

A man's profile is shown in a blue-tinted, high-tech aesthetic. His head is partially obscured by a complex network of glowing blue lines and nodes, resembling a neural network or data flow. A bright, glowing square icon is positioned on his forehead, with circuit-like patterns radiating from it. The background features a large, light blue abstract shape and a pattern of small, white, semi-transparent circles.

INSPIRATION SERIES:

22 TRENDS, TECHNOLOGIES, AND INNOVATIONS TO LOOK OUT FOR IN 2022



**RICHARD
VAN HOOIJDONK**

TRENDWATCHER & FUTURIST

Richard van Hooijdonk is a popular and well-known futurist, trendwatcher and keynote speaker. His famous inspiration sessions take you into the future and introduce you to developments that will completely transform our world.

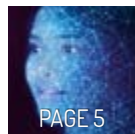
Examples are the high-profile 'Trends 2030' keynote and sector-specific keynotes on, among others, the future of education, healthcare, construction, finance, logistics, agriculture, and government.

Van Hooijdonk makes complex subjects understandable and the unimaginable plausible – with a focus on technology and innovation and peppered with a dose of humour. More than 550,000 people around the world have already attended his inspiration sessions. Van Hooijdonk has more than 1,500 articles and 60 e-books to his name, and his book 'The world of tomorrow' became a bestseller. The popular trendwatcher is also a regular guest speaker on radio and TV.

**Want to book an inspiration session?
Go to www.richardvanhooijdonk.com**



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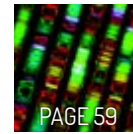
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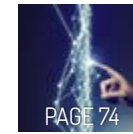
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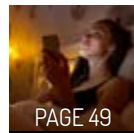
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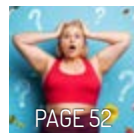
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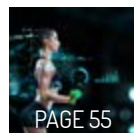
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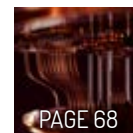
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INTRODUCTION

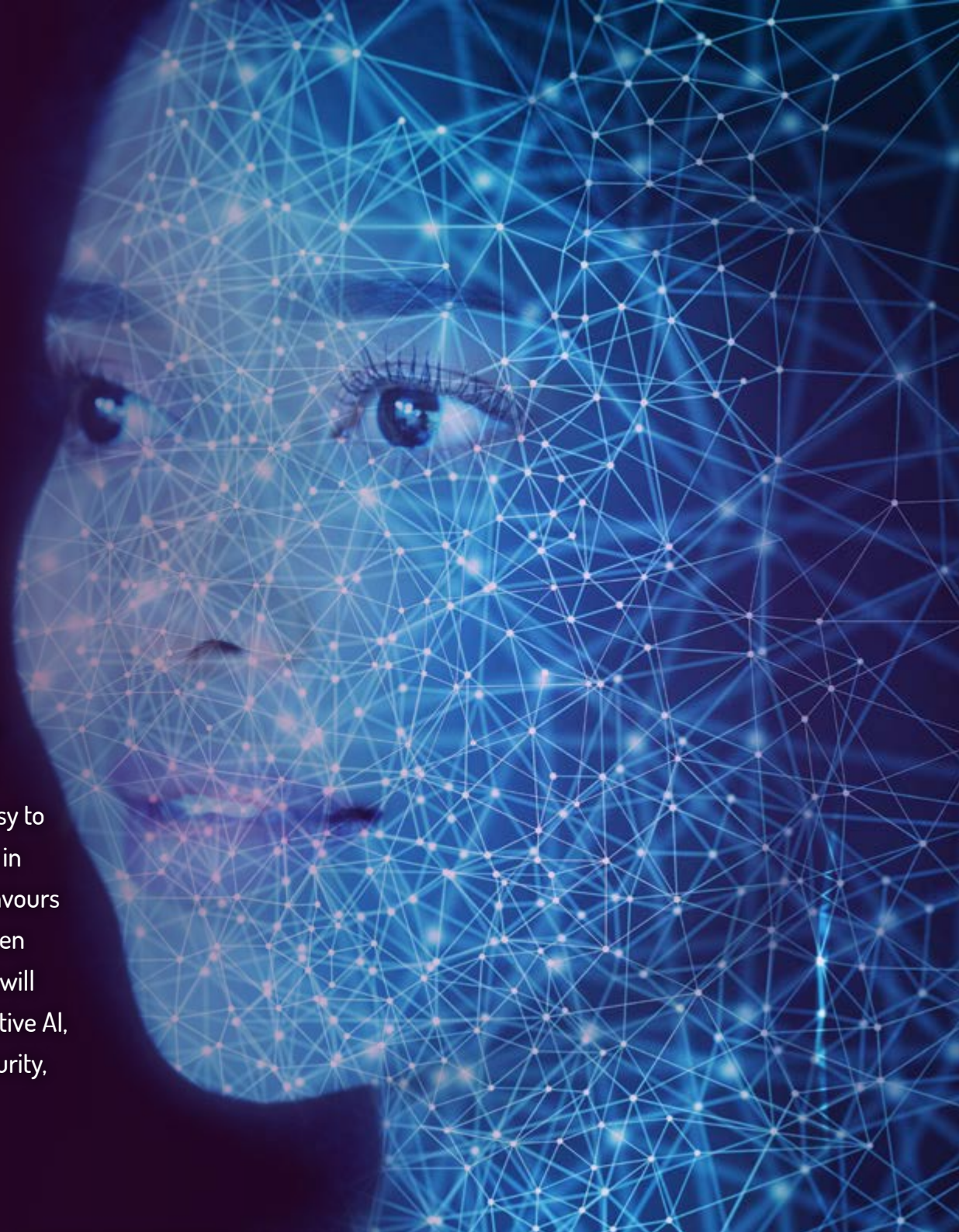
Technology trends of this past year will spill over into 2022 and beyond, and lead to a more data-filled and digitised world than we have ever experienced.

Yes, it's that time of year again – where experts start looking for trends for the year ahead. We're in the midst of a technological revolution and the 22 trends, technologies, and innovations to look out for in 2022 are all game-changers. They bring competitive advantages, increase the effectiveness of operations, make our daily lives more efficient, improve healthcare, and significantly change the landscape in 2022 and beyond.

We've created a comprehensive overview of disruptive technologies and trends that will take off and take centre stage in 2022, along with their implications for society. The list of emerging technology trends highlights innovative developments and tech solutions that are geared toward delivering even more widespread digitalisation and increasing efficiency.

1. WHAT'S NEXT FOR ARTIFICIAL INTELLIGENCE?

In 2022, it will become even clearer that artificial intelligence will turn out to be the most transformative technology we have ever developed, with an unparalleled impact on humanity. And it's easy to see why, as AI is already instrumental in every single thing we do in day-to-day life, and will play an increasingly critical role in endeavours like space exploration, tackling issues like climate change, and even the development of cancer treatments. New developments in AI will encompass breakthroughs in fields like language modelling, creative AI, workforce augmentation, environmental sustainability, cybersecurity, and – of course – the metaverse.



1.1 WHAT'S NEXT FOR ARTIFICIAL INTELLIGENCE?

Language modelling

The language modelling process enables machines to understand and communicate with us in language we understand. It can turn natural human language into computer code that can run programs and applications. As Mor Kapronczay writes for Towards Data Science: “A language model gives the probability of a certain word sequence being ‘valid’. Validity in this context does not refer to grammatical validity at all. It means that it resembles how people speak (or, to be more precise, write) – which is what the language model learns. There is no magic to a language model like other machine learning models, particularly deep neural networks. It is ‘just’ a tool to incorporate abundant information in a concise manner that is reusable in an out-of-sample context.”

Artificial intelligence research lab OpenAI recently released GPT-3, the largest and most advanced language model ever created. It consists of approximately 175 billion parameters – data points and variables used by machines to process language. In the past couple of years, GPT-3 has practically ‘read’ all the text on the entire internet. This has enabled it to reflect most of the complexity contained in natural language and become incredibly powerful. OpenAI is currently working on its even more powerful

successor, GPT-4. Containing up to 100 trillion parameters, some experts estimate that GPT-4 may be 500 times larger than GPT-3, which would enable it to create language and have natural conversations. So natural, in fact, that humans would not be able to tell they’re talking to a machine – bringing us one step closer to creating human-like intelligence systems.



1.2 WHAT'S NEXT FOR ARTIFICIAL INTELLIGENCE?

Creative AI

AI has already been used to help compose pop ballads, mimic the styles of great painters, write poetry, inform creative decisions in filmmaking, and even create video games. But to what extent could or should artificial intelligence be involved in creative processes? And what will 2022 bring in terms of new developments in creative AI? For one, with models like Google Brain and GPT-4, the limits of what we thought AI is capable of are already being surpassed, and 2022 will see AI produce even more creative results – such as designing infographics, and company logos, or even writing article headlines or subject lines for newsletters. Seeing these creative skills ‘emerge’ from machines really is a new frontier. Jason Toy, technologist, AI enthusiast, and founder of Somatic, a startup specialising in deep learning applications, says: “What’s interesting is that deep learning technology learns how to mimic the data it’s been trained on. If you feed it thousands of paintings and pictures, all of a sudden you have this mathematical system where you can tweak the parameters or the vectors and get brand new creative things similar to what it was trained on.”



1.3 WHAT'S NEXT FOR ARTIFICIAL INTELLIGENCE?

Workforce augmentation

For more and more companies, automation is becoming a priority. It enables shorter product cycles, increased customisation, and significant cost reductions. And while initial predictions indicated that automation would result in the replacement of human workers, we expect a different scenario to play out in the years ahead. Technology like artificial intelligence will actually be used to enhance or support the work of human employees. The year 2022 will increasingly find us collaborating with or working alongside smart technology – an increasingly essential hybrid work relationship that will help us generate faster, more efficient work outputs. Artificial intelligence can provide predictive maintenance capabilities, which will enable us to know in advance when a machine will need to be serviced. It also enables us to complete laborious tasks quicker and more efficiently, such as sorting through huge heaps of information to extract specific information. In manufacturing plants, AI can be used to detect faulty products, and in e-commerce businesses will increasingly deploy AI to predict purchasing behaviour.



1.4 WHAT'S NEXT FOR ARTIFICIAL INTELLIGENCE?

AI for environmental sustainability

In 2022 and beyond, businesses and governments alike will increasingly make use of artificial intelligence to cut CO2 emissions, minimise deforestation, reduce our reliance on fossil fuels, improve economies worldwide, and create job opportunities. According to PwC, the increased adoption of sustainable AI systems could create up to 38.2 million jobs globally and, by 2030, the economic impact of AI-driven environmental solutions could reach a value of \$5.1 trillion. And according to Boston Consulting Group (BCG), the

use of AI could help companies reduce greenhouse gas emissions by up to 10 per cent and lead to up to \$424 billion in savings for global companies in the years ahead. BCG's CO2 AI, for instance, is a sustainable AI solution that will help companies lower their carbon footprint by up to 40 per cent. It does this by measuring and analysing CO2 emissions and providing smart, data-backed recommendations. Furthermore, the United Nations says that AI could help the world achieve 93 per cent of its environmental sustainability goals.



