing agreements opens the door to hyper-efficient transactions facilitated by computers. By converting agreements into structured digital information, the software can assemble, manipulate, store, share, and understand these agreements in ways that weren't previously impossible. When done successfully, the end-user sees a document written in natural language and can edit the agreement's text in the same way they would in a traditional word processor.

But behind the scenes, the agreement is still a collection of database values updated to reflect the user's interactions with that document. Ultimately, the impact will be a future with radically more efficient markets that free up massive amounts of wasted human potential to be re-directed toward more meaningful objectives.

REMOTE SENSING DATA STREAMS WILL ACCURATELY MONITOR NATURAL ECOSYSTEMS

KEVIN LANG, CHIEF EXECUTIVE OFFICER AND PRESIDENT, AGERPOINT

To achieve the United Nations goal to reach carbon neutrality by 2050 and keep global warming below +1.5 °C, nature-based solutions to restore, conserve or enhance forests or agricultural lands are a valuable contributor to removing carbon dioxide from the atmosphere and capturing it into the soil. However, to determine the impact of these solutions, measurements such as tree height, trunk diameter and biomass are required to quantify the carbon stock potential in plants accurately.

These measurements are traditionally assessed through labour-intensive and subjective manual methods. With the increased demand for credible carbon credits and a heightened need for transparency, remote sensing data streams from high-resolution cameras and lasers (i.e., LiDAR) are enabling new scalable and efficient digital measurement techniques. Satellite imagery increases in resolution and frequency as more constellations enter orbit. Rapid advances in smartphone optical sensors and positional systems provide growers and conservationists extensive access to capture rich datasets easily.

These data sources, combined with cloud data processing, artificial intelligence and data fusion, will empower accurate measurement and monitoring of plant health and carbon sequestration potential for natural ecosystems. wn

The Impacts of IR 4.0 on Jobs and the Future of the Third Sector

Many commentators are increasingly talking about the potential impact of the "4th Industrial Revolution." It will change how we live and work, how the economy works and how we are governed. For example, a Citi and Oxford University joint report in 2016 estimated that 57% of jobs across the OECD are at risk of automation.

The Financial Times reported in 20161 that between 2000 and 2010, of all the jobs lost in the US, over 85% were lost to new technologies. The Bank of England estimated that two-thirds of all jobs could be automated within 20 years. Regardless of the specific data, an indisputable fact is that the 4th Industrial Revolution has already come, and the current workforce is already feeling the heat.

Whilst the business world is already discussing and preparing for how this revolution will affect their businesses, dubbing it "Industry 4.0", the broader societal impacts of this new revolution have not, to date, been discussed in depth nor planned for. Past Industrial Revolutions have forced society to undergo significant and often painful adaptation processes, for example, from rural, primarily agricultural societies, to urban, industrial societies, and then to post-industrial societies dealing with the loss of traditional industries and sources of employment. The societal impacts of the 4th Industrial Revolution also appear likely to be far-reaching, resulting not only in the social and economic impacts of the loss of many current jobs but also fundamental and increasingly volatile shifts in the nature of work and future jobs and in how public and private services will be delivered.

The Third Sector has always been at the forefront of meeting societal challenges and needs, ranging from mental health and broader health and social care services to services for older people to meeting transport needs in less accessible areas which private or public sector operators could not provide on a commercial or cost-effective basis. The Third Sector is therefore well-placed to play a vital role in meeting the changing societal needs likely to emerge from the 4th Industrial Revolution.

Welcome to the 4th Industrial Revolution Building on the First Industrial Revolution which used water and steam power to mechanise production, the second, which used electric power to create mass production and the third, which used electronics and information technology to automate production; the 4th Industrial Revolution is taking automation to new levels, blurring the lines between the physical, digital, and biological spheres and using technologies to perform tasks previously carried out by humans, ranging from piloting vehicles to 'rules-based' jobs in areas such as accounting and law.

When we compare it with previous Industrial Revolutions, we find the dramatic differences between the fourth Industrial Revolution and the other three. The 4th Industrial Revolution is not merely a prolongation of the Third Industrial Revolution but a new and distinct revolution. The transformation will be unlike anything humankind has experienced in its scale, scope and complexity.

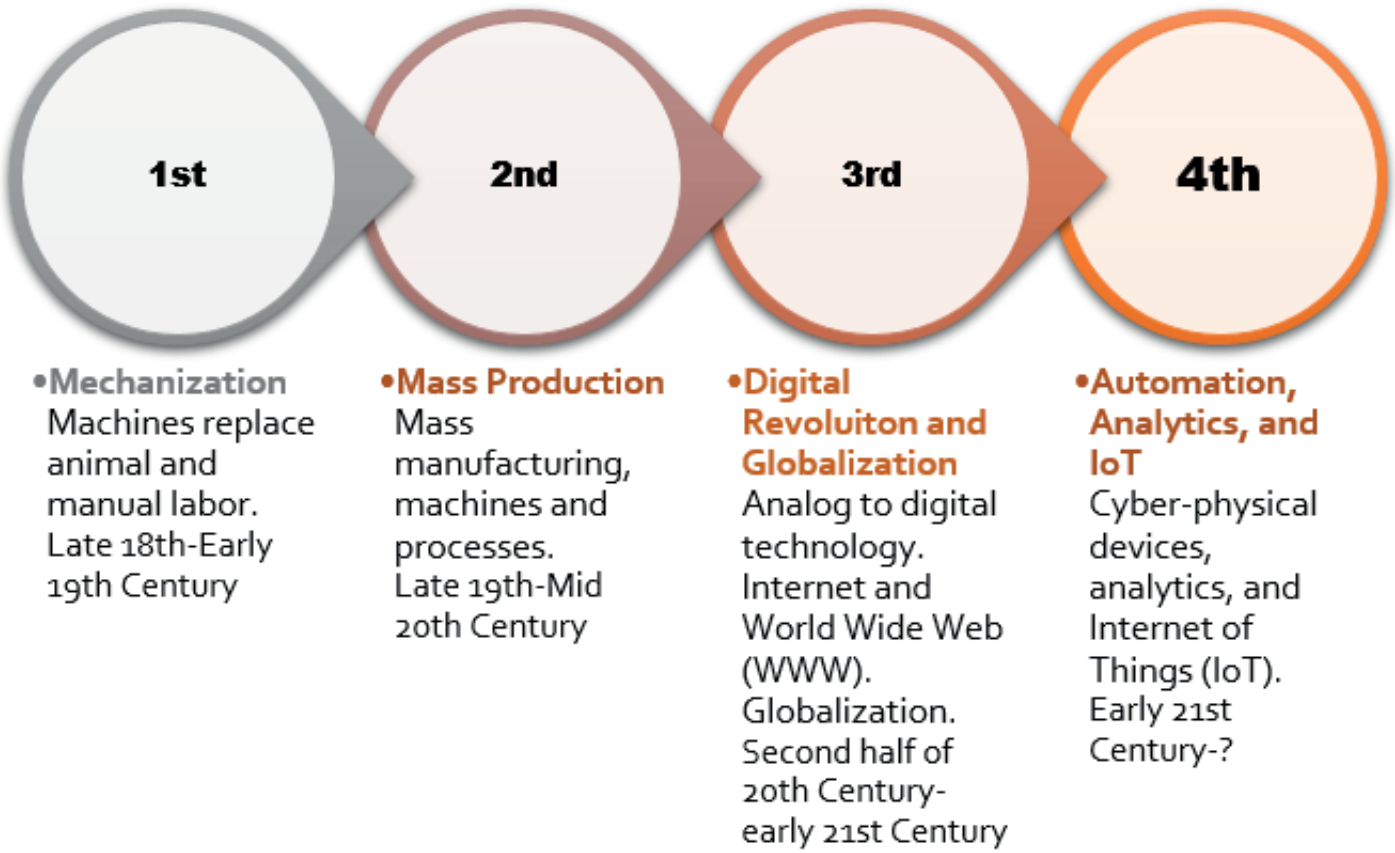


Figure 1: Depicting various Industrial Revolutions

The possibilities of billions of people connected by mobile devices, with unprecedented processing power, storage capacity, and access to knowledge, are unlimited. Firstly, people can continuously produce new information and generate new knowledge by mining information. We can record a person's daily life through their mobile phone location. When this data is monitored for an extended period, we can get to know a person's lifestyle habits, such as their workplace, the supermarkets they shop in, the restaurants where they dine, the times they do so, and even their personal preferences. This technology will increase the intelligence level of machines through continuous data accumulation and analysis.

Secondly, the Industrial Revolution represents not only a huge advance in technology and productivity

improvement. Still, it will also transform modes of production and the relationships between elements of production processes. The 4th Industrial Revolution, by enabling the complete communication of all relevant information at every stage in the production chain, creates separate production sectors for each process. It informs how they relate to each other, bringing together such processes as inventory taking, improving production efficiency, saving energy and reducing emissions, thus making the manufacturing industry part of the information industry. At the same time, it can make production flexible and allow mass customisation, enabling different products to be produced in a production line, which will revolutionise the warehousing, transportation and the whole manufacturing industry.

Thirdly, the 4th Industrial Revolution will spawn a new economic form, the 'sharing economy.' From the shared motors and houses to the shared umbrellas, basketballs, toys, clothing and jewellery, the sharing economy is constantly updating and will be very profound and revolutionary. A typical example of sharing economy is ride-hailing online services, such as Uber and the Chinese Didi service, allowing customers to obtain taxi services from private car owners.

The impact of this new form is disruptive not only to the taxi industry but also to the whole transportation industry. (Maybe soon, we won't need drivers, and unpiloted vehicles will fill the streets.) The impacts of the sharing economy are not limited to online ride-hailing services but also include the shared space service, e.g. Airbnb, and the global online work platform, e.g. AAwork.

Last but not least, like the economists Erik Brynjolfsson and Andrew McAfee have pointed out, the revolution could yield greater inequality, particularly in its potential to disrupt labour markets. With the growth of automation, robots and computers will replace workers across various industries. Low-skill/low-pay jobs will disappear, and the poor will face more formidable challenges, which will lead to increased social tensions. In a strict sense, this is not a unique feature of the fourth Industrial Revolution.

Historically, Industrial Revolutions have always begun with greater inequality, followed by periods of political and institutional change. However, humanity will face a more serious challenge in this revolution because robots and computers take our jobs, not the flow of labour between different sectors.

WHAT HAPPENS WITH EMPLOYMENT?

The characteristics of the fourth Industrial Revolution are destined to bring about different impacts on employment, which are no longer confined to one industry, but all industries. At the same time, many jobs will disappear, but there will be a lot of new job requirements. It is expected that more than 65% of children entering primary school today will end up working completely new jobs that currently do not exist when they enter the workplace 15 years from now. With the changes brought by social media, digital publications and e-commerce, the most in-demand occupations did not exist ten or even five years ago. According to the Future of Employment report, around 47 per cent of US employment is in the high-risk category. People may be more concerned about what jobs are at high risk than specific Numbers. So which jobs are at the most significant risk? What jobs will be safe in the future?

Researchers at Oxford University published a widely referenced study in 2013 on the likelihood of computerisation for different occupations. Out of around 700 occupations, here are the top 30 most risky occupations having a 98-99 per cent chance of being automated in the future:

- Telemarketers
- Title Examiners, Abstractors, and Searchers
- Sewers, Hand
- Mathematical Technicians
- Insurance Underwriters
- Watch Repairers
- Cargo and Freight Agents
- Tax Preparers
- Photographic Process Workers and Processing Machine Operators
- New Accounts Clerks
- Library Technicians
- Data Entry Keyers
- Timing Device Assemblers and Adjusters
- Policy & Procurement Clerks
- Brokerage & Order Clerks
- Loan Officers
- Insurance Appraisers, Auto Damage
- Umpires, Referees, and Other Sports Officials
- Tellers
- Etchers and Engravers
- Packaging and Filling Machine Operators and Tenders
- Shipping, Receiving, and Traffic Clerks
- Milling and Planing Machine Setters, Operators, and Tenders, Metal and Plastic
- Credit Analysts
- Parts Salespersons
- Claims Adjusters, Examiners, and Investigators Driver/Sales Workers
- Radio Operators

On the other hand, the following list comprises the top 30 safest occupations with a 0.66 per cent or less probability of being computerised based on current technology.