1.5 WHAT'S NEXT FOR ARTIFICIAL INTELLIGENCE?

Cybersecurity

The World Economic Forum (WEF) identified cybercrime as as one of the biggest threats facing society in the next decade – a more significant threat to the world, in fact, than terrorism. And it's easy to see why. With technology and machines controlling ever more aspects of our lives – and the fact that every connected device that is added to a network can be used for malicious purposes – incidences of cybercrime are also expected to see a significant increase and will become more complex to identify. But artificial intelligence can play a critical role in mitigating the dangers of cybercrime. Smart algorithms can be deployed to analyse network traffic and learn to recognise patterns that could be indicative of malicious activity. We expect to see a myriad of AI applications develop in the years ahead that will protect critical information assets and help companies and individuals stay safe while online.



1.6 WHAT'S NEXT FOR ARTIFICIAL INTELLIGENCE?

The Metaverse

The Metaverse is a digital environment that everyone – from any place, and at any time – can plug into to socialise, work, and many other things we do in the real world.

It enables immersive experiences, often created by the users themselves, and will increasingly enable things, sensations, events, capabilities, creatures, and 'worlds' that we could previously only dream about. Since Mark Zuckerberg shared his ideas about the Metaverse with the public – by combining VR technology with the social foundations of his Facebook platform – it has become a hot topic. Users will be able to jump in and out of this parallel world, which will encompass an infinite number of virtual spaces inside other virtual spaces, include any kind of environment you can possibly imagine, and even offer real-world benefits. Artificial intelligence will, of course, be instrumental to the success of the Metaverse. It will help create online environments where humans feel at home. We will also be sharing our metaverse environments with AI 'entities' that will help us with various tasks, or even just be our gaming buddies.





Worldwide, **79%** of executives are of the opinion that AI will make their jobs easier and more efficient.

(Source: Semrush)



The top three challenges companies face when considering implementing AI are staff skills **(56%)**, fear of the unknown **(42%)**, and finding a starting point **(26%)**.

(Source: Semrush)



2. ALGORITHMS GOING WRONG

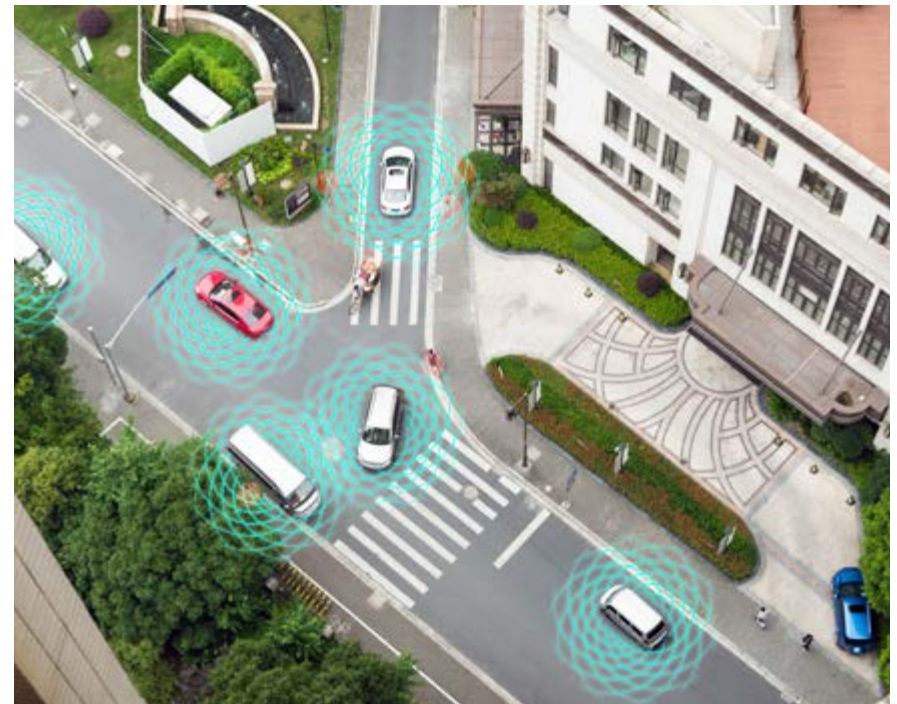
Algorithms are a major part of our everyday lives. In fact, we couldn't even function without them anymore. The internet runs on algorithms. All our online searches are done using algorithms, and none of the apps we use would work without them. And although algorithms have been created to improve our lives, they increasingly cause major issues and lead to ethical challenges. They make mistakes, are biased, and can be used for criminal purposes. In this chapter, we list some of the most significant algorithm-related ethical challenges we expect to see (intensify) in 2022 and beyond, and talk about how we can leverage 'ethics by design' to mitigate some of these challenges.

2.1 ALGORITHMS GOING WRONG

Decisions and morality

We increasingly expect – and depend on – machines to make split-second decisions for us, even the most critical and complex ones. One example is high-frequency trading, during which more than 90 per cent of transactions are currently algorithmically driven and human input or oversight is virtually impossible. Another example is self-driving cars. These autonomous vehicles will eventually be expected to immediately respond to sudden changes on the road, which requires AI to be in full control of any and all situations that may happen.

And what about unmanned aerial vehicles or drones in warfare? They might eventually be expected to decide which targets to bomb without any human involvement. How will we deal with issues of morality and how will AI be able to make the 'right' decisions? In January 2022, An AI summit will be held in San Francisco, California, named 'The Moral Model Development and Accountable Algorithms Conference'. The aim of the summit is to discover responsible and ethical approaches to developing AI for the common good and to solve societal challenges around AI and morality.



2.2 ALGORITHMS GOING WRONG

Privacy and consent

Another ethical dilemma concerning the use of AI revolves around privacy and consent issues. We need data to train AI, but where does this data come from, how is it gathered, and – more importantly – who uses it, and for what purpose? Some of the most worrying current developments include the harvesting of data from minors. Some of the latest dolls, for instance, are AI-enabled. This means your child can chat to the doll, and AI enables the doll to actually respond and have full conversations with your child.

For this, the AI needs to record and analyse what your child says, and there is no way of knowing what actually happens to this data. Our young children – and many adults, for that matter – aren't always capable of giving consent, especially since the relevant information isn't always fully disclosed or even remotely

understandable. Data is often sold off to third parties without us being aware of it. And not many people have insight into the rules around this type of data collection, and often don't know whether or not any legislation is in place to protect their private information.

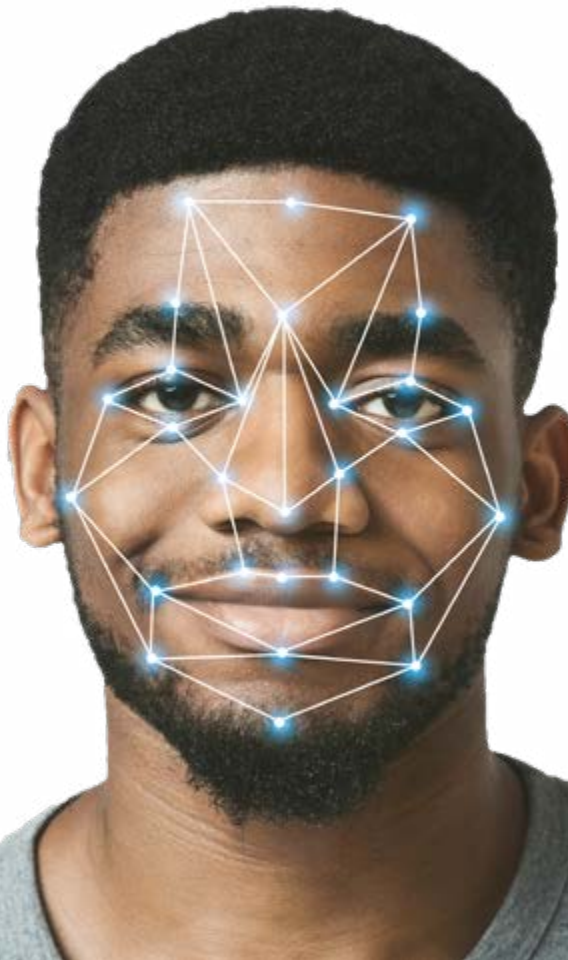
Experts predict that we will see the data protection-as-a-service market grow to \$18.96 billion by 2026, and that incorporating data privacy strategies and information security into one will become a major trend in the years ahead. In addition, strict penalties for non-compliance with the General Data Protection Regulation (GDPR), which imposes stringent rules on processing and controlling personal user data, are expected to push organisations and businesses to continuously improve their cyber policies aimed at data protection and information security.



2.3 ALGORITHMS GOING WRONG

Algorithmic bias

Algorithmic bias has been known to take place in hiring decisions, various credit scoring systems reflect class divisions along racial lines, and some facial recognition technologies struggle to identify Black people. Algorithms have unfairly categorised incomplete paperwork for welfare applications as 'failure to cooperate', resulting in millions of people being denied access to cash benefits, healthcare, and food stamps. To prevent a repeat of some of the most horrendous cases of algorithmic bias we've seen in recent years, we need to do whatever we can to eliminate bias in the data we use to train these algorithms in 2022 and beyond.



According to predictions by research and advisory firm Forrester, in 2022 tech giants like Twitter, Google, and Microsoft, but also non-tech organisations like healthcare companies and financial institutions, will start implementing so-called bias bounties. Forrester states: "AI professionals should consider using bias bounties as a canary in the coal mine for when incomplete data or existing inequity may lead to discriminatory outcomes from AI systems. With trust high on the agenda of stakeholders, organizations will have to drive decision-making based on levers of trust such as accountability and integrity, making bias elimination ever more critical."

2.4 ALGORITHMS GOING WRONG

Ethics by design

To mitigate some of AI's ethical and moral challenges as described above, an approach like 'Ethics by Design' could be implemented to ensure that AI is aligned with ethical principles and values. Ethics by design is a new way of thinking for companies. It aims to incorporate ethical principles at the very first stages of the design and development processes. Companies will need to assess the potential harm and impact of AI beforehand, with the aim to prevent issues from developing at all – instead of trying to remedy them at a much later stage, when any potential damage has already been done. The EU AI Act, for instance, aims to mitigate the harmful use of artificial intelligence, ensure more transparent and ethical use of AI, and outlaw systems used for 'indiscriminate surveillance' operations.

While these new regulations will (only) come into effect within the next two years, companies will already need to start preparing for this. The AI Act aims to keep machine intelligence under human control and to facilitate the transparent, ethical use of AI. It outlaws unacceptable uses of AI, such as those posing "a clear threat to safety, livelihoods and rights". Examples are real-time biometric identification systems; dark-pattern AI; systems that facilitate social scoring – such as China's social credit system; and software designed to manipulate behaviour to circumvent users' free will. The year 2022 and beyond will see organisations and companies preparing for these developments, which will require changes in governance, hierarchy, and culture, in order to safely implement AI and ensure compliance with the EU AI Act.



3. CYBERCRIME IN 2022 AND BEYOND

The scale and sophistication of cyberattacks are expected to keep breaking records. With many businesses having bounced back after the pandemic, so have cybercriminals, who are looking for new ways to target companies and sabotage operations. According to cybersecurity experts, 2022 will see cybercriminals adjusting their *modi operandi* and becoming even more accomplished with their cyber assaults. Maya Horowitz, VP research at Check Point Software (CHKP) warns: “The sophistication and scale of cyberattacks will continue to break records and we can expect a huge increase in the number of ransomware and mobile attacks. Looking ahead, organisations should remain aware of the risks and ensure that they have the appropriate solutions in place to prevent, without disrupting the normal business flow, the majority of attacks including the most advanced ones.”



3.1 CYBERCRIME IN 2022 AND BEYOND

Attacks on supply chains will intensify

Cybercriminals can wreak untold havoc on the supply chain. Once they've breached a system, they can cause a domino effect of disruptions spreading multi-directionally along supply chains, affecting suppliers, buyers, and even consumers. Aside from the obvious logistical chaos these attacks cause, they can also lead to millions in recovery costs.

The largest and most sophisticated supply chain attack in 2021 – but by no means the only one – was the SolarWinds attack. The attack gave hackers access to government offices like the US Treasury, Justice, and

Commerce departments, as well as other agencies and companies using the company's Orion network monitoring software, affecting 18,000 customers. And highly-publicised attacks often garner the attention of other cybercriminals who are inspired to trump them. Looking ahead to 2022, supply chain attacks are expected to become more widespread. Cybersecurity will need to be the top priority for governments and the private sector, and regulations will need to be established to protect networks and identify threats, not only regionally, but on a global scale as well.



3.2 CYBERCRIME IN 2022 AND BEYOND

Smartphone malware attacks

According to cybersecurity firm WatchGuard Technologies, state-sponsored mobile threats will increasingly find their way into the cybercrime underworld in 2022. A spokesperson for the company says: "Mobile malware certainly exists especially on the Android platform but hasn't yet risen to the same scale of traditional desktop malware. In part, this is due to mobile devices being designed with a secure mechanism from the start, making it much more difficult to create zero-touch threats that don't require victim interaction. However, serious remote vulnerabilities have existed against these devices, though harder to find."

Smartphones and other mobile devices are very enticing targets for state-sponsored cyber teams, not only because of the capabilities of these devices but also because of the valuable information they hold. And the increased use of mobile payment platforms and mobile wallets will also lead to an increase in mobile malware attacks. Unfortunately, like in the case of Stuxnet, when these sophisticated threats make headlines criminal organisations learn from them and copy the attack techniques. In 2022 and beyond, all of these factors are expected to lead to a further increase in sophisticated mobile cyberattacks.



3.3 CYBERCRIME IN 2022 AND BEYOND

Attacks on the cryptocurrency industry

Cyberattacks on the cryptocurrency industry are expected to increase in 2022, according to a report by cybersecurity firm Kaspersky. One of the attractive features of digital currency is its anonymity, but there's also the fact that it's susceptible to digital manipulation and that crypto wallets can be stolen from their users. A spokesperson for Kaspersky says: "However, it's not only cybercriminal organisations but state-sponsored threat actors who have targeted this industry. We have already witnessed APT groups rising to attack the cryptocurrency business aggressively, and we anticipate that this activity will continue."

According to the report, in the years ahead many cybercriminals and hacker groups who traditionally targeted large financial institutions will increasingly focus on the growing cryptocurrency industry's assets. Going forward, attacks are expected to not only target currency creators but the cryptocurrency supply chain in its entirety. Other cryptocurrency-related threats to expect in the years ahead include smart contract attacks and fake hardware wallets.



3.4 CYBERCRIME IN 2022 AND BEYOND

‘Weaponised’ deepfake technology

In recent years, deepfakes have garnered widespread attention for their uses in the spread of fake news and hoaxes, (pornographic) celebrity videos, and financial fraud. In 2022 and beyond, deepfake technology is expected to be ‘weaponised’ to trick people into making financial transfers or gain access to valuable, sensitive data.

Alon Arvatz of IntSights says deepfakes are a trend we all need to be wary of in the future. “Using artificial intelligence, cybercriminals use deepfake technology to either impersonate the face or voice, or both, of a person in order to carry out scams, fraud and social engineering attacks. Based on the hacker chatter that we track on the dark web, we can definitely expect hacker interest in deepfake technology to rise and we will inevitably see deepfake attacks becoming a more utilised method for hackers in 2022. We predict that threat actors will look to monetise the use of deepfakes by starting to offer deep-fake-as-a-service, providing less skilled or knowledgeable hackers with the tools to leverage these attacks through just the click of a button and a small payment.”



While 80 per cent of companies acknowledge the threat of deepfakes, less than 30 per cent have taken preventative measures. To stand a fighting chance against the multi-faceted threats of deepfakes, companies should focus on implementing automated detection systems, training staff on how to spot potential fake content, and formulating response strategies if a deepfake attack occurs.



By 2024, organisations across the US and Europe that adopt a cybersecurity mesh architecture will lower the financial impact of security incidents by **90%**.

(Source: Gartner)



By 2025, **40%** of boards of directors in the US, EMEA and APAC will have a dedicated cybersecurity committee overseen by a qualified board member.

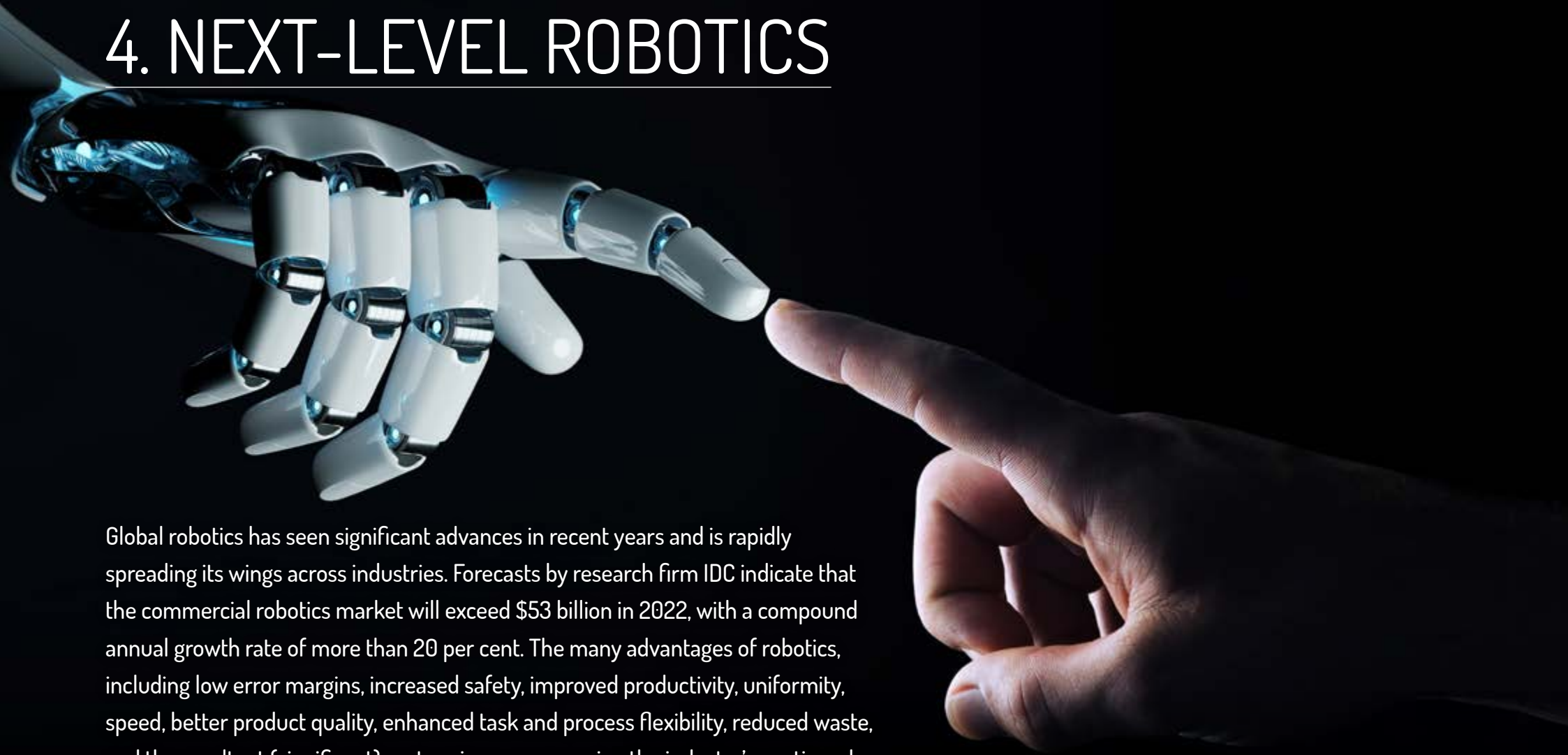
(Source: Gartner)



By 2025, **70%** of CEOs will mandate a culture of organisational resilience to survive threats from cybercrime, severe weather events, civil unrest and political instabilities.

(Source: Gartner)

4. NEXT-LEVEL ROBOTICS



Global robotics has seen significant advances in recent years and is rapidly spreading its wings across industries. Forecasts by research firm IDC indicate that the commercial robotics market will exceed \$53 billion in 2022, with a compound annual growth rate of more than 20 per cent. The many advantages of robotics, including low error margins, increased safety, improved productivity, uniformity, speed, better product quality, enhanced task and process flexibility, reduced waste, and the resultant (significant) cost savings are powering the industry's continued growth. And as a result of the ever growing shortage of workers in the service industry, 2022 and beyond will see as much as 35 per cent of service companies deploying robots in industries like warehousing, hospitality, and healthcare.