- Recreational Therapists
- First-Line Supervisors of Mechanics, Installers, and Repairers
- Emergency Management Directors
- Mental Health and Substance Abuse

Job family/Driver of change	Employment outlook
Computer and Mathematical	**3.21%**
Rapid urbanization	6.11%
Middle class in emerging markets	5.00%
Changing nature of work, flexible work	4.94%
Sharing economy, crowdsourcing	4.88%
Processing power, Big Data	4.59%
Internet of Things	4.54%
Geopolitical volatility	3.89%
Mobile internet, cloud technology	3.71%
Consumer ethics, privacy issues	2.40%
Architecture and Engineering	**2.71%**
Middle class in emerging markets	5.88%
Robotics, autonomous transport	4.49%
Climate change, natural resources	3.68%
Internet of Things	3.54%
Adv. manufacturing, 3D printing	3.33%
Changing nature of work, flexible work	3.18%
New energy supplies and technologies	2.25%
Geopolitical volatility	1.33%
Management	**0.97%**
Young demographics in emerging markets	2.14%
Geopolitical volatility	1.67%
New energy supplies and technologies	1.44%
Processing power, Big Data	1.39%
Changing nature of work, flexible work	0.90%
Middle class in emerging markets	0.72%
Mobile internet, cloud technology	0.62%
Climate change, natural resources	0.40%
Longevity, ageing societies	0.23%
Business and Financial Operations	**0.70%**
Sharing economy, crowdsourcing	3.11%
Middle class in emerging markets	1.96%
Changing nature of work, flexible work	1.88%
Young demographics in emerging markets	1.67%
Geopolitical volatility	1.59%
Climate change, natural resources	1.39%
Processing power, Big Data	1.34%
Mobile internet, cloud technology	1.03%
Consumer ethics, privacy issues	0.54%

Job family/Driver of change	Employment outlook
Sales and Related	**0.46%**
Processing power, Big Data	1.25%
Sharing economy, crowdsourcing	0.58%
Mobile internet, cloud technology	0.43%
Internet of Things	–0.89%
Middle class in emerging markets	–1.14%
Consumer ethics, privacy issues	–1.28%
Geopolitical volatility	–1.50%
Changing nature of work, flexible work	–1.51%
New energy supplies and technologies	–1.58%
Installation and Maintenance	**–0.15%**
Climate change, natural resources	3.00%
Changing nature of work, flexible work	0.45%
Mobile internet, cloud technology	–3.89%
Internet of Things	–8.00%
Construction and Extraction	**–0.93%**
New energy supplies and technologies	1.38%
Climate change, natural resources	0.38%
Geopolitical volatility	–0.07%
Changing nature of work, flexible work	–0.11%
Arts, Design, Entertainment, Sports and Media	**–1.03%**
Mobile internet, cloud technology	0.95%
Middle class in emerging markets	–0.83%
Geopolitical volatility	–1.00%
Manufacturing and Production	**–1.63%**
Adv. materials, biotechnology	0.67%
Robotics, autonomous transport	–0.83%
New energy supplies and technologies	–1.81%
Middle class in emerging markets	–2.16%
Climate change, natural resources	–2.45%
Geopolitical volatility	–2.47%
Changing nature of work, flexible work	–2.99%
Longevity, ageing societies	–3.13%
Adv. manufacturing, 3D printing	–3.60%
Office and Administrative	**–4.91%**
Changing nature of work, flexible work	–2.77%
New energy supplies and technologies	–3.33%
Mobile internet, cloud technology	–5.82%
Processing power, Big Data	–6.06%
Consumer ethics, privacy issues	–6.18%
Internet of Things	–6.20%
Rapid urbanization	–6.36%
Climate change, natural resources	–6.67%
Geopolitical volatility	–9.72%

Source: Future of Jobs Survey, World Economic Forum.
Note: Names of drivers have been abbreviated to ensure legibility.

Table 1: Employment effect of drivers of change, by job family
Compound growth rate, 2015-2020, %

Social Workers
- Audiologists
- Occupational Therapists
- Orthotists and Prosthetists
- Healthcare Social Workers
- Oral and Maxillofacial Surgeons
- First-Line Supervisors of Fire Fighting and Prevention Workers
- Dietitians and Nutritionists
- Lodging Managers
- Choreographers
- Sales Engineers
- Physicians and Surgeons
- First-Line Supervisors of Transportation and Material-Moving Machine and vehicle operators
- Instructional Coordinators
- Psychologists, All Other
- First-Line Supervisors of Police and Detectives
- Dentists, General
- Elementary School Teachers, Except Special Education
- Medical Scientists, Except Epidemiologists
- Education Administrators, Elementary and Secondary School
- Podiatrists
- Clinical, Counseling, and School Psychologists
- Mental Health Counselors
- Fabric and Apparel Patternmakers
- Set and Exhibit Designers
- Human Resources Managers
- Recreation Workers

In another report, the *Future of Jobs*, the World Economic Forum (WEF) surveyed chief human resources officers and senior talent executives of employers who represent 15 of the world's largest economies, accounting for 65 per cent of the global workforce. According to WEF, expected employment changes over the next five years vary widely by job family (or category). Table 1 indicates the expected impact on various job families by drivers. The table shows that the category of "Office and Administrative" will see the most significant drop with 4.91%, much more than the decrease in "manufacture and production" at 1.63%. According to this survey, the main drivers of the drop in "Office and Administrative" are big data, mobile internet, cloud technology, workplace flexibility and so on. The data shows that expected declines in "Manufacturing and Production" employment also will be driven by technologies that can substitute human labour.

On the other hand, some categories show an increase in employment, such as "Computer and Mathematical" (3.21%), driven by changing work, flexible work, sharing economy, big data and the internet of things. Architecture and Engineering are fueled by the need for skilled people to run and manage new technologies like robotics, autonomous transport, new energy supplies and 3D printers.

WHO LOSES, WHO GAINS?

Humanity will face a significant challenge in the short term, and the jobless will soar. The 4th Industrial Revolution created a demand for new jobs while eliminating some of the jobs highlighted in the above reports. According to Erik Brynjolfsson and Andrew McAfee from the MIT Sloan School of Management, starting around 2011, technology has fueled productivity but not job growth—quite the opposite. McAfee and Brynjolfsson indicate that part of the reason is that our skills aren't keeping up with technological advances.

However, people should not be too pessimistic because, in the long run, the 4th Industrial Revolution will create more wealth and additional jobs elsewhere in the economy, and the number of new jobs will grow dramatically. Due to the difficulties for some people to adapt to the new job requirements and master new job skills, the real problem that people are facing is structural unemployment, not a lack of job opportunities.

WHO LOSES?

Firstly, the jobs that are most at risk are those that "are on some level routine, repetitive and predictable", as Martin Ford, futurist and author of "Rise of the Robots: Technology and the Threat of a Jobless Future" explains, because they are possible to replicate through Machine Learning algorithms.

Richard Johnston from Ulster University's Economic Policy Centre said: "Sectors like manufacturing, logistics and retail and wholesale and some of the lower-skilled occupations within are the most vulnerable to being replaced by some technology, machinery or robots." For any business owner, the pursuit of profit maximisation is the most crucial goal and reducing costs is an essential factor to consider. Machines are better at the job: The National Institute of Standards predicts that "machine learning can improve production capacity by up to 20%" and reduce raw materials waste by 4%. No matter how low people's wages are, they'll never be able to compete with the robots and machines, no salary, no break and no illness.

Many highly routine occupations are being replaced today. Telemarketing, for example, ranks first according to The Future of Employment report, with a 99% probability of automation. The vast majority of people have received irritating robocalls. Library technicians, whose responsibilities are compiling records, sorting and shelving books, removing or repairing damaged books, registering patrons, and checking materials in and out of the circulation process, also have a 99% probability of automation. Existing technologies, like Amazon's fulfilment centres, can solve these problems, where people work with carefully coordinated robotic machines. Previously, Amazon workers walked around shelves looking for products,

but now robotic shelves rearranged themselves to bring products to the worker. These sorting techniques will also be used for book sorting, saving a lot of human resources and providing additional efficiencies.

Secondly, jobs that were once regarded as secure jobs, such as office workers, administrative personnel, and even law, will be hit hardest. Future technological advances will enable people to work more flexibly, allowing people to work at home or in the office and during working hours or off-duty hours. Employers, for their part, are also happy to choose this kind of flexible work pattern to reduce office expenses. Each employee may not need a fixed working seat but can share working space with others. This can save thousands of pounds in furniture, office equipment and supplies, and utility savings compared to similar workers who have fixed places in the office.

Moreover, The "Gig Economy", a labour market characterised by the prevalence of short-term contracts or freelance work as opposed to permanent jobs, may become increasingly common as part of the evolution of job flexibility. Remote platforms on which freelance or independent workers sell work to customers, such as Upwork, Freelancer, TaskRabbit, Clarity, and 99designs facilitate the Gig Economy. Some call this trend the "Uberization" of work, as the Future of Jobs report mentioned.

In the future, people may have several jobs for several companies simultaneously rather than working for one big corporation, and routine full-time work seems to be in trouble.

Thirdly, jobs based on big data analysis, such as credit analysts, financial advisers, and mathematical technicians, will face huge risks. The total amount of digital data in circulation was estimated to be 4.4 zettabytes[2] in 2013. This number is predicted to increase tenfold to 44 zettabytes in 2020 and grow faster and faster in the future. Computers have a distinct advantage over the human brain in dealing with big data. Computers can store, access, analyse, interpret and draw meaningful inferences from big data more accurately and efficiently than the human brain.

The floating-point arithmetic ability of the most ordinary computer can compute more than 10 billion times a second, which is far more than the computing power of the human brain. The best chess-trained computers can strategise many moves ahead, problem-solving far more deftly than the best chess-playing humans can. It is no wonder that Google's AI beat the Go world champion.

Computers enjoy other advantages over people. Computers have better memories so they can be fed a large amount of information and tap into it almost instantaneously. For computers, the word "oblivion" has no meaning, but for humans, no one can remember everything that happens to them. In China, a variety show, 'Stand to the end', is very popular. The best player, who beats all the other people taking part, must complete with an intelligent robot to answer ten questions. Now, no one can beat this robot after more than five episodes because it never makes a mistake.

Because of the nature of computers, jobs based on the analysis of big data can be done better by computers than by humans. Our credit ratings are based on recording our personal behaviours and analysing these by computer. There is no need to meet a financial adviser face to face because we can just get the computer's advice.

WHO GAINS?

Firstly, jobs requiring a level of human interaction or guiding robot behaviour will be prevalent in the future, such as first-line supervisors of mechanics, installers, and repairers and first-line supervisors of transportation and material-moving machine and vehicle operators. These skilled people possess in-demand skills to run and manage new technologies like robotics, autonomous transport, new energy supplies and 3D printers. People will be working with robots and machines, not competing with them.

Preparing the necessary data sets in advance is essential for any artificial intelligence. In the future, there may be machine trainers who teach machines to work better. For instance, in medicine, they may teach robots and machines how to detect diseases with existing marker cases as demonstrations of what to look for.

Since the trend toward developing artificial intelligence appears inevitable, artificial intelligence developers are likely to become very popular. Presently, there is a massive gap in demand for artificial intelligence engineers, which directly leads to a $345,000 annual salary for advanced AI researchers in DeepMind Technologies Limited. AI testers will test intelligent robots, spotting problems and errors and correcting error codes, especially in the early stages.

The second area is occupations that involve building complex relationships with people, especially customer-facing jobs to supply personalised services, such as sales engineers, mental health

2. The zettabyte is a multiple of the unit byte for digital information. The prefix zetta indicates multiplication by the seventh power of 1000 or 10^{21} in the International System of Units.
1 ZB = 1000^{7}bytes = 10^{21}bytes

and substance abuse social workers and mental health counsellors. These jobs need high interpersonal skills, teamwork and leadership, which computers cannot go beyond, such as dealing with coordinating people and communication, and divergent communications. It does not help to have a robot give people a pep talk. According to data from The Future of Jobs, the clergy only has a 0.81% probability of automation.