4.1 NEXT-LEVEL ROBOTICS

Increasingly intelligent robots

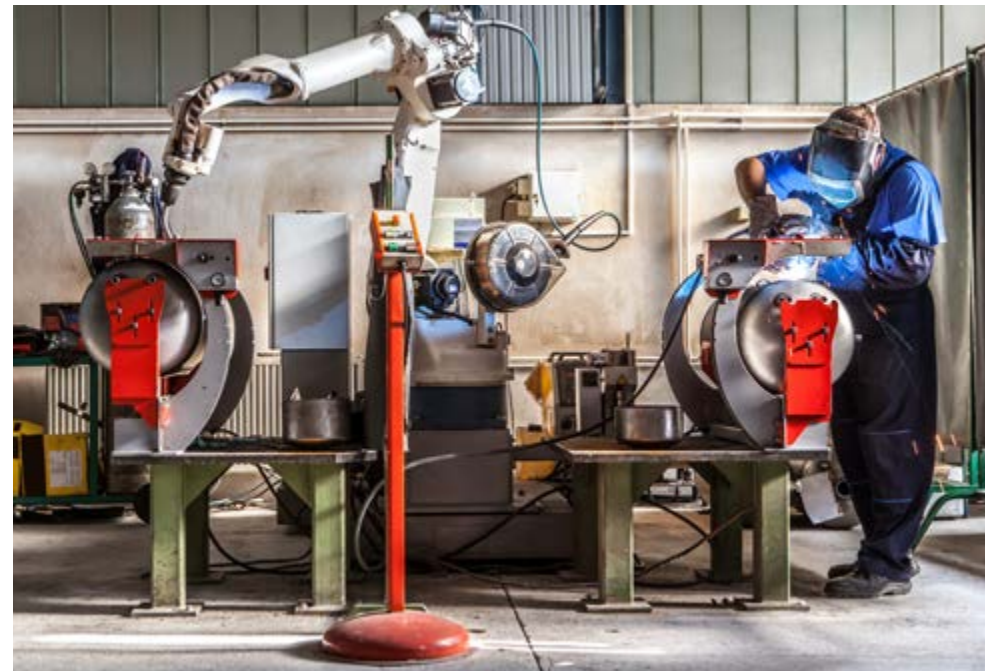
While autonomous vehicles have pretty much dominated the robotics headlines, developments quietly taking place at the intersection of artificial intelligence, machine learning, and machine vision are ushering in a new era in robotics in 2022 and beyond. These developments are enabling a spectacular range of new and promising possibilities and will fundamentally change our world, as robots empowered with vision and advanced AI are able to see, learn, and make decisions on the basis of the situation at hand. This will enable autonomous pick-and-place robots in warehousing, vision-based drone technology, robotic sorting at recycling plants, robotic crop harvesting, and many other applications in agriculture, manufacturing, healthcare, and so on.



4.2 NEXT-LEVEL ROBOTICS

The rise of collaborative robots

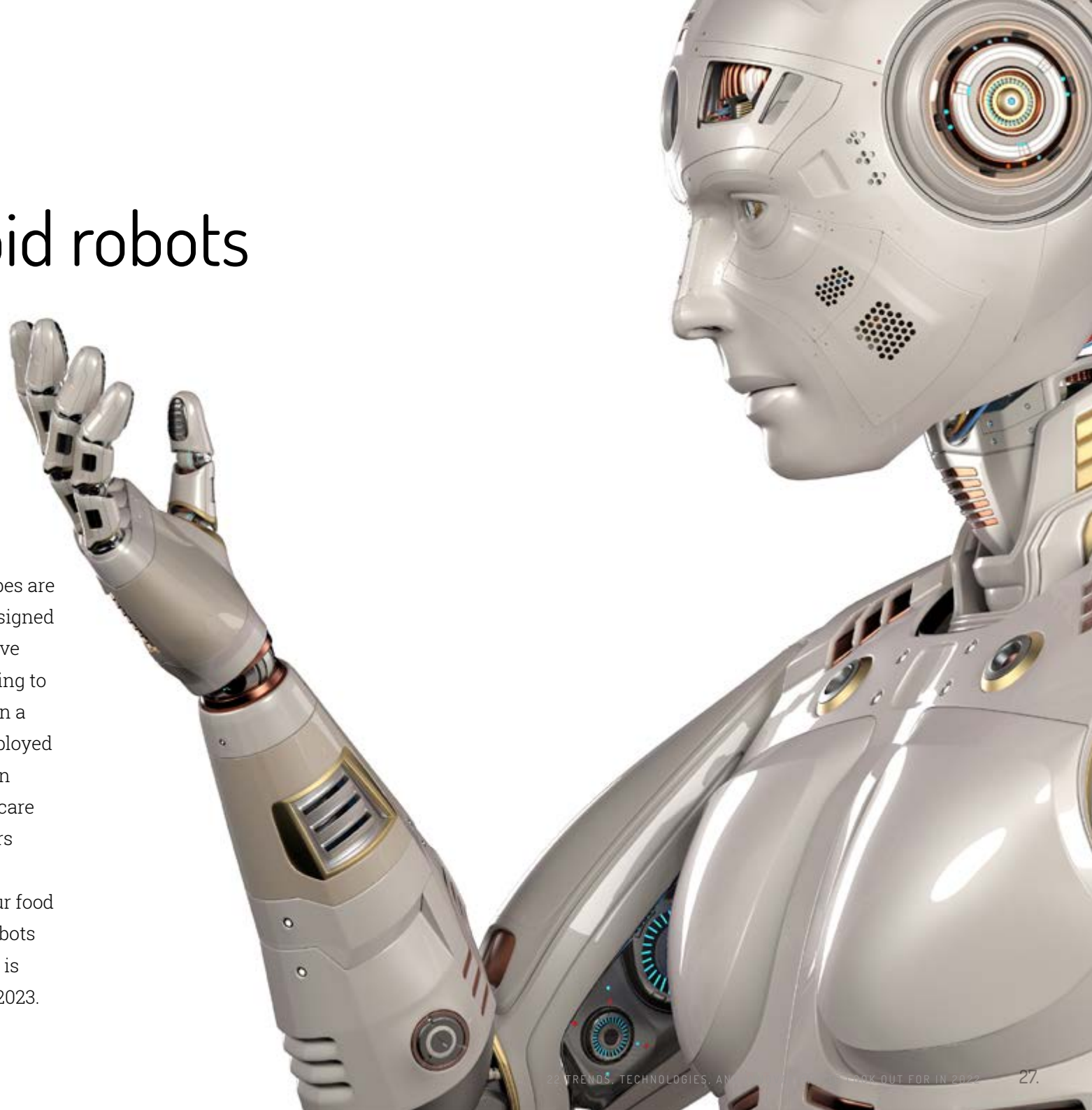
Cobots – short for collaborative robots – are among the most popular robots in use today. These high-performance robot systems work and navigate through their surroundings fully autonomously. Once trained, they can handle almost any manual task on all kinds of assembly lines, including direct human-robot collaboration. Using laser scanners, with which they monitor their environment, cobots can independently navigate their workstations and correctly position themselves using orientation points. The robots then connect themselves to electricity, gather their tools, and get to work. Cobots are safe enough to work alongside human workers. They reduce speed or stop completely when they come close to a person. By communicating with each other and with ERP systems, multiple cobots can be networked to serve complete production lines. Predictions are that, as a result of the latest developments in programmable software, the collaborative robots sector will have seen substantial growth by 2025.



4.3 NEXT-LEVEL ROBOTICS

New humanoid robots

Probably the most intriguing of all robot types are humanoid robots. These are specifically designed to look like humans and are used for intuitive interaction and collaboration. They're starting to become increasingly commercially viable in a wide range of applications. They can be deployed as a personal assistant, to help the elderly in care homes, or look after patients in healthcare centres. They can also function as educators or entertainers, work in search and rescue operations, clean office buildings, serve your food in restaurants, and so on. The humanoid robots market is poised for significant growth and is projected to reach a value of \$3.9 billion in 2023.



4.4 NEXT-LEVEL ROBOTICS

Ameca, the world's most advanced human-shaped robot, represents the forefront of human-robotics technology. Created by UK-based firm Engineered Arts, Ameca was designed as a platform for AI and human-robot interaction (HRI) and is capable of some incredibly (and eerily) realistic facial expressions. A video shows the robot waking up, distorting its face into a grimace, examining its hands with a surprised look, and then grinning as if trying to make the audience believe it's self-aware – an incredibly impressive example of how far humanoid robotics has come.

In 2022, Tesla will be launching its friendly humanoid prototype the Tesla Bot – codenamed Optimus. At Tesla's Artificial intelligence Day 2021, Elon Musk said it makes sense to use the technology that already powers the semi-autonomous Teslas – such as the sensors, actuators, autopilot software, and batteries – in a humanoid robot. Musk envisions his Tesla Bot taking care of boring, repetitive, or dangerous tasks. The bot will be 1.73 m tall, weigh 57 kg, and have a top speed of 8 km/h. "We're setting it in such a way that it is, at a mechanical level, at a physical level, you can run away from it and most likely overpower it. Hopefully, that doesn't ever happen, but you never know", Musk said for a YouTube recording of the event. The Tesla Bot will feature an FSD computer, FSD hardware, eight autopilot cameras, neural net planning, multi-cam video neural networks, and even receive dojo training. All of this should equip the humanoid to navigate through the world without having to train it with explicit line-by-line instructions.

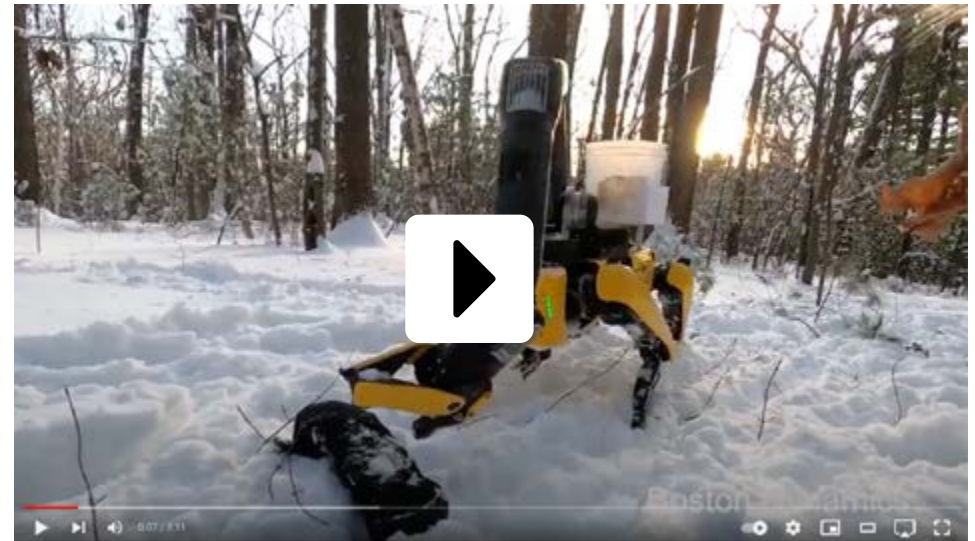


4.5 NEXT-LEVEL ROBOTICS

Quadrupedal robots

Quadrupedal robots have four articulated legs, which gives them animal-like mobility that enables them to move around all sorts of terrain. This makes them particularly useful for security operations and inspections. Quadrupedal robots are easier to build and easier to program, and have become the standard test-bed for emerging mobile robotics systems. These four-limbed bots can be deployed in areas where bipedal or wheeled robots are unable to navigate, or in situations that may be dangerous for humans.

Currently, they are used in three main applications: firefighting, sewer inspection, and warehousing and retail automation. Boston Dynamics' Spot is probably the most well-known quadrupedal robot. The bright yellow machine resembles a very agile yet headless dog that has the ability to map environments and navigate complex terrain. It is also able to interact with a range of objects, walks up and down stairs, dances, jumps on and off tables, opens doors, digs holes to plant small trees, picks up rubbish, and even skips rope. Robots like Spot will be particularly useful in the military, search and



rescue operations, and repair and maintenance. And with the myriad of incredible tasks it can be taught to do, predictions are that Spot will likely remain at the forefront of the quadrupedal robot revolution.



China's production of industrial robots has been increasing continuously by **29.2%** annually.

(Source: The National Bureau of Statistics)



In 2021, there were **1,287** robots for every 10,000 workers in the US automotive industry.

(Source: IFR)



Some **88%** of industries worldwide are planning to implement robotic automation within every aspect of their IT infrastructure.

(Source: TechJury)



Veebot robots offer **83%** accuracy in spotting the best vein for drawing blood from patients.

(Source: Hospitalnews.com)

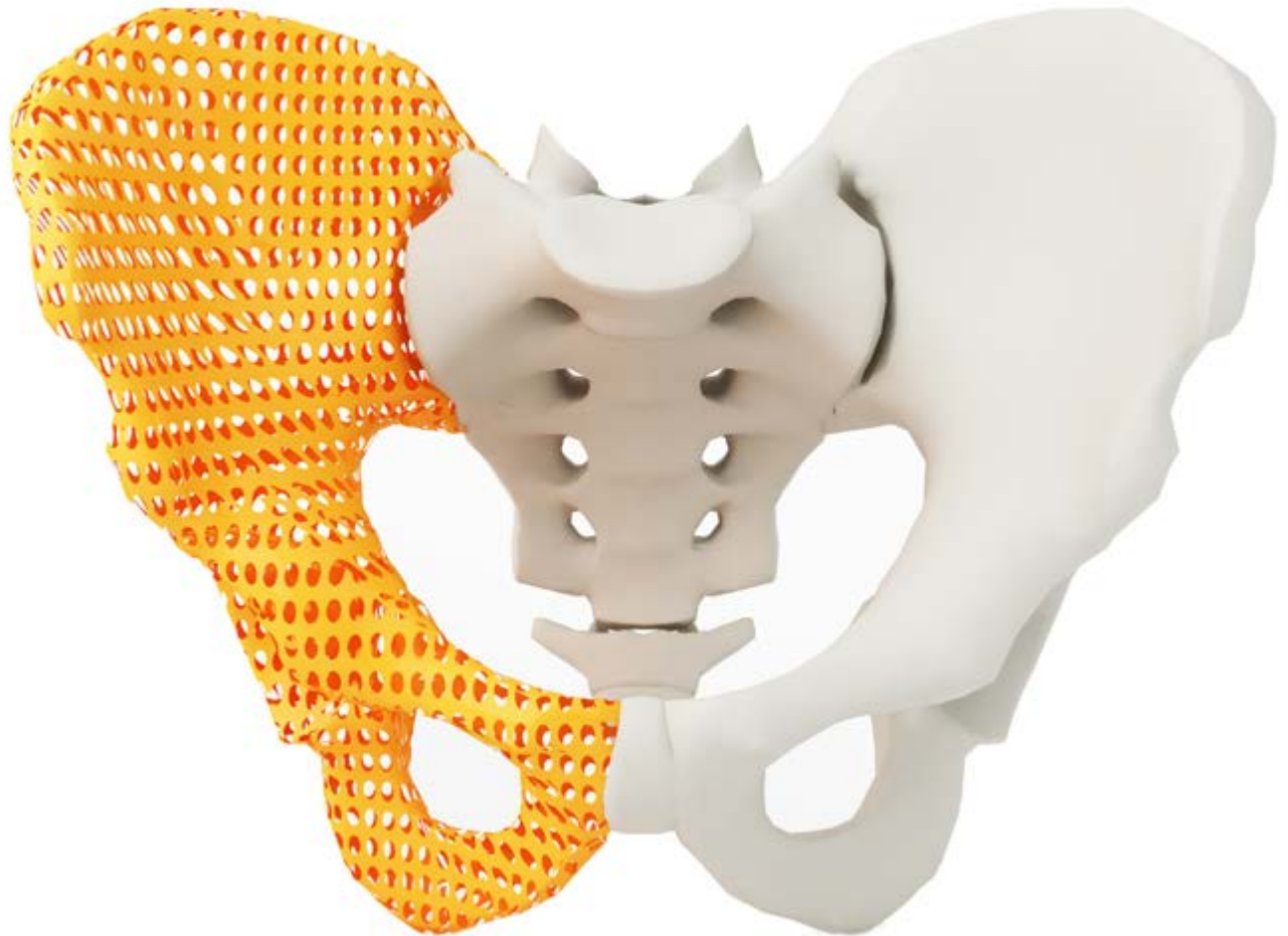
5. NEW DEVELOPMENTS IN MEDICAL 3D PRINTING TECHNOLOGY

In the past couple of years, more and more companies have embraced 3D printing technology as an integral part of their product development processes. In fact, according to Business Wire, 3D printing technology – also known as additive manufacturing – generated \$12 billion in revenue in 2020 and is predicted to reach \$78 billion by 2028. 3D printing technology is also greatly benefitting the medical world as it's becoming increasingly cost effective and accessible, enabling everything from 3D printed artificial limbs to organs. In fact, additive manufacturing in the medical implant sector is expected to reach \$0.27 billion by 2025.



3D-printed bone implants

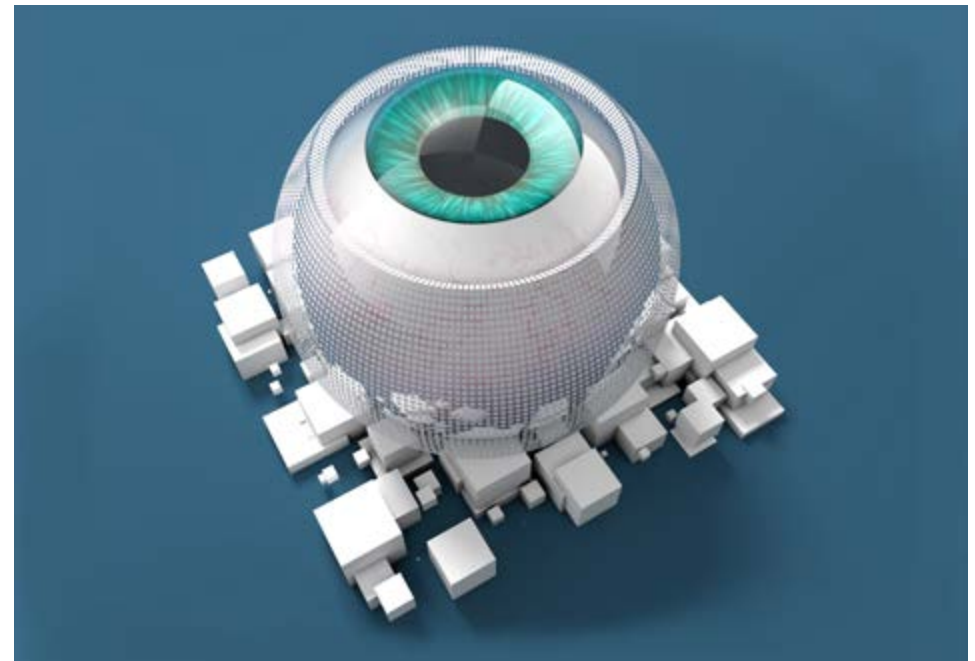
Particle3D, a Danish medico company that creates bone replacements, and A.D.A.M., a developer of personalised implant manufacturing infrastructure, have entered into a collaboration to create 3D-printed bones for implantation in humans. The firms use calcium-based minerals to 3D print custom-made bones based on the patients' MRI and CAT scans. Eight weeks into trials in mice and pigs, Particle3D discovered that blood vessels and bone marrow had grown into the implants. According to A.D.A.M., the 3D-printed implants stimulate natural bone growth, gradually biodegrade, and are eventually replaced by the patient's own bone tissue. The companies hope to receive regulatory clearance for the use of bone implants in 2022, with the firms' next endeavours including 3D-printed blood vessels, bronchial implants, and heart valves.



5.2 NEW DEVELOPMENTS IN MEDICAL 3D PRINTING TECHNOLOGY

3D-printed 'biomimicking' eyes

Medical experts at Moorfields Eye Hospital in London recently performed a surgery in which the first fully digitally created 3D-printed eye implants were implanted in a patient. Traditionally, creating an eye prosthetic requires a technician to create a mould from the eye socket in order to be able to create a properly fitting prosthetic eye. But thanks to 3D printing technology, this invasive step can be skipped. The structure of the socket is first scanned and mapped using advanced technology. Then, the digital 3D model is sent to a lab in Germany where the eye implant is printed within only 2.5 hours. The eye is then shipped back to London, where it is finished, polished, and fitted by Moorfields' ocularist. The new prosthetic eye is classed as a 'biomimicking' device, which means that it closely resembles a real eye. It has much clearer definition and the pupil has depth, which makes the eye look more realistic when light hits it. Its design and manufacturing process reduces waiting times from a few months to approximately two or three weeks.



5.3 NEW DEVELOPMENTS IN MEDICAL 3D PRINTING TECHNOLOGY

3D-printed ear implants

Located in our ear are the tiniest bones in our body. Their shape, size, and position are critical for the proper functioning of the ear. Sometimes, however, they get damaged and need to be replaced. A team of surgeons led by professor Mashudu Tshifularo at Steve Biko Academic Hospital in South Africa completed a landmark operation: a middle ear transplant using 3D-printed titanium to replace the hammer, anvil, and stirrup ossicles. The transplantation is potentially the first procedure of its kind in the world. For the operation, a 3D scan was made of the patient's ear, which had been damaged by an injury. Then, the team of surgeons modelled a bespoke implant, which was printed on a powder bed laser fusion machine. The implant was made with titanium for its biocompatibility and strength. Professor Tshifularo said: "Our future is in innovation towards excellent, internationally recognised solutions. Our aims are to improve safety and efficiency and to reduce costs in our communities as the field of ENT progresses."



GauntegHealth on Twitter



The market for 3D-printed medical devices is estimated to reach a value of \$5.1 billion by 2026, up from \$2.4 billion in 2021, at a CAGR of **16.3%**.

(Source: MarketsAndMarkets)



3D-printed casts heal bones **40-80%** faster than traditional casts, leading to improved patient outcomes.

(Source: HBR)



Some **75%** of medical device companies expect 3D printing to disrupt the sector, with **62%** of industry leaders believing the disruption will take place within the next 2-3 years.

(Source: GlobalData)



In **82%** of cases, 3D-printed models led to reduced surgical time, improved medical outcome, and decreased radiation exposure.