Ageing populations will dramatically increase spending on healthcare and other personal services. By 2030, there will be at least 300 million more people aged 65 years and older than in 2014. This will create significant demand for various occupations, including doctors, nurses, health technicians, home-health aides, personal-care aides, and nursing assistants. Moreover, Health care will go from general to personal. Doctors are already using computers and other high-tech devices to improve health care. As data becomes more readily available, extensive and personalised, it will revolutionise the way doctors diagnose disease and treat patients. The online data will help doctors access more patient information and link patients' wellness to their lifestyle, which leads to personal services. To some extent, the treatments must be done in thousands of ways because everyone is unique.

Thirdly, highly unpredictable jobs would be challenging to be replaced by robots and machines, such as emergency management directors and repairers. They are technically challenging to automate because machines are good at repetitive tasks. The other reason is that they often command relatively lower wages, making automation a less attractive business proposition.
Employment of emergency management directors is projected to grow 6 per cent from 2014 to 2024, about as fast as the average for all occupations, according to the Bureau of Labor Statistics forecast.

The last area is occupations in training and education. Upcoming workforce transitions could be huge. According to the Future of Employment report, around 47 per cent of total US employment will disappear. Meanwhile, new jobs will be available, but people need to find their way into these jobs. The changes in net occupational growth or decline imply that many people may need to shift occupational categories and learn new skills in the years ahead. Many people may have to re-train several times during their working life.

Work that requires a high degree of imagination, creative analysis, and strategic thinking is harder to automate. Creativity will determine whether human beings can develop sustainably in the future, and education should nurture creativity. Josefino Rivera, Jr., an educator, indicated education would be not just taking in information and sharing it back but also figuring out what to do with that information in the real world.

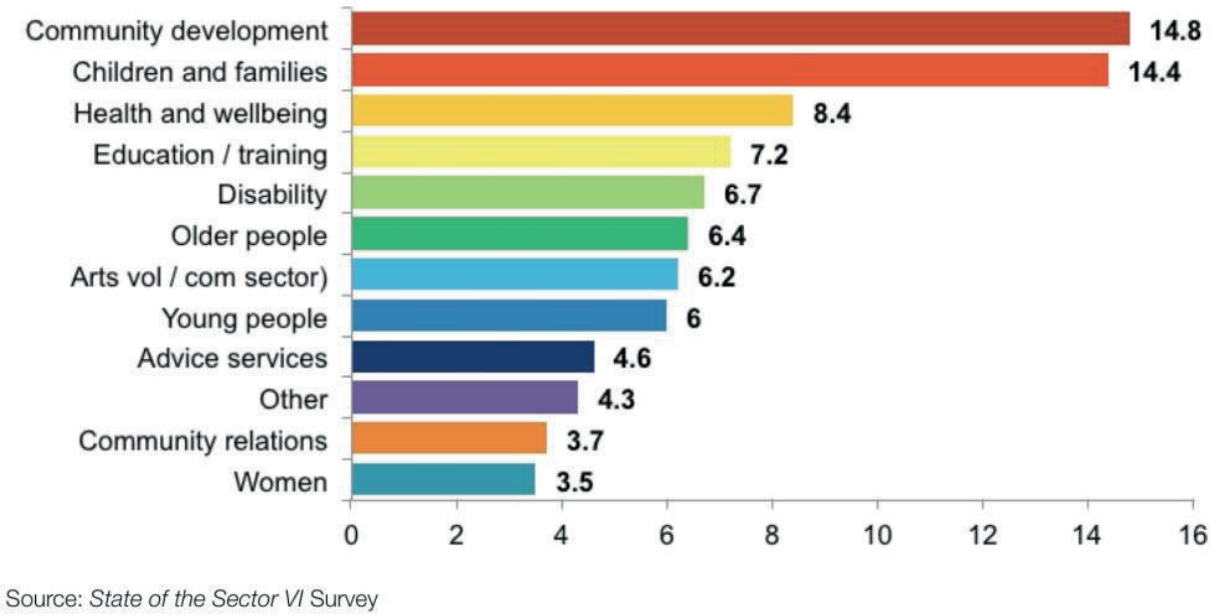
OPPORTUNITIES OR CHALLENGES FOR THE THIRD SECTOR?

The 4th Industrial Revolution is significantly different from the previous Industrial Revolutions. It will completely change everyone and every aspect of life. As Stanford University academic Jerry Kaplan writes in Humans Need Not Apply: today, automation is "blind to the colour of your collar." It doesn't matter whether you're a factory worker, a financial advisor or a professional flute player: automation is coming for you. This applies not just to individuals but even more so to organisations, and the implications for the third sector in the coming age of change are profound.
The 'third sector, belonging neither to the public sector nor the private sector, covers various organisations with different structures and purposes.

It is often described as the charity and voluntary sector, non-governmental organisations, non-profit organisations, community sector, civil society sector and so on. This sector has evolved in scope and scale in the last hundred years. According to the 2017 report by the Johns Hopkins Center on Civil Society Studies, the global civil society sector today has mushroomed into a workforce of 350 million professionals and volunteers, "outdistancing major industries in the scale of its workforce and its contribution to social and economic life." Put differently, if the global civil society workforce were a country, it would be the third most populated country in the world, following China and India.

Moreover, every Industrial Revolution brings many social changes and problems. Typically, most third-sector organisations devote themselves to a particular social issue that needs solving or to a particular group in society that requires support and representation. Many charities focus on issues surrounding social services, housing, education, human rights, community development, international development, health and medicine, and conservation and the environment. From this point of view, the impact of the 4th Industrial Revolution on the third sector is profound.

Is the third sector equipped to successfully navigate the challenges and opportunities of the 4th Industrial Revolution? Can they ensure the 4th Industrial Revolution advances in a manner that maximises benefits and minimises harms to people and society? The bar chart in Figure 2 shows the main areas of work conducted by voluntary, community and social enterprise organisations -weighted ranked scores.



Source: *State of the Sector VI* Survey

Figure 2: The main areas of work conducted by voluntary, community and social enterprise organisations -weighted ranked scores

It may be surprising that the main areas of work in which the third sector is currently engaged are highly coincident with the work required for the 4th Industrial Revolution. For example, occupations that involve building complex relationships with people, such as healthcare and other personal services, will increase dramatically in demand. Charities always play a significant part in health and well-being areas, providing expert healthcare, conducting research, raising awareness, supporting patients, and promoting mental health and well-being.

Health is the third-largest charity sub-sector by expenditure, with 6,626 health charities spending £4bn in 2011/12. In the UK, the National Health Service (NHS) provides much health care in the public sector. However, there is also a significant provision of supplementary care by third-sector bodies. Charities are at the heart of the communities they support: some directly deliver health and social care services; many work with a range of beneficiaries to provide care for daily problems. Compared with the public sector, charities can think more holistically, taking into account physical, emotional and environmental challenges and tackling the root causes of health inequality. It even has the potential to allow a more significant shift in focus onto the causes rather than the symptoms of problems, lessening the onset of preventable diseases and potential demand for treatment in future. These services cater to the needs of personalised medical services in the future. A similar situation exists in the work areas of disability and older people. At the dawn of the 4th Industrial Revolution, more and more people are aware of job losses and unemployment challenges. Many people may have to re-train several times during their working life, which will lead to a growing demand for education and training. At present, much education is provided by the public sector. However, some independent schools and colleges are third-sector bodies and some forms of education, such as private tuition, are provided on a for-profit basis.

The third sector has a distinct advantage over statutory agencies in personalised education and training. Some third-sector organisations are more flexible than statutory agencies in their services. For example, colleges only have intakes twice per year. This causes problems for the service users who may not be able to progress to college provision when they are ready to do so. Any "thirst for learning" that users have engendered can be lost while individuals wait until the next intake. Moreover, often working with individuals or small groups, third-sector organisations can also tailor their learning offer so that public services, which generally provide for a much more comprehensive range of needs and abilities, find much more challenging. Working with specific groups, they can develop in-depth knowledge of specific needs and expertise in designing services to meet those needs. In this perspective, the third sector will meet the requirements of changing the labour market better in the future.

HOW WILL THE THIRD SECTOR CHANGE?

The third sector has a tremendous opportunity in the future. At the same time, the 4th Industrial Revolution will transform the third sector significantly.

RAPID EXPANSION

The advent of the 4th Industrial Revolution will bring new societal problems and issues, and societal problems and issues are often the focus of the work of the third sector. So, people might see more new charities and NGOs popping up to tackle social issues. As Rob Acker, CEO of Salesforce.org, predicts, good social organisations can scale like never before because we're more connected than ever. Historically, a lack of resources and funding has plagued the social sector.

For example, one in five smaller charities is struggling to survive, but technology can help small organisations make a significant impact. The cloud is helping to break down barriers to entry. With increased access to data, previously unreachable populations can now be tapped and connected with particular causes without drastically increasing overhead costs.

IMPROVED SERVICES

First, AI offers the potential for more personalised service by freeing up community sector workers to do more people-oriented roles and a lot less grunt work. They will speak to residents, talk to customers, help the elderly, and do all those compassionate, emotionally needy jobs that machines can't and shouldn't do.

Second, services will become more timely and even predictable. There's a massive opportunity for non-profits to reach more people than ever before and connect with their donors, volunteers, students and constituents in real-time from anywhere. Non-profits can instantly reach their community of donors and volunteers to help with urgent matters that may mean the difference between life and death. For example, a non-profit focused on the humanitarian crisis could identify the specific location and number of refugees coming into different countries and preemptively send the appropriate aid and supplies.

INCREASED INCOME

According to the State of Charities and Social Enterprises 2015, generating income and achieving financial sustainability is the most pressing challenge facing charity chief executives. Two-fifths of chief executives in large charities are concerned about public or government funding reduction. However, with the 4IR, this problem will be solved thoroughly. Organisations can also start to organise and understand these communities better than ever, resulting in deeper engagement. With deeper engagement, these organisations will start seeing increases in donations and volunteer time, directly impacting their mission. According to the recently released Connected Nonprofit Report, 65% of donors would give more money if they felt their non-profits knew their personal preferences—and 75% of volunteers would give more time.

The 4th Industrial Revolution will redefine what it means to be human and how we engage with one another and the planet. The third sector can use technology to find and connect with more people who need their services, understand their communities on a deeper level, and supply better services to achieve more goals. At the same time, their capabilities and potential will all evolve along with the technologies.

In the coming decades, the third sector will face increased opportunities and challenges (e.g. an ageing population). They must recognise and seek to address future societal challenges, particularly in social inequality and unemployment. This effort requires all stakeholders—governments, policymakers, international organisations, regulators, business organisations, academia, and civil society — to work together to steer the powerful emerging technologies in ways that limit risk and create a world that aligns with common goals for the future.

SO MUCH MORE TO DISCUSS

This report was written as an introduction to a topic that may not be on everyone's radar, and there are many questions to address:

- How should the third sector tailor its activities and services to the needs of the future, for example, to provide more personalised, flexible education and training services to develop new and rapidly changing skills needed for the 4th Industrial Revolution?
- Which skills will become more important for staff in the third sector?
- What could be the role of the third sector in addressing the needs of the potentially large number of people who could become unemployed as a result of the 4th Industrial Revolution and the transition towards new ways of working
- How will we evaluate the impact of the third sector in meeting the challenges of the 4th Industrial Revolution?
- How can the government be persuaded that they should support the third sector in particular to develop responses to the 4th Industrial Revolution?
- How should the third sector organisations cooperate with each other and other sectors in the future to meet the challenges of the 4th Industrial Revolution?
- How will public policy and legislation need to change to keep up?
- What new services or jobs will be created by the 4th Industrial Revolution that the third sector could provide?
- How will the 4th Industrial Revolution affect rural areas differently from urban areas? wn

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INDUSTRY 4.0

Is Africa ready for digital transformation?