(Source: SuperTrends)



6. BREAKTHROUGHS IN EXTENDED REALITY (XR)

We're transitioning to a future in which the lines between the real and virtual worlds become even more blurred than they already are. The year ahead will see many advances in extended reality (XR), an umbrella term that covers virtual reality (VR), augmented reality (AR), and mixed reality (MR). These advances are set to significantly transform our everyday lives.



6.1 BREAKTHROUGHS IN EXTENDED REALITY (XR)

Smaller, lighter VR headsets



Dlodlo V1 VR Glasses

VR headsets will get smaller, lighter, and have more built-in features, such as eye tracking and hand detection. Accurate hand tracking enables the use of gestures (swiping and pinching motions) to perform commands and allows for far more precise interactions than what would be possible with controllers. This adds to the user's sense of immersion and also improves the accuracy of their movements as it offers a real-time representation of the hand's actions. The eye tracking technology enables a VR headset to measure the eye's position and movement to determine the user's level of presence and what he or she is focusing on. This informs the system to

generate the best possible image quality on the content sections the user looks at – exactly like it is in real-life situations. This technology enables manufacturers to increase screen resolutions as well as refresh rates, which leads to decreased lag. It also facilitates more natural and intuitive interactions, offering users the ability to read emotions and have their own analysed in order to inform their responses. Eye tracking tech also minimises the risk of nausea, which is still a common occurrence during the use of VR technology.

6.2 BREAKTHROUGHS IN EXTENDED REALITY (XR)

Lidar-enhanced augmented reality

The cost of lidar (light detection and ranging – remote-sensing technology that uses laser to get information about surrounding objects) has seen significant reductions in recent years. This means that the technology is increasingly implemented in technologies like augmented reality (AR), where it can significantly boost an AR device's capabilities and contribute to even more realistic AR experiences. Lidar technology has, for instance, already greatly improved Apple's AR capabilities, especially in terms of scanning real-world environments and displaying virtual objects within them. AR apps enhanced with lidar are now able to recognise what should be in front of or behind a virtual object and enable these objects to remain in the same spot, no matter where you are in relation to them. Predictions are that lidar will become an integral part of AR and many other technologies in the next few years.



6.3 BREAKTHROUGHS IN EXTENDED REALITY (XR)

AR contact lenses

Extended reality technologies may even start integrating with our bodies over the next couple of years – such as via AR contact lenses. In fact, AR contact lenses are already being developed as we speak. California-based startup Mojo Vision's AR contact lenses with micro-LED displays, for instance, 'project' information directly onto the wearer's eyes. While Mojo's priority is to assist people struggling with vision problems, these lenses are also becoming accessible to everyday consumers, helping us to consume content in incredible new ways. The lenses can give you important information during any activity, such as a firefighter seeing the floor plan of a burning building he needs to enter. Or imagine having your health information, text messages or even the weather projected directly onto your eye. This technology will even enable you to change the colour of your neighbour's ugly wall or call up all the information you need about a famous landmark you're looking at in Paris. Mojo Vision also plans for the lenses to recognise faces so that it can help us remember things like names and other details that will help us during important conversations or presentations. When Mojo's AR lenses hit the market, let's hope the company promises not to share any of this information with third parties.





Around **32%** of people across the globe use AR apps and it's estimated that the landscape for AR/VR spending will increase at approximately **52%** in the next five years.

(Source: IDC)



There are around **1 billion** AR customers worldwide. **1 million** customers in the US already use AR on a monthly basis.

(Source: eMarketer)

7. FLYING TAXIS

Electric vertical take-off and landing (eVTOL) aircraft or flying taxis were always part of fantasy worlds. But they are becoming more real with each passing day. In fact, according to a new study by Deloitte and the Aerospace Industries Association, the potential market for air mobility will reach a whopping \$115 billion by 2035, offering employment opportunities for 280,000 people. Several companies have already done a substantial number of test flights, while others are starting theirs in 2022 with the aim to get approval from the US Federal Aviation Administration (FAA) to start commercial operations in 2024.



7.0 FLYING TAXIS

Flying taxis would carry two to four passengers and travel at speeds of up to 300 km/h. They would be much cleaner, cheaper, and faster than our current four-wheeled versions and offer important solutions to the traffic congestion challenges in every major city on earth. They would also represent a critical link between urban centres and rural areas. Multiple small rotors would enable eVTOLs to land and take off vertically, like a helicopter, but fly forward like an aeroplane once airborne. Urban planners in cities like Dallas and Los Angeles are already focusing on the design of skyports or vertiports where eVTOLs can drop off and pick up passengers, with Orlando being the first US airport that will host such a vertiport. The FAA and NASA are currently partnering with eVTOL companies to work on ways to integrate these aircraft into existing air traffic.





The global air taxi market size is expected to reach a value of **\$817.50** million by 2021, and **\$6.63** billion by 2030.

[Source: AlliedMarketResearch]

TAXI

By 2030, flying taxis can become an alternative to the conventional taxi, with the market opportunity being an estimated **several billion US dollars**.

[Source: McKinsey]



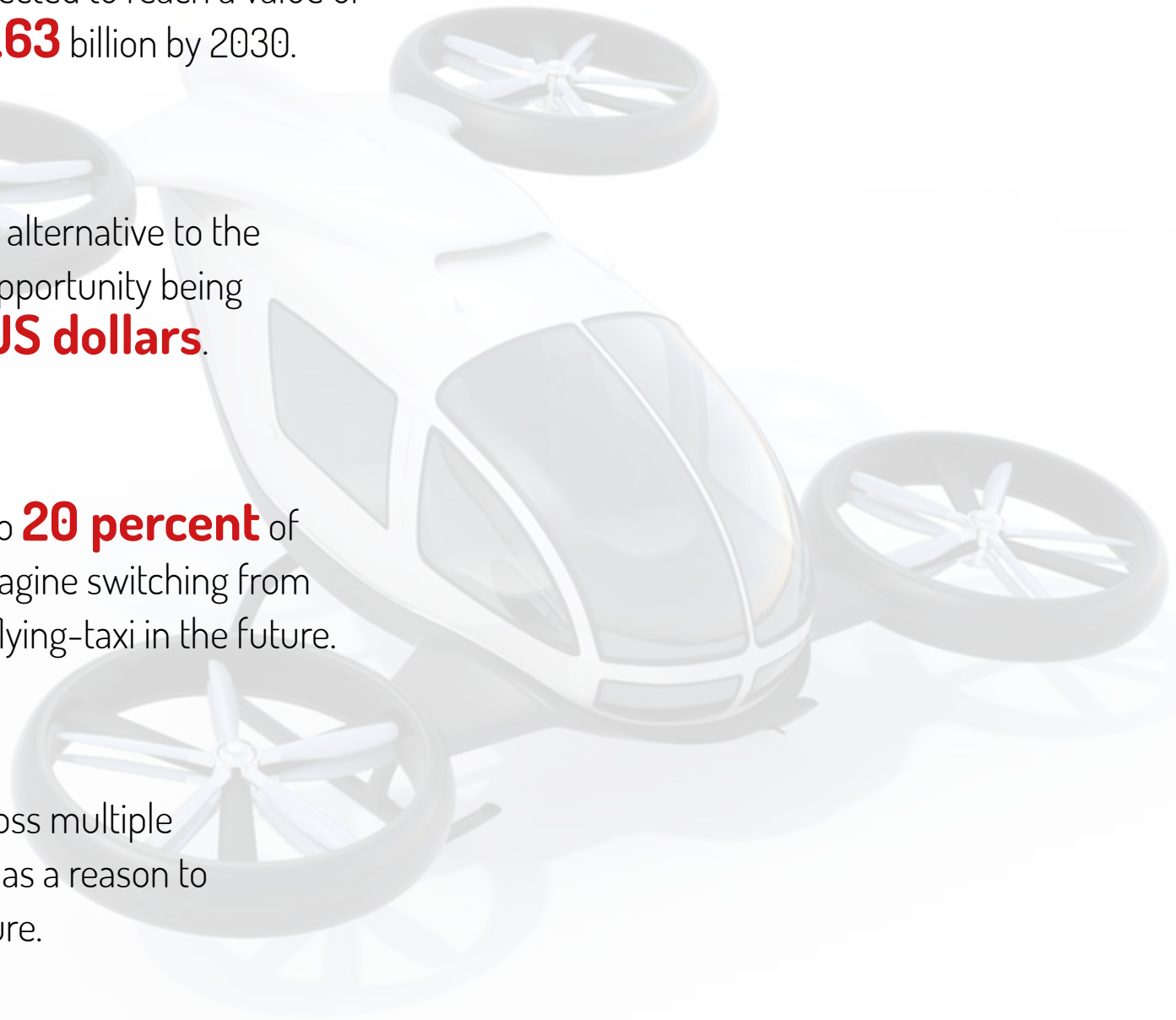
Across geographies, more than **15 to 20 percent** of survey respondents say they can imagine switching from their current mode of mobility to a flying-taxi in the future.

[Source: McKinsey]



More than **30%** of consumers across multiple countries named faster travel times as a reason to use advanced air mobility in the future.

[Source: McKinsey]



8. DELIVERY DRONES

Delivery drones can be used to transport groceries, medicines, food, and a host of other products. Drone delivery services are gaining more and more importance in last-mile deliveries. This is mainly due to the fact that they are an environmentally-friendly alternative to regular delivery services and because of their lower operational cost. Drone delivery will be getting a lot more common in 2022 and beyond. In the US and China, for instance, delivery drones are expected to become more regulated and increasingly used commercially at scale. According to predictions by Gartner, in 2026 more than one million drones will be carrying out retail deliveries, and the size of the global drone package delivery market is estimated to reach \$8 billion by 2027, at a significant CAGR of 41.8 per cent.



8.0 DELIVERY DRONES

In Australia, delivery drones have already been taking to the skies in large numbers. The delivery drone company Wing, a subsidiary of Google's parent company Alphabet, recently reached a pivotal milestone, with its drones delivering more than 10,000 cups of coffee, 1,000 loaves of bread and 1,200 roasted chickens. According to a Wing spokesperson, the company has also run thousands of delivery tests and there have been no delivery issues during these flights. In the US, Walmart's delivery fleet will soon include technologies like drones and self-driving vehicles, while Uber, UPS, and technology giants like Amazon are also working on making commercial drone deliveries a reality. China, where most of the non-military drones used in the world are manufactured, is expected to play a significant role in e-commerce warehouse logistics with drones worldwide.

In February 2021, US Federal Aviation Administration's (FAA) new rules governing commercial drone activity came into effect – an important step toward developing broad safety standards. FAA chief Steve Dickson said: "The new rules make way for further integration of drones into our airspace by addressing safety and security concerns. They get us closer to the day when we will more routinely see drone operations such as the delivery of packages." And if consumer excitement about even faster and more efficient e-commerce is anything to go by, it looks like drone delivery will soon truly take off.





Some **87%** of 22,000 US residents surveyed reported that they liked the idea of drone delivery, and **89%** indicated that they were likely to use or had already used the service.