Around the world, the traditional manufacturing industry is in the throes of a digital transformation that is accelerated by the exponential growth of smart technologies. Companies and industrial processes need to adapt to this rapid change and exponential growth if they are not to be left behind by developments in their sector and by their competitors. In today's globalised world, this applies to traditional industrial economies such as Germany and the US and emerging economies in Asia, Africa and South America.

These new trends are global and universal and cannot be ignored by manufacturing companies. Everybody is affected and will need to adjust to remain competitive.

The current digital transformation is not to be compared simply with a greater level of production automation. Developments in electronics and information technology have driven this process since the 1970s. The global manufacturing industry's widespread adoption of information and communications technology is now paving the way for entirely new disruptive approaches to development, production and the entire supply chain.

Experts use the term 'industry 4.0' to refer to a 'fourth industrial revolution' that will produce, with the help of smart technologies, smart machines and factories, smart products and services and new interaction models, among other things, that go beyond simply automating production. The merging of the real and virtual worlds and the networking within an 'internet of things, services, data and people' will entirely transform the future of manufacturing and make it much more competitive for manufacturers that operate across global and local markets.

WHAT IS INDUSTRY 4.0?

The term 'industry 4.0' refers to the next developmental stage in the manufacturing industry's organisation of the entire value chain process. It is also known as the 'fourth industrial revolution.'

The German government first introduced the concept of industry 4.0 as a high-tech strategy to promote the computerisation of its manufacturing industry. It is now widely used across Europe and has also been picked up in Asia, especially in China. In the US and the English-speaking world, the terms' internet of things' (IoT), the 'industrial internet' or the 'internet of everything' are often used as equivalents.

All these terms and concepts have in common the recognition that traditional manufacturing and production methods are going through a digital transformation process. For some time, industrial processes have increasingly embraced modern information technology (IT). Still, the most recent trends go beyond simply the automation of production that has, since the early 1970s, been driven by developments in electronics and IT (see chart 1).

The widespread adoption by the manufacturing industry of information and communication technology (ICT) is increasingly blurring boundaries between the real world and the virtual world. It is creating new production systems, namely cyber-physical production systems (CPPSs).

CPPSs are online networks of social machines that are similarly to social networks. They link IT with mechanical and electronic components that communicate via a network. Radio frequency identification (RFID) technology, which has been used since 1999, was a very early form of this technology.

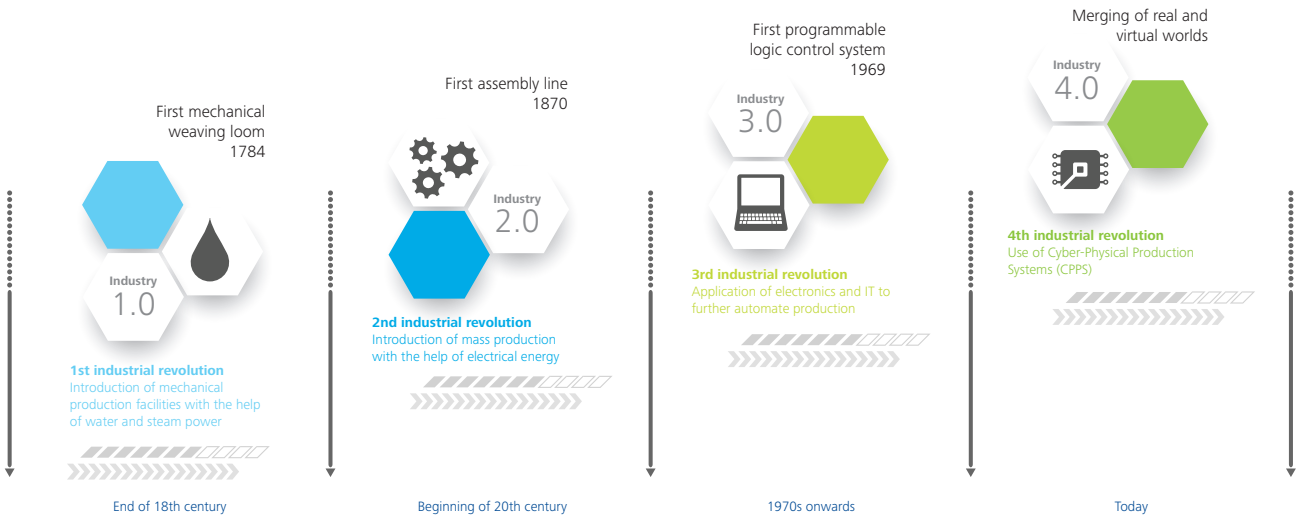

Chart 1. Evolution of industry 4.0

Smart machines continually share information about current stock levels, problems, errors or faults, and changes in orders or demand. Processes and deadlines are coordinated to boost efficiency and optimise throughput times, capacity utilisation and quality in development, production, purchasing, sales and marketing.

CPPSs network machines with each other and create a smart network of machines, properties, ICT systems, smart products and individuals across the entire value chain and the full product life cycle. Sensors and control elements enable machines to be linked to plants, fleets, networks and human beings. Full traceability in any part of the value chain and live product data and customer feedback will make it possible to assure and improve overall product and service quality.

Smart factories and their CPPSs are at the heart of industry 4.0, interfacing with other smart infrastructures, such as smart mobility, the smart grid, smart logistics and smart homes and buildings (see chart 2). Links to both business and social networks – the business web and the social web – also play an increasingly important role in the digital transformation of manufacturing to industry 4.0.

All these new networks and interfaces offered by industry 4.0 within an 'internet of things, services, data and people' mean that manufacturing will undergo enormous changes in the future. This trend is still in its infancy in some manufacturing companies, industrial sectors and geographies, but in others, the transformation to industry 4.0 is already well underway.

Traditional industrial economies such as Germany and the US expect this fourth industrial revolution to bring many advantages, ranging from enhanced global competitiveness to the reversal of the trend to relocate production to low-cost countries and opening more domestic production locations in Europe and North America. Substantial government funding for industry 4.0 and advanced manufacturing initiatives are already taking place. Emerging economies can become early adopters of industry 4.0, acquire capabilities to develop advanced manufacturing systems and leapfrog their global competitors with unique locally-developed high-tech products and services. China's shift in recent years from a manufacturing-intensive 'made in China' economy to an innovation-driven 'designed in China' economy clearly illustrates that opportunity.

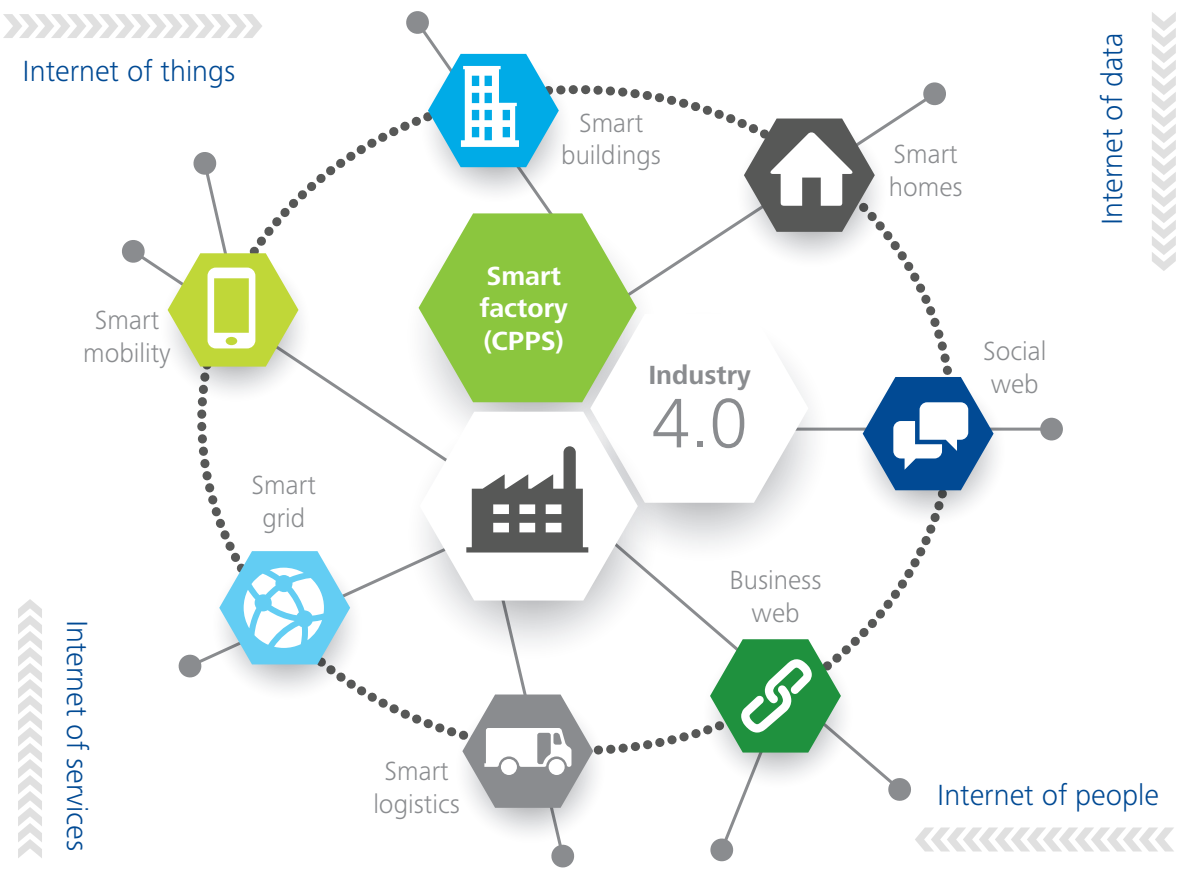

Chart 2. Environment of industry 4.0

SMART TECHNOLOGIES AND TRENDS

Different smart technologies are helping speed up the digital transformation of manufacturing and enable a decisive move towards industry 4.0 (see chart 3).

The most crucial smart technologies for this digital transformation are advanced materials and manufacturing processes, which extensively leverage connectivity and use advanced computing and big data capabilities. In addition, these smart technologies will facilitate new cooperation and interaction models with suppliers, business partners and customers (e.g. crowdsourcing, gamification, mass customisation and collaborative consumption).

The smart factories of the future will organise themselves and enable collaborative, customer-specific and individualised production. This requires data to be extensively integrated. Smart sensor technology is needed to help with monitoring and autonomous organisation.

However, besides autonomous and smarter production management, smarter maintenance management will be possible. Resources and products can be networked, and materials and parts can be located anywhere at any time. All processing stages in the production process can be logged, with discrepancies registered automatically.

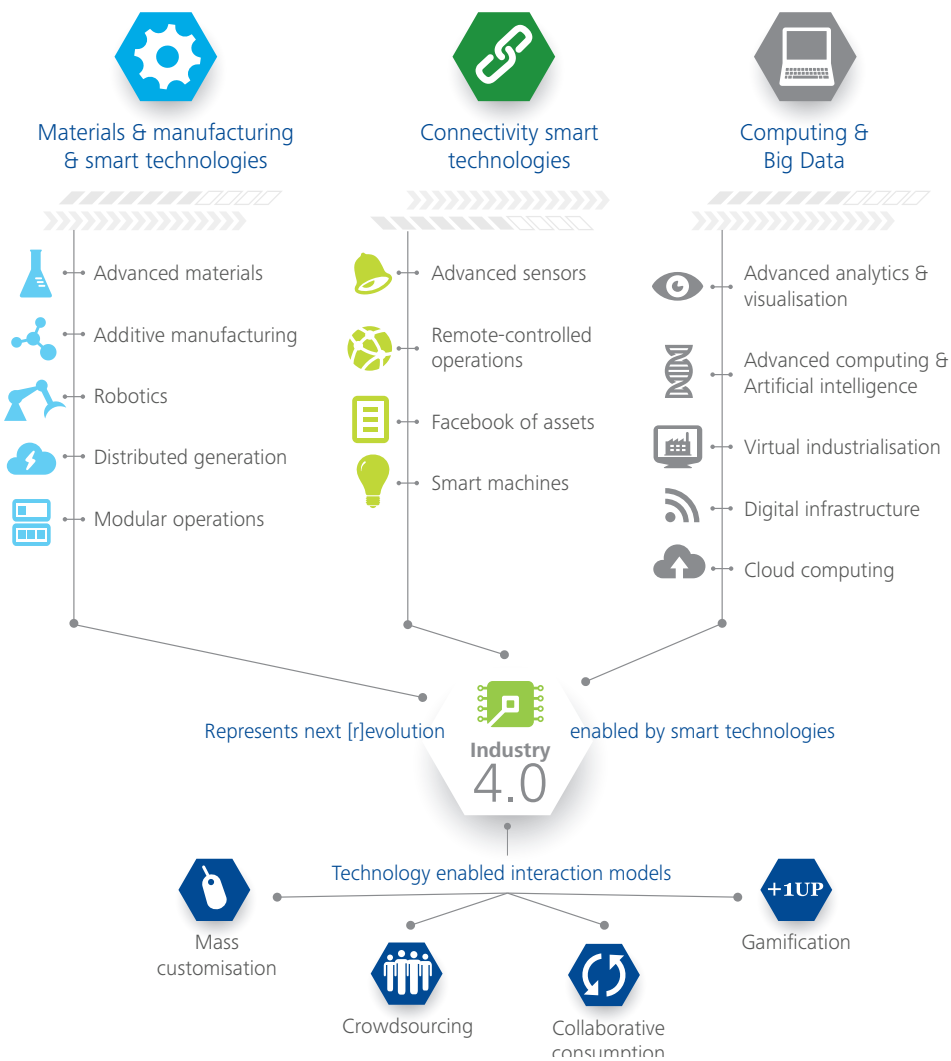

Chart 3. Smart technologies and trends

Amendments to orders, fluctuations in quality or machinery breakdowns can be dealt with more rapidly. Smart technologies enable wear and tear on materials to be monitored more effectively or pre-empted. All in all, waste is reduced.