(Source: MAAP)



As of January 2022, the majority of registered drones in the US are recreational **(527,112)**, while the rest **(327,047)** are for commercial purposes.

(Source: PhillyByAir)



9. SPACE TOURISM

With space tourism having become reality, various companies are already active in the industry, such as Blue Origin, Virgin Galactic, and SpaceX. The year 2021 was a particularly busy year for private space tourism. More than 15 billionaire-sponsored civilians were catapulted into suborbital travels. Elon Musk's SpaceX took four passengers on a cruise around Earth, while Richard Branson of Virgin Galactic and Jeff Bezos of Blue Origin took their own spacecraft on interstellar journeys. There are currently various other companies travelling to different space destinations, such as Boeing, Axiom Space, and Space Perspective. Blue Origin and Virgin Atlantic are working on suborbital missions – flights during which you don't travel into orbit but make a huge arc and eventually fall back to the Earth.



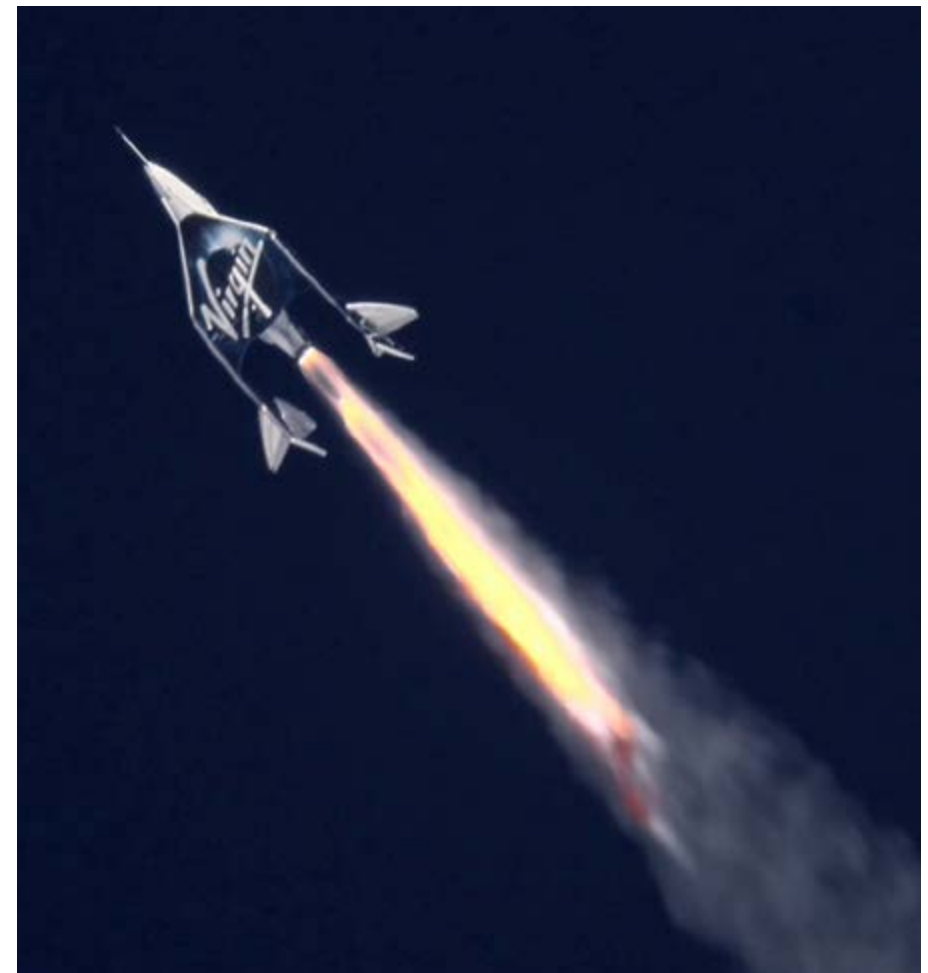
9.0 SPACE TOURISM

By the time Virgin Galactic starts its commercial operations, which will be towards the end of 2022, it hopes to have sold 1,000 tickets for two-hour rides to suborbital space at 80 km altitude, for which it will charge \$250,000 per ticket. Justin Bieber and Leonardo Di Caprio are rumoured to be among the fortunate few that have managed to get their hands one one of these tickets. Virgin Galactic says it has plans for 400 flights per year. Richard Branson said: "Virgin Galactic spaceships are built specifically to deliver a new, transforming perspective to the thousands of people who will soon be able to experience the wonder of space for themselves. As a SpaceShip III class of vehicle, Imagine is not just beautiful to look at, but represents Virgin Galactic's growing fleet of spaceships. All great achievements, creations and changes start with an idea. Our hope is for all those who travel to space to return with fresh perspectives and new ideas that will bring positive change to our planet."

Axiom is focused on orbital trips of several days, a week, or even ten days, during which you go into orbit and continually swirl around the planet. A 10-day trip will cost \$55 million. SpaceX is aiming for lunar travel, and Space Perspective wants to take tourists to the stratosphere, which will cost \$125,000 for a six-hour trip at 32 km above the Earth. To be able to go on a space trip, you will either need to be sponsored, win a competition, or be incredibly wealthy. Predictions are, however, that the astronomical prices (pun intended) for space tourism will likely drop in the coming years.

Around **40%** of people with a net worth of more than \$5 million are interested in paying \$250,000 for a Virgin Galactic flight. The company is expected to carry 150 passengers into space in 2022.

(Source: Cowen)



Virgin Galactic

10. SLEEP AND RELAXATION TECHNOLOGY

Insomnia and other sleep and relaxation issues are a huge problem; not just for the individuals who suffer from it, but also for employers and insurance companies. In recent years, sleep problems have become an increasingly critical issue, with far-reaching implications for people's health and well-being. As much as 45 per cent of people globally don't get enough sleep. Sleep deprivation affects cognitive function, attention, and decision making, and is linked to chronic health conditions, such as depression, heart disease, anxiety, obesity, hypertension, type 2 diabetes, dementia, and Alzheimer's disease. In addition to these detrimental effects on our health, sleep deprivation also carries high economic costs.



10. SLEEP AND RELAXATION TECHNOLOGY

Thankfully, there are all kinds of technologies that aim to improve and optimise sleep and relaxation. The information from various smart devices provides a better understanding of sleep problems and can help us find ways to remedy sleep loss. Beyond smartwatches and other wearables, exciting new advances are being made in sleep tracking technology. Think headsets that record and monitor sleep quality, smart alarm clocks that wake you at precisely the right moment, devices that regulate air circulation and adjust the temperature of your mattress, or devices that emit soothing sounds to help you relax and drift into a slumber. But even jewellery, textiles, and brain-tracking caps and earbuds are being developed with the aim to improve sleep quality and relaxation. The year 2022 and beyond will see sleep improvement technology rapidly evolving, providing ever more options for people suffering from sleep deprivation through a myriad of increasingly advanced technologies. Forecasts indicate that the sleep technology market could reach \$32 billion by 2026, up from \$11 billion in 2019.





A survey among 13,000 adults in 13 countries reveals that **70%** of respondents have experienced sleep challenges since the start of the pandemic. **60%** reported that the pandemic has directly impacted their ability to sleep well.

(Source: Philips)



More than **57%** of respondents expressed a willingness to seek help for sleep related concerns via telehealth services.

(Source: Philips)

11. PERSONALISED NUTRITION

It's a well-established fact that nutrition plays an important role in human health. However, finding the right diet that will enable someone to reach their health goals can be quite difficult. The main problem is that conventional diets largely rely on a one-size-fits-all approach, failing to account for each person's individual needs and preferences or how their metabolism reacts to a particular type of food. Poor nutrition is considered the main cause of chronic disease and obesity, a problem that has become increasingly prominent in recent years. In the United States, for example, as many as 60 per cent of people have at least one chronic disease. Similarly, in the UK nearly 65 per cent of the population are either overweight or obese. Thankfully, more and more people around the world are deciding to take ownership of their own health and wellness. This has also given rise to a number of health-focused trends, such as personalised nutrition.



11. PERSONALISED NUTRITION

According to the American Nutrition Association (ANA), personalised nutrition is “a field that leverages human individuality to drive nutrition strategies that prevent, manage, and treat disease and optimise health.” It takes into account a person’s unique traits, such as their genomic reports or food preferences, to provide a personalised diet or nutrition plan that will allow them to improve their health and strengthen their immune system. For instance, the US-based supplements company Pharmavite offers a monthly subscription service called Nurish, which delivers its users personalised nutritional supplement packets based on their age, diet, lifestyle, wellness, and general health.

“It is rooted in the concept that one size does not fit all,” explains Michael Stroka, CEO of the ANA. “Differences in our genetics, biochemistry, metabolism, and microbiota all contribute to our unique nutritional needs and expressions of



health or illness. Many circumstantial factors are at play in our immune responses – nutrition and nutrient status, environmental exposures, stress response, and lifestyle factors.”

Statista predicts that the personalised nutrition industry will grow from \$8.2 billion today to \$16.4

billion in 2025, doubling in size. The growth of this market has been driven by a wide range of factors, including the increased availability of commercial blood tests, DNA analyses, and health questionnaires that offer real-time feedback, as well as the proliferation of mobile apps and wearable devices that allow consumers to collect an abundance of data about their own health and wellness.

Another recent trend that has facilitated the growth of personalised nutrition is the emergence of companies that offer continuous glucose monitoring (CGM) solutions. In addition to allowing consumers to keep an eye on their blood glucose levels, CGMs also provide valuable insights into how specific foods, meals, physical activity, stress, or sleep affect individuals. For example, the Dutch startup Clear Health offers an innovative programme that consists of a device, a personalised meal plan, and access to experts.



The global human nutrition market is predicted to hit \$465.4 billion by 2025. It's growing at a rate of **6.6%** each year and is expected to continue at this pace.

(Source: Global Newswire)



The global market for personalised nutrition through apps, testing kits, and programmes is growing at a rate of **15%**.

(Source: MarketsAndMarkets)



Some **39%** of consumers worldwide are aware that genetic profiling can assist in personalising nutrition. Only **11%** have considered their genetic makeup in the context of their food choices.

(Source: FMCG Gurus)



12. HUMAN AUGMENTATION

The human body is a highly sophisticated organism capable of some extraordinary feats. Unfortunately, it's also very fragile. In addition to deteriorating as we grow older, the human body can also lose some of its functionalities due to injury or illness, leaving people without the use of one or more of their senses or limbs. For as long as we can remember, humans have been looking for ways to halt this decline and augment the human body in ways that will enable it to restore some of its lost functionalities or even push it beyond what it's capable of naturally.



12. HUMAN AUGMENTATION

However, due to our technological limitations, progress in the field of human augmentation has been rather slow. That is now starting to change, though. Thanks to recent technological advancements, there have been some remarkable developments in the field in recent years, ranging from powerful exoskeletons to brain-computer interfaces. According to a recent report published by MarketsandMarkets, the human augmentation market will grow from \$70.9 billion in 2019 to \$206.9 billion by 2024.