In addition, a new generation of local and global value chain networks will be created with the help of smart technologies.

These new value-creation networks are real-time optimised networks that enable integrated transparency, offer a high level of flexibility to respond more rapidly to problems and faults, and facilitate better local and global optimisation.

Smart networking from inbound logistics through warehousing, production, marketing and sales to outbound logistics and downstream services will be possible. The history of any part or product can be logged and accessed at any time, ensuring constant traceability (a concept known as 'product memory').

This can create transparency and flexibility across entire process chains. Customer-specific adaptations can be made not only in the production but also in the development, ordering, planning, composition and distribution of products. This can enable quality, time, risk, price, and environmental sustainability to be handled dynamically, in real-time and at all stages of the value chain.

Industry 4.0 already requires automation solutions to be highly cognitive and highly autonomous. Artificial intelligence, advanced robotics and sensor technology have the potential to increase autonomy and speed up the mentioned collaboration, individualisation and flexibilisation. Artificial intelligence not only helps to

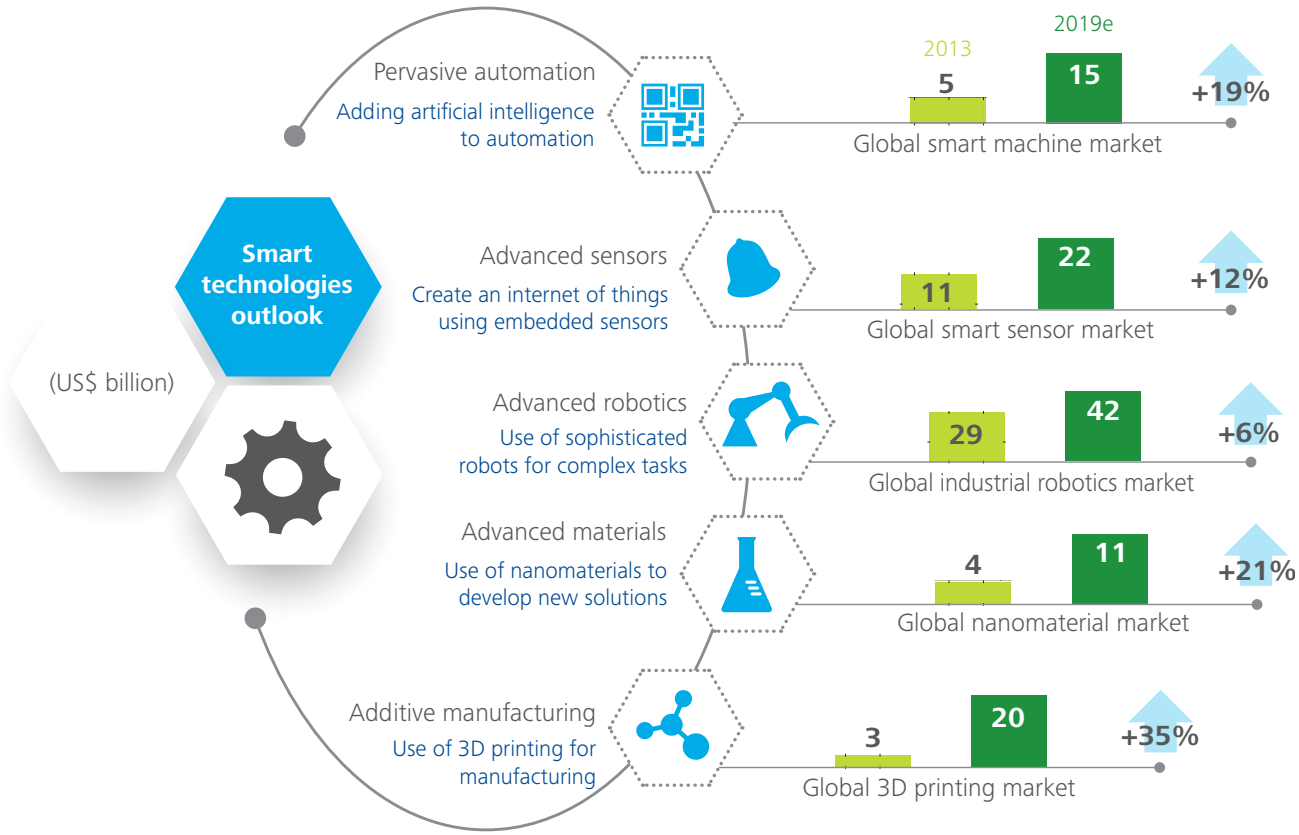

Chart 4. Smart technologies market outlook

plan driverless vehicle routes in factories and warehouses more flexibly, save time and cost in supply chain management, increase reliability in production and analyse big data but can also help to find new construction and design solutions and enhance the cooperation between humans and machines across the whole value chain up to the point of services.

The strong global market outlook for smart machines, smart sensors and industrial robotics in the coming years emphasises the significant potential for industry 4.0 and IoT applications in the manufacturing industry (see chart 4).

Although from a lower base, an even stronger global market growth is also expected for nanomaterials and additive manufacturing (3D printing).

Nanosensors and functional nanomaterials can be used in an industry 4.0 environment in production control functions to make quality management more efficient or allow the production of next-generation robots that work' hand in hand' and safely with humans.

Additive manufacturing (3D printing) is an example of a smart technology that will accelerate industry 4.0 and make it more flexible. 3D printing can enable new production solutions (e.g. functionality, higher complexity without additional cost), new supply chain solutions (e.g. inventory reduction, faster delivery times), or a combination of both that can lead to disruptive new business models (e.g. disintermediation of supply chain members, customer integration).

EXPONENTIAL GROWTH AS AN ACCELERATOR

One important aspect of smart technologies is that the majority of them are growing exponentially and will further accelerate the digital transformation of traditional manufacturing towards industry 4.0 (see chart 5).

Research has shown that Moore's law – which states that the capacity of microchips, bandwidth and computers doubles every 18 months, representing exponential growth – also applies to other technological developments5. Additive manufacturing, sensor technology, robotics, artificial intelligence, nanotechnology or drones are just a few examples of exponentially growing smart technologies that radically change industrial processes,

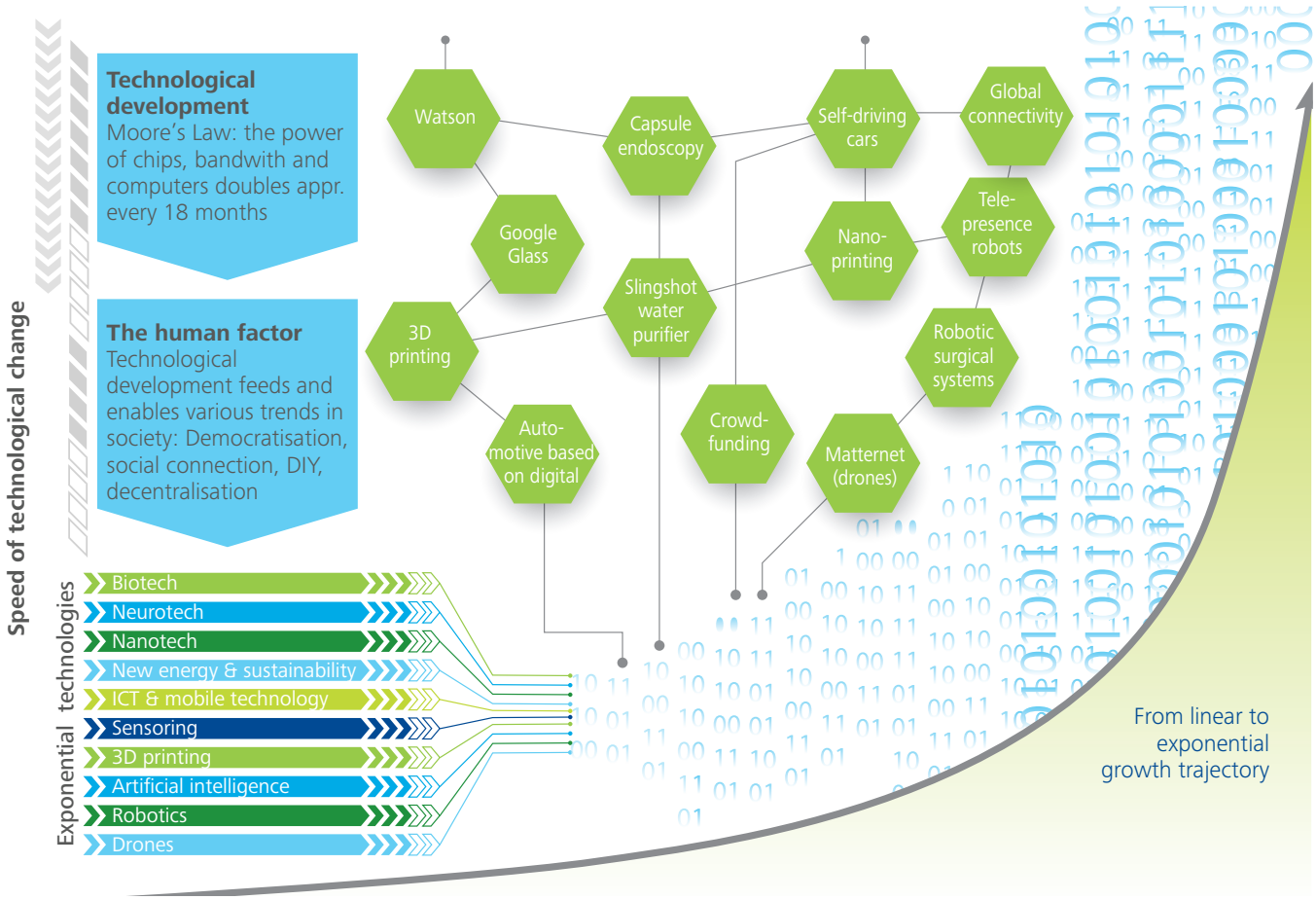

Chart 5: Exponential Growth

accelerating them and making them more flexible.

Many of these smart technologies are not new and were, in fact, 'invented' some 20 to 30 years ago. However, the recent massive boost in computing power (Moore's law) and the cost reduction, along with miniaturisation, now make them suitable for industrial use.

New technologies can be overrated and cause concern because of the slow development curve in absolute terms at the beginning. When exponential development takes off, the influence of such technologies is often underestimated, and disruptive market changes are missed. Several of these smart technologies will leave their linear growth paths in the coming years, and we expect exponential growth. This exponential growth will fundamentally shape and accelerate industry 4.0.

HOW DOES AFRICA/SOUTH AFRICA STACK UP?

THE CURRENT IMPACT OF INDUSTRY 4.0

Most of our interviewees believe that industry 4.0 will have a strong impact in the coming years on Africa/South Africa in general and especially the South African manufacturing industry. The current adoption and impact of industry 4.0 in Africa/South Africa are still relatively low compared to the rest of the world.

Emerging economies have more constraints than the developed world regarding new technology adoption. However, it is a topic that is increasingly being acknowledged and discussed by industry leaders and policymakers. The biggest challenges on the African continent remain connectivity and accessibility, and progress in these will drive broader adoption of industry 4.0 or IoT applications by businesses and consumers.

Strong wireless connectivity investments are a good basis for further technology development, but more private and public investments and incentives are needed.

A broader industry 4.0 adoption is hindered by a general reluctance to invest in new knowledge and technologies within government and industry. In addition, the current economic environment is forcing South

African manufacturers to save costs first and spend less on innovation—global manufacturers operating in South Africa leverage some global industry 4.0 or IoT applications. Not many local applications have been developed yet. More innovation still needs to happen first before widespread adoption occurs.

However, Africa has an advantage over developed markets because it is not weighed down by infrastructure legacy issues and may have little difficulty embracing change.

Great leapfrog potential exists to adopt or develop specific industry 4.0 or IoT applications directly. Numerous possibilities can be created to use connected networks across various industries for competitive advantages.

There is also a huge potential for collaboration between government, industries and research institutions. However, more education and information about advanced manufacturing and its benefits for policymakers and industry leaders are needed.

Overall, industry 4.0 offers great opportunities for South African manufacturers to lead the way and create new business models. A move of value propositions from products to more services and usage of smart technology could also make a real impact on a socio-economic level. It is key for manufacturers to plug into a networked economy and develop completely new offerings that enable faster, simpler customer service. The world-leading mobile money services in African banking are a prime example that could serve as a successful blueprint for manufacturing companies. The best-known example of an innovative mobile money service that allows people without a bank account to transfer funds is M-Pesa, launched in Kenya in 2007. Money deposits, withdrawals, bill payments or microcredit provisions have become as easy with M-Pesa as sending a text message. Many of today's successful mobile money offerings across the world are very similar to or result from M-Pesa.

USAGE OF SMART TECHNOLOGIES AND NEW INTERACTION MODELS

According to our interviewees, the majority of the mentioned smart technologies – i.e. advanced analytics, cloud computing, advanced sensors and robotics, and additive manufacturing (3D printing) – are slowly being adopted by South African manufacturers. Nevertheless, they are seen as very promising for the future of manufacturing.

Current usage of smart technologies in the South African manufacturing industry (Findings from interviews):

ADVANCED ANALYTICS

- Strongest adoption of advanced analytics within automation and automotive sectors; other sectors like the process industry are still catching up
- Many manufacturers do not know what kind of data they have, how much it is already connected and what insights and benefits they could derive from it
- Majority of manufacturers have a 'reactive approach' when it comes to data usage and analysis and not a 'predictive approach'
- There are huge opportunities in advanced analytics that are not fully explored yet by South African manufacturers (e.g. to support decision-making, condition monitoring or predictive maintenance)

CLOUD COMPUTING

- Adoption of cloud solutions has increased in recent years with the implementation of better mobile infrastructure/connectivity in South Africa
- Currently, there is a stronger adoption happening by consumers than by businesses/industry
- However, this is bound to change in the coming years, with higher business adoption expected
- Fear of cyber-crime and privacy concerns are cited as the main concerns hindering cloud adoption

ADVANCED SENSORS

- With a few exceptions, advanced sensor technology like machine-to-machine (M2M) communication is mostly at a foundation stage in South African manufacturing
- Higher traction can be found in the automotive industry and some non-manufacturing sectors (e.g. retail, logistics/freight)
- However, South African manufacturers are interested in better leveraging the potential of sensor technology in their manufacturing processes (e.g. monitoring, controlling, tracking etc.)

ADVANCED ROBOTICS

- Adoption of advanced robotics remains low across different South African manufacturing sectors
- Usage of robotics is mostly at an automated stage and not yet at a smart or advanced stage
- Stronger adoption of advanced automation/robotics technology can be found only in a few industries, e.g. automotive
- Cost factors are a prohibitive adoption factor for many South African manufacturers

ADDITIVE MANUFACTURING (3D PRINTING)

- No widespread adoption of 3D printing yet within the South African manufacturing industry
- Manufacturers are aware of the significance and the potential of this

exponential technology
- Examples of actual usage are mostly in rapid prototyping, testing of design options or understanding engineering problems better
- No examples of usage of 3D printing for low-level or mass production due to cost reasons
- Affordability remains an issue in developing markets compared to developed economies
- Once the cost of printers and materials comes down further, more investments by manufacturers and greater usage are expected

South African manufacturers are also slow in adopting technology-enabled interaction models within an industry 4.0 environment.

However, some of our interviewees seriously follow developments in new forms of cooperation and interaction with suppliers, business partners and customers – like mass customisation, crowdsourcing, collaborative consumption or gamification.

Current usage of technology-enabled interaction models in the South African manufacturing industry (Findings from interviews):

MASS CUSTOMISATION
- The general trend towards highly individualised and customer-specific solutions is seen as an important topic by South African manufacturers, albeit with some sector differences
- However, most manufacturing companies see customisation as a special service at a higher price and not necessarily as part of the main business
- Some flexible manufacturing is taking place, but mass customisation, like the mass production of highly customised products and services, is not yet seen as feasible by many manufacturers

MASS CROWDSOURCING
- Stronger collaboration with customers through 'crowdsourcing', e.g. getting input from a crowd of people for the development/production process, is not a real topic yet within South African manufacturing
- Customer integration and contribution towards ideas and development of products and services remains generally low and is seen by traditional manufacturing companies as something that creates more (rather than less) complexity and costs
- Concerns around IP rights and industrial espionage dominate the discussions around open innovation and crowdsourcing

COLLABORATIVE CONSUMPTION
- The collaborative consumption trend as part of the increasing sharing economy remains a relatively young phenomenon within the South African manufacturing industry
- New trends in owning, sharing, trading, renting etc. of manufactured goods and services are only slowly being picked up by traditional manufacturers
- The automotive industry has been at the forefront of this new trend, with extensive partnering with new car-sharing companies or launching their own car-sharing businesses

GAMIFICATION
- Gamification, e.g. the inclusion of game design elements and principles into the employee, supplier or customer experience, is also not a significant topic in South African manufacturing yet
- Globally on the rise, not many South African manufacturers use already gamified applications for their marketing purposes and customer retention or as a motivational tool for their employees

INFRASTRUCTURE AND TALENT OPPORTUNITIES AND CHALLENGES

Most of our interviewees see the main opportunities and challenges South African manufacturers are facing while getting themselves ready for the digital transformation towards industry 4.0 as being related to the infrastructure and the people/ talent dimension.

Infrastructure opportunities and challenges in South African manufacturing (Findings from interviews):

IT INFRASTRUCTURE
- Many old and disparate IT systems are in places that need upgrading to be able to handle the speed of change in a new industry 4.0 environment
- Old IT systems are not ready to network and communicate with each other
- Complexity amongst many South African manufacturers is very high, with different systems in place in different business areas, such as research and development, procurement and purchasing, production, warehousing and logistics, marketing, sales and services
- However, this is also an opportunity to introduce brand new industry 4.0-ready infrastructure
- Cost is a key factor in deciding on harmonising and upgrading existing IT infrastructure or replacing them with entirely new systems

CYBER-RISKS
- Fear of cyber-risks and privacy concerns in light of the digital transformation towards industry 4.0 is very high
- However, the majority of South African manufacturers think that the risks will be manageable through tailored risk management and appropriate security strategies
- Investments are needed so that the

developments in cyber security can keep pace with the ever-changing nature of cyber threats

ELECTRICITY INFRASTRUCTURE

- Electricity constraints, e.g. load shedding as well as a lack of stable electricity supply, are big challenges for South African manufacturers and are seen as an obstacle to the digital transformation towards industry 4.0
- Trend to embrace renewable energy, become completely self-sufficient and get production off the grid
- Great opportunity to leapfrog with industry 4.0 applications (e.g. smart metering etc.)

Talent opportunities and challenges in South African manufacturing (Findings from interviews):

IT SKILLS

- More collaboration in the field of IT skills between the manufacturing industry and the university/ educational sector is required
- Often, it is not a lack of skills, but a misalignment of skills
- Generally, a lot more software/digital skills are needed to support the move toward industry 4.0
- Lots of entry-level IT skills are available in South Africa; however, the blend of the right skills is crucial (e.g. a combination of IT skills, business experience and storytelling capabilities for analytics)
- A major challenge for South Africa is also the fact that the IoT talent shortage exists not only locally but also globally
- Global manufacturing companies operating in South Africa are more attractive for the local talent than South African manufacturers; SMEs are finding it harder to keep the good talent

TRAINING NEEDS

- Extensive need to (re-)train existing workforce/upskill labour to understand and operate new and smart technologies
- Significant opportunity for industry and government involvement to develop the digital workforce of the future

MINDSET

- Mindsets of many manufacturing companies are not fully geared towards industry 4.0 solutions, even though the trend is acknowledged
- Companies have to deal with the surprisingly high number of technology-averse people within the workforce
- Different degrees of technology readiness across the different workforce generations (X, Y and soon Z)

HOW CAN YOU PREPARE YOUR BUSINESS FOR INDUSTRY 4.0?

To navigate a world that is changing exponentially, you as a manufacturing company will be increasingly challenged to shift from a 'push' to a 'pull' approach (see chart 6).

To develop the full potential and truly maximise the opportunities of the digital transformation towards industry 4.0, companies will be required to switch from the 'push into the market' of better products for their customers to an individualised understanding of customers' needs and specialised, industry-specific solutions ('pull from the customer').

The world has traditionally been organised around labour, with many assets and knowledge pools focused on efficiency. Superior engineering allowed for higher prices and planning and driving change where needed.

To benefit from exponential growth and the digital transformation towards industry 4.0, successful manufacturing companies of the future will require a long-term vision, need to organise around digital power, tap into external pools of knowledge, combine assets, gain better knowledge about markets, industries and customer preferences and focus on scalable learning.

Suppose you want to remain successful and competitive in the age of the fourth industrial revolution. In that case, you will need to prepare yourself for the exponential speed of change, organise your business for 'pull' and scale the edges of your business for new innovative business models.

GET READY FOR THE EXPONENTIAL SPEED OF CHANGE

As a manufacturing company, you will need to prepare yourself for the depth and speed of how traditional manufacturing processes will be completely changed and transformed in the fourth industrial revolution. If you do not, you may be left behind by developments in your sector and by your competitors.

Urgency is required because competition will increase rapidly with many new entrants challenging traditional players. Somewhere in a garage nearby or far away, the next breakthrough innovation is currently being developed by your future competitor that will disrupt your industry. You will need to ensure that you are aware of these industry-changing processes and trends and need to spread this understanding within your organisation.

It will be increasingly important to have a long-term vision of your future environment rather than just short-term strategic plans. This should include keeping abreast of the latest trends and technologies that will impact the

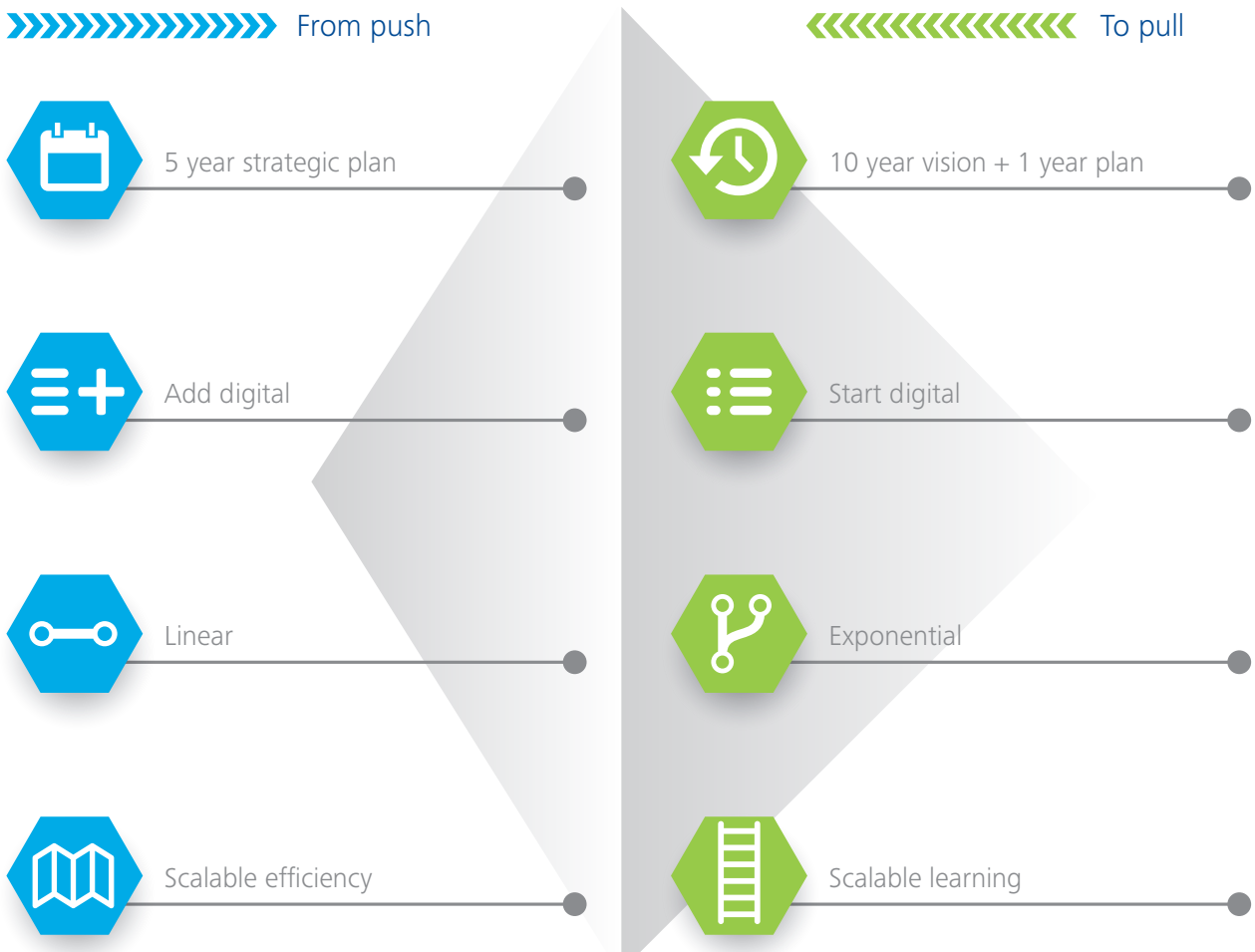

Chart 6. From push to pull

industry in the coming years, being on the lookout for the next big idea, and developing disruptive innovations that will change the rules of the current business.

To be successful in the future, you will need to explore these current trends and new technologies and create space for the development and growth of new business areas on the edge of your current business activity that could, in time, become central to your actual business.

ORGANISE YOUR BUSINESS FOR PULL

Moving from a push-world to a world with pull-based business models will also require an organisational change from your company.

To organise your business for pull, re-invent yourself and profit from the exponential growth and digital transformation towards industry 4.0, you need to confront and change the core of your business. This will cause anxiety within your organisation. The antibodies in the core (e.g. people who have difficulty with change) can be powerful and will try to crush any attempt at transformation.

It is, therefore, important that you tap into the passion of your employees. It will be essential that you invest in the right talent that already exists in your organisation and that has the right attitude and will embrace the digital transformation towards industry 4.0. You will need to identify talented people who are passionate, unafraid of change and willing to explore new possibilities. In many cases, there is not enough talent within the organisation, so you will need to recruit new people with the right skills.

New policies, practices and actions are required to unlock your employees' potential and passion in the digital transformation towards industry 4.0. Additionally, the workplace itself will need to be redesigned. This could mean that you must encourage employees to work cross-functionally and more collaboratively with suppliers or customers or on projects they are interested in but outside their responsibilities. Your new workplace design should also include the creation of spaces for creativity.

Overall, this redesign should facilitate continuous experimentation and innovation of new, scalable business models, not just the traditional area of product innovation.

Innovation has traditionally focused predominantly on product offerings. Still, its major potential lies in company structures, processes, networks and profit models, together with customer-facing functions, such as new services and distribution channels, new uses for a strong brand and distinctive customer engagement. Industry 4.0 will make it easier for your company to innovate beyond products and build breakthroughs11.

SCALE THE EDGES OF YOUR BUSINESS

Once you have prepared your company for the exponential speed of the digital transformation towards industry 4.0, organised your business for pull-based business models, and unlocked the passion in your workforce, you will be ready for the next step: Scaling from the edge.

It is not easy to introduce the successful innovation and creation of new business models in your entire organisation. A top-down approach will create resistance in your organisation while introducing pockets of innovation within the traditional business areas will provoke a reaction from less engaged employees. Placing innovation entirely outside an organisation also has drawbacks because there will not be any connection with the rest of the company nor with the organisation's benefits.

To succeed, you need to innovate and create new business models not within your core business or outside your organisation but on the edge of your current business. The first step is to develop an inspiring vision of exponential technologies and the new possibilities of industry 4.0 at the edge of your business and to consider which of these are relevant for your company and your customers.

Your next step will be starting a small initiative based on this inspiring vision and a scalable learning mindset. Continuous experimentation and failing forward ('failing quickly to learn fast') will be key. The intent should not be to pull this initiative back to the core.

The core can crush even well-articulated edge initiatives. Rather than pulling the edge back into the core, the alternative is 'scaling from the edge.' This means that if you can find an edge that has the potential to scale extremely rapidly, you can pull more and more of the core out to the edge to the point where the new edge becomes the core of the business over time. New stakeholders and new innovators – e.g. other companies – will want to join you, as well as the explorers within your organisation.

The digital transformation towards Industry 4.0 will help your company come to grips with radical new approaches to business rather than merely making incremental improvements to established business models.

WHAT WILL YOU NEED TO DO?

IT INTEGRATION

Industry 4.0/IoT will change everything. A new digital world is emerging, and we are entering another era in Enterprise IT that focuses on business models and digital business innovation. Business leaders need to use IT effectively to stay ahead of the game. IT leaders must bring new solutions for businesses to innovate and stay relevant. Smart organisations need to focus on their strategic alignment and IT governance to drive IT integration and become more efficient and competitive for the explosion of information.

Digital business is about 'people, business and things' working in sync to transform manufacturing operations in the coming years to 'autonomous manufacturing.' The loop will be closed with the integration between different devices and solutions, and smart factories will evolve. IT integration involves end-to-end business with key focus areas on Enterprise Resource Planning (ERP), Customer Relationship Management (CRM), Supply Chain Management (SCM), collaboration and digital transformations supported by best-of-breed and innovative technologies. Standardisation is key as it makes a business more efficient and assists in achieving speed and customer service with a move to dynamically integrated systems.

CASE STUDY

OVERALL PROJECT

The client's solution drivers for this project included a solution that would provide fully integrated/interfaced online Applications systems, covering accounting, finance, administration, HR, apprenticeships, artisans, skills, ETQA, SCM, learnerships and project modules, including collaboration suites and CRM. The client chose a solution that would provide a cost-effective option with shared services hosted environment and a dedicated team of experienced specialists who could service and support the systems with any legislative necessities and enhancements required to align with business processes.

APPROACH

The project was planned in a phased approach, bringing in the new integrated solutions with the ERP Microsoft AX and MIS platforms, with blueprint and specifications sessions, user acceptance testing and data migration completed as a web-based solution available to all stakeholders countrywide. The solution formed part of a fully outsourced

solution, including an ERP solution, Applications systems, SharePoint and Website and other outsourced services.

The service offered caters to the non-core functions of the client and is underpinned by ITIL and COBIT principles frameworks, audit and legislative compliance alignment, readiness and support for corporate and IT governance, and King III alignment.

VALUE DELIVERED/RESULTS

The new technology and enhanced IT integration systems have given the client best-of-breed systems to support their business processes, key management reporting functionality, and support for audit readiness and IT governance.

CLOUD-BASED APPLICATIONS

"Change is constant, and 'technology' can be referred to as the most recurring change in today's world."

Cloud computing is a technology for delivering information or services in which resources are retrieved from the internet through web-based tools and applications, rather than a direct connection to a server.

Simply put, all the computer hardware and software sitting on local machines or somewhere inside a company's network is provided as a service by another company over the internet, usually completely seamless. In several ways, the cloud computing infrastructure is revolutionising all fundamental areas of IT – from security and investment in infrastructure to application development.

Most IT departments spend excessive time on frustrating implementation, maintenance and upgrade projects – without adding value to the company's bottom line. IT teams in major global organisations and small businesses are turning to cloud computing technology to minimise time wasted on lower-value activities allowing IT to focus on high-impact strategic activities. Adopting cloud technology allows for fast implementation and no major upfront costs. It also requires no maintenance, and solutions can be provided anywhere and at any time on demand.

CASE STUDY

OVERALL PROJECT

A pharmaceutical company's five-year vision was to embrace cloud computing and replace the current delivery model with a multi-sourced, multi-layer cloud eco-system.

The organisation's objective for the cloud was to dramatically increase IT responsiveness by being agile and instantly scalable, ensuring reduced cost and driving more value from IT investments, and enabling workload flexibility and mobility between providers as the cloud market develops and matures.

APPROACH

The first step of the vision was migrating a large proportion of workload to infrastructure as a Service (IaaS). As IaaS technologies developed, the company used multiple suppliers and broker services. By 2015, once cloud technologies and standards matured, the company sourced services from multiple cloud vendors, brokering and coordinating the cloud eco-system.

VALUE DELIVERED/RESULTS

Deloitte is currently supporting the company with defining the new cloud service and preparing for the migration of 6 000 servers and 1 200 applications. Through the experience gained with the company and multiple other cloud engagements, Deloitte has identified several key learnings for successfully migrating to the cloud.

OPERATIONAL EFFICIENCY

Industry 4.0 offers new opportunities to drive operational efficiency by providing immediate access to data. The effective analysis, assessment and application of data collected from machines and sensors enable rapid decision-making to improve operational safety, work processes, servicing and maintenance. The application of focused analytics and statistics can be mined and analysed to inform specific hypotheses or create new ones about performance. Data itself is difficult to interpret.

Data is turned into usable information in the form of graphics and dashboards. These can be easily interpreted and acted upon to make fact-based decisions about processes, equipment and even human performance.

Transparency and real-time information can make development and production processes more efficient. They also offer cost reductions that benefit the operations through better management and control of working capital and provide customers with improved services and better product quality. Maintenance work can be done in a needs-oriented, proactive manner (e.g. only a short while before a risk develops) through understanding certain trends observed in equipment. This creates long-term competitive advantages in reliability, sustainability, predictability and cost. More price-competitive products/services are possible, and even innovative solutions allow customers to track the performance of goods in a broader supply chain.

CASE STUDY

OVERALL PROJECT

A leading South African steel producer experienced failure on blowing fans inside a bell-shaped container where steel coils are placed for 'normalising' (normalising is a term for a specific heat

treatment where the steel is heated to a specific temperature and allowed to be air-cooled). Failures were experienced on the fans inside the bell container that housed the coil, which was to be cooled after being heated. On failure, the bell needed to be lifted and the coil removed to access the fan. This was a demanding task due to the environment being unsafe and challenging to access. The motor failure often caused subsequent damage to the fan housing and other components, resulting in repairs taking longer than expected. These delays also impacted the heat treatment process. The coil was removed from the normalised environment and, depending on repair duration. It often needed to be heated again to restart the treatment process, resulting in production delays.

APPROACH

During the project, a mechanism was installed on the fans that measured the vibrations from the motor. This allowed a live data feed on motor performance. The data was measured for a set period, and all information on maintenance and motor failures was recorded. The data were analysed using various regression and correlation techniques.

The hypothesis was that the motor's vibration and noise increased when it approached the failure point. A prediction model was developed to accurately predict failure by evaluating the degree of vibration experienced on the motor. This model was programmed into the motor-control system. Problematic motors were flagged and prevented from starting if the model predicted they would fail during the treatment process.

VALUE DELIVERED/RESULTS

This intervention reduced unplanned maintenance on the motors by approximately 80%. It reduced maintenance and repair time by 55%, as additional repair work on damage that previously resulted from failed motors decreased, and planned maintenance could be done more effectively. This affected the correct parts being held and available when maintenance was required. Overall downtime in production was reduced. The simple use of sensors to provide feedback on motor vibration predicted failures for the client. Data analysis and development of a prediction model helped improve productivity, reduce downtime, plan more effectively, reduce rework and save on operational costs. Such data and measures provide valuable information about almost any production operation; once this is known, it can be acted upon to improve performance.

IT SECURITY MANAGEMENT

The extensive networking already cited and the high levels of data sharing involved in industry 4.0 will greatly increase the demands made on data security. The connected technologies envisaged to be used by the manufacturing industry will still be made up of software and hardware, each with unique vulnerabilities and weaknesses. If not adequately protected, these devices can be identified from remote locations and targeted – often without the custodian's knowledge.

Companies urgently need a tailored risk-management system and a security strategy geared to cyber security and aimed at improving operational security and protection from attack right across the value chain. In this respect, the manufacturing industry currently lags a long way behind the financial services sector but has the opportunity to learn from it.

New products, data, intellectual property and so on will have to be protected against unauthorised use and abuse. But the focus should not just be on the potential of data loss. The possibility of devices being manipulated to fail should always be kept in mind, as downtime means an immediate loss in productivity and revenue.

CASE STUDY

OVERALL PROJECT

In 2015 Deloitte successfully proposed and is currently implementing a cyber-fusion concept for a large financial services company. Establishing a Cyber Intelligence Centre (CIC) is a big move away from the monolithic security operations centre approach to a security operation model that includes all security aspects. In a CIC, there will be continuous monitoring of cyber incidents, continuous vulnerability management and threat intelligence services, all interlinked to consider new technologies and business practices.

APPROACH

The client benefit from subscribing to CIC services is derived from the common difficulties experienced in today's security environment. Security is complex, expensive and suffers from a shortage of skills. The CIC-managed security services attempt to make continuous security services affordable and easy to use and provide the skill set required by today's challenges.

Included in the CIC monitoring scope is Operational Technologies (OT). OT cannot be seen as purely an engineering responsibility anymore. Thanks to the expertise in the CIC, OT monitoring and security can also be included in daily surveillance and incident response. OT is now being included in security operations because it has also become a target. Where IT is the business enabler, OT is the revenue generator. If OT grinds to a halt, revenue is immediately lost.

VALUE DELIVERED/RESULTS

In the end, the CIC will enable the client to focus on its business while the

security monitoring and improvement are placed in the hands of the security team from Deloitte. Information security or IT security management cannot be an ad hoc or infrequent activity. It also cannot stay stuck in a legacy approach to security management. For one, the advent of Industry 4.0/IoT, mobile computing and cloud computing have essentially forced the remodelling of security thinking. The traditional network boundaries and perimeter security principals have been radically altered, thanks to industry 4.0 and other connected paradigms.

DISRUPTIVE INNOVATIONS

Exponential technologies dramatically influence business and society, and manufacturing is no different. The rise of additive, customised and real-time manufacturing offers the potential to deliver on evolving customer expectations by delivering small volumes of customised products at competitive prices. It is not difficult to conceive of a fully automated factory that can create hundreds of different products in a real-time multiproduct assembly based on online orders delivered to homes within hours by self-driving vehicles. Similarly, it may be possible to produce ultra-low-cost products to serve the bottom of the pyramid by completely eradicating the supply chain and aggregating regional demand for scale.

Although these ideas may seem radical, they could be table stakes in a few years. If manufacturing companies do not have a dedicated focus on exponential technologies, they face the danger that they will fall behind and become obsolete. The only certain thing is that the rate of change will continue to accelerate.

CASE STUDY

OVERALL PROJECT

A large financial services company was struggling under new capital constraints and increasing bureaucracy. At the same time, radical new funding mechanisms began emerging from outside the banking sector, namely in the form of crowdfunding, where the likes of Lending Club became a billion-dollar business without the traditional constraints. Despite seeing this as an attractive opportunity, the client did not know how to pursue such a strategy, given its legacy structures and inherent organisational resistance.

APPROACH

Deloitte evaluated the client and the market and advised on and secured a potential M&A target who was operating a fledgling crowdfunding platform. This was structured as a minority interest to maintain the flexibility and dynamism of the start-up.

VALUE DELIVERED/RESULTS

From this case, we can learn that large companies need to be able to tap into new exponential revenue streams but must be aware of their limitations and configure accordingly.

THE LEARNING ORGANISATION

Industry 4.0 means getting to grips with radical new approaches to business rather than merely making incremental improvements to established business models. These new approaches can be seen as the best or worst of times for organisations. We have more than enough incremental evidence about the positive implications technology has brought to the business. Still, on the other hand, many organisations struggle with rapid change. Regrettably, the increasing pace of progress has also led to unprecedented levels of disruption and uncertainty.

If organisations are going to respond to these radical new approaches to business succinctly, due consideration needs to be given to a 'shift' in how learning takes place. Traditional ways of learning are disrupted not only by the changing demands in how workers work but also by how their environments are changing simultaneously. As a result, access to learning differently has come to the forefront. This new way of learning for today's modern learner is called a 'continuous learning' culture. Continuous learning is defined as "structuring resources, expectations, and learning culture in such a way as to encourage employees to learn continuously throughout their tenure with the organisation."

Moving away from a traditional classroom/e-Learning 'push' approach needs to enter into more of a 'pull' learning environment. Employers need to establish a 'demand learning' culture, where employees can access learning unconventionally. An organisational competency of 'problem-solving' needs to be inbred into the learning culture and any learning initiative. So as Human Resources transforms itself to meet the demands of the modern worker and learner, it is critical to redefine and re-imagine these roles to cater for the changes industry 4.0 brings to the manufacturing sector.

CASE STUDY

OVERALL PROJECT

A large food and beverages company recently announced its goal to redesign the learning organisation, identify new content needs and establish a learning culture across the organisation. The company engaged Deloitte to assess and recommend opportunities to enhance the learning operating model, curriculum offerings, and processes.

APPROACH

Through extensive engagement using interviews and workshops, Deloitte began by reviewing background

learning information, examining leading practices and working and collecting data on learning-focused headcount at the client. Based on this, a learning operation model, governance structure and funding approach were recommended, with clear action items for the short-term and a more long-term comprehensive roadmap for transforming the learning organisation.

VALUE DELIVERED/RESULTS

Through our work with the client, Deloitte was able to provide clear, actionable steps and structures (including roles, responsibilities and processes) required to take their learning environment to the next level, with a sound operating model aligned to leadership vision and learning differentiators, and a curriculum structure with impactful courses and opportunities of future curriculum enhancements.

CONCLUSION

The fourth industrial revolution transcends the traditional manufacturing industry, and the penetration of industry 4.0 concepts in companies' manufacturing processes is growing rapidly. The use of smart technologies and the fast flow of information makes it possible to manufacture new things in new ways and revolutionise research and development, supply chains, production and business models. Being at the forefront of this exponential change will be the key differentiator and competitive advantage for successful manufacturing companies.

Traditional industrial economies such as Germany and the US already embrace industry 4.0 as the leading strategy for future manufacturing success.

China is following in the same footsteps, with a strong emphasis on an innovation-driven future economy. Even though the current impact of industry 4.0 on the African continent remains comparatively low, some emerging economies such as South Africa could still become early adopters and leapfrog their global competitors with unique, locally developed high-tech products and services. Emerging markets often have an advantage over developed ones because they are not weighed down by infrastructure legacy issues and have no difficulty embracing change.

To prepare for the exponential speed and change of industry 4.0, South African manufacturers need to adjust their infrastructures, develop new ones, upskill their workforce, and reorganise their businesses.

An integrated IT system that can handle the increased speed of change, higher flow of data and new networking and communication needs while leveraging new applications such as cloud computing, for example, will become indispensable in an industry 4.0 environment. Attracting the right digital talent/skills and (re-)training and developing the existing workforce to understand and operate the new and smart technologies (e.g. advanced analytics, sensors and robotics, 3D printing) will be equally important.

Last but not least, South African manufacturers need to develop the right industry 4.0 vision and mindset within their organisations, embrace a new collaborative culture with suppliers, business partners and customers, innovate beyond product levels and create opportunities for new disruptive business models on the edges of their businesses.

Industry 4.0 offers huge opportunities for South African manufacturers to re-invent themselves and become more successful and competitive in local and global markets. wn

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Unlocking the opportunities for electric vehicle manufacturing in South Africa

Electric vehicles are the future of transportation, with many countries already putting a time limit on the future of fossil fuel-driven cars. In South Africa, this is both a challenge and an enormous opportunity. The import duties on these vehicles are prohibitively high, so there isn't much incentive to bring them into the country.

By Viren Sookhun, MD at Oxyon

However, it also means that manufacturing them locally would be incredibly beneficial, not only in terms of carbon emissions reduction but also in job creation and economic sustainability. We already have everything we need to unlock this opportunity, it is simply a matter of adjustment, and it could be a sustainable long-term solution for economic progression.

POISED FOR SUCCESS

The difference between an electric vehicle and one driven by fossil fuels is the engine and the battery storage needed. South Africa already has vehicle manufacturing setups in place, as well as manufacturing facilities for battery storage. We also can mine lithium locally, which is a vital component in manufacturing lithium-ion batteries.

Our climate in South Africa is ideal, and we already have ports available for export and plans to expand ports in areas like Gqeberha and Richards Bay. There are also plans to extend the special economic tax-free zones for manufacturing, both on the coast and inland.

The rail infrastructure needs to be extended and improved. This is critical to facilitating more inland manufacturing of the various components. The private sector needs to be more involved to enable greater efficiency, improved maintenance, and a more cost-conscious rail transport network.

BRINGING IT ALL TOGETHER

South Africa has both the capability and the capacity to become a significant player in the electric vehicle manufacturing space. Still, all the elements need to be brought together, and supply chain and logistics challenges addressed to unlock this significant opportunity.

This will involve collaboration between the government, state-owned entities, and the private sector since everyone will need to work together to offer an effective solution to the global market.

THE LABOUR COMPONENT

From a labour perspective, there is an excellent opportunity to build and connect the supply chain and create the entire ecosystem necessary to manufacture, assemble, and export electric vehicles. There are also, therefore, many job opportunities throughout the value chain.

Some of the jobs that will be created are highly specialised and skilled, so we will need to source this expertise globally and then ensure that local training and skills transfer takes place so that our engineers and designers can upskill, which can filter downstream.

Upskilling, cross-skilling and preparing people for the different roles associated with manufacturing electric vehicles are crucial. Having the right Temporary Employment Services (TES) partner throughout the development and evolution of this up-and-coming sector can be hugely beneficial.

A reputable, experienced TES partner will have affiliations with training companies and accreditations with the various Sector Education Training Authorities (SETAs), which is vital for obtaining funding for training.

In addition, TES providers can leverage this opportunity for individuals who have the skills and have had to seek work elsewhere to be repatriated back to South Africa and provide sustainable employment through a broad base of clients.

UNLOCKING THE OPPORTUNITY

Even looking at one area of battery manufacture, the opportunity is enormous. If we manufacture the batteries here, they will be less costly for locals who wish to purchase electric vehicles. We will also be able to recycle them here, which is currently a significant environmental concern.

However, we need to start with manual skills and then automate to reduce cost, which will, in turn, create greater demand, more growth, and a circular economy. There are so many opportunities, from one end of the supply chain to the other, but having the right TES partner lies at the very heart of unlocking this opportunity for economic progression. wn

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