Elon Musk's neural interface technology company Neuralink recently announced that it would be ready to start implanting its microchips in humans as early as 2022, following successful trials on monkeys. Once implanted into the human brain, the chip records and stimulates brain activity, which could lead to new treatments for spinal cord injuries and neurological disorders.

"We hope to have this in our first humans – which will be people that have severe spinal-cord injuries like tetraplegics, quadriplegics – next year, pending FDA approval", says Musk. Musk hopes that the chip will one day enable quadriplegics (people with full or partial paralysis of all four limbs) to control digital devices with their minds.

Similarly, a team of researchers at Monash University recently announced that they have developed the world's first bionic eye, which will enable blind people to see again. Nearly a decade in development, the Gennaris bionic vision system consists of custom-designed headgear equipped with a camera and a wireless transmitter, which conveys signals to a set of 9-mm tiles implanted into the brain. This allows it to bypass the damaged optic nerve and transmit the signal from the retina directly to the brain's

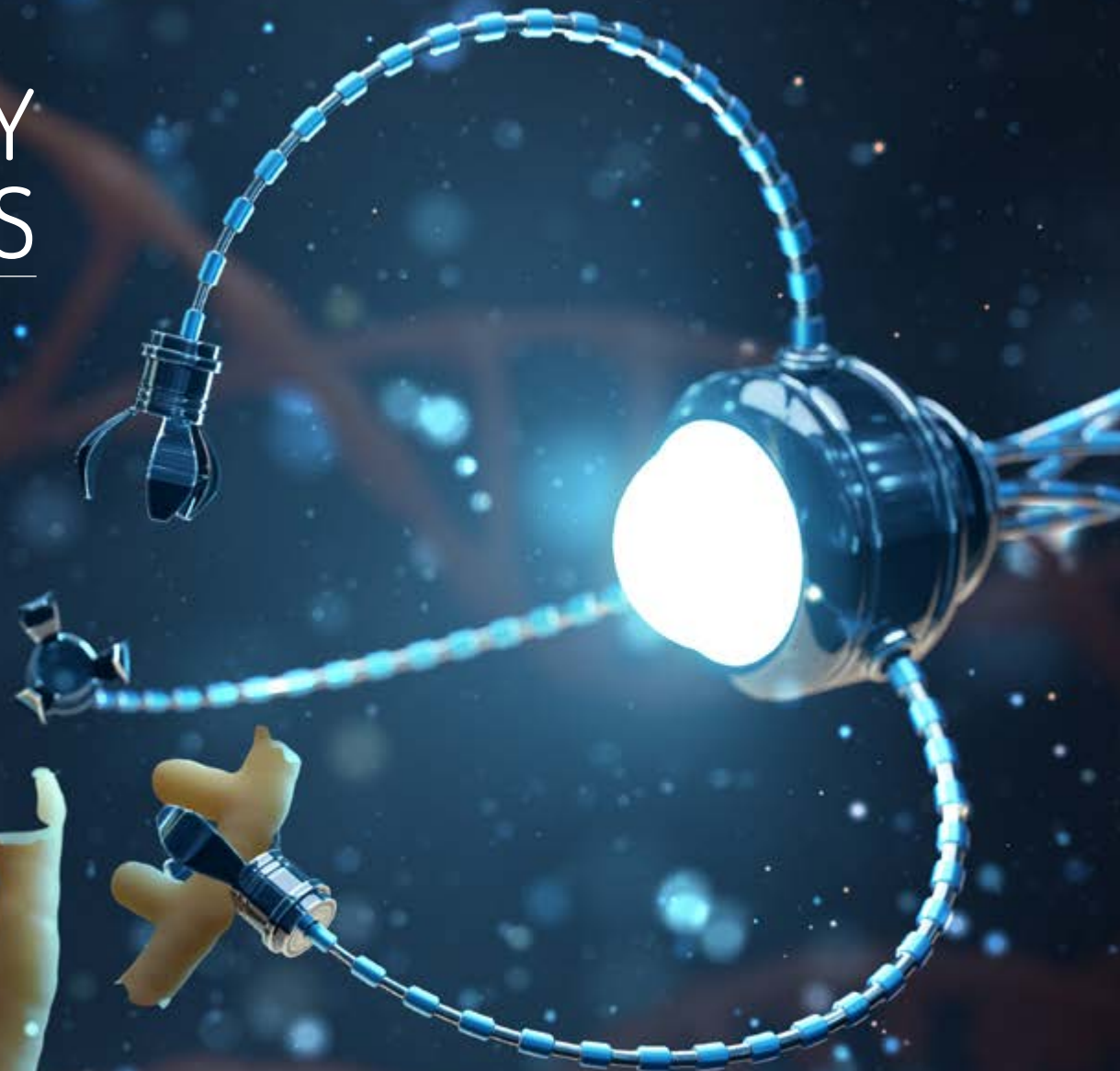


Gennaris Bionic Eye

visual centre. "Our design creates a visual pattern from combinations of up to 172 spots of light (phosphenes) which provides information for the individual to navigate indoor and outdoor environments, and recognise the presence of people and objects around them", explains Arthur Lowery, professor at Monash University's Department of Electrical and Computer Systems Engineering. The researchers also hope that they will be able to adapt the system so that it can be applied to other neurological conditions, such as quadriplegia.

13. NANOTECHNOLOGY INSIDE OUR BODIES

One of the most exciting areas of research in the world today is nanotechnology, which involves the manipulation of matter on a scale between 0.1 and 100 nanometres. Nanotechnology has a wide variety of useful applications in many different fields, including medicine, life sciences, manufacturing, energy, and construction. According to a recent report published by ResearchandMarkets, the global nanotechnology market is predicted to reach \$70.7 billion by 2026.



13. NANOTECHNOLOGY INSIDE OUR BODIES



PillCam™ SB 3 Capsule, medtronic.com

When it comes to its medical applications, nanotechnology can be used to develop miniature devices that can be injected into the human body and used to detect and treat various diseases. For instance, the PillCam is a digestible pill camera developed by the medical device company Medtronic. The PillCam can capture high-resolution images of the small bowel, which are then transmitted using sensors attached to the patient's abdomen. This enables doctors to diagnose conditions like Crohn's disease, obscure bleeding, and iron deficiency (anaemia) with more accuracy and minimal discomfort for the patient. Nanotechnology could also be used to develop implantable biosensors for early detection of Alzheimer's disease, early cancer screening, or diabetes management.

A team of researchers led by scientists from Tel Aviv University has developed a new nanotechnology device that will make it possible to generate electric current and voltage through natural movements of the human body. The device is made of a newly developed biological material

that has similar properties to collagen, the most prevalent protein in the human body. Among other things, the new material also displays piezoelectric properties, which is the ability to generate electricity when exposed to mechanical force. Most importantly, the material is biological and non-toxic to the human body, unlike other existing piezoelectric materials.

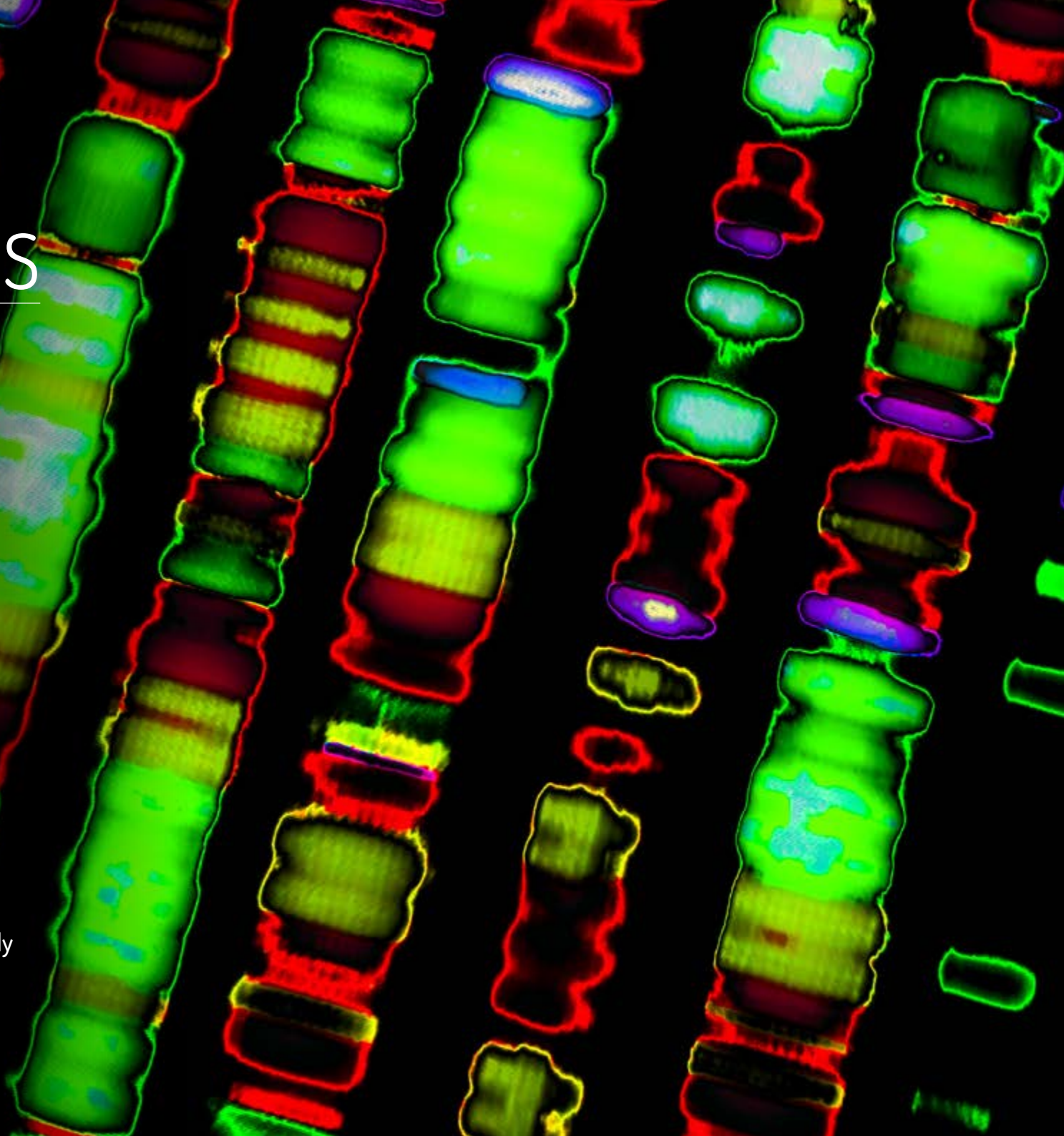
"Most of the piezoelectric materials that we know of today are toxic lead-based materials, or polymers, meaning they are not environmentally and human body-friendly. Our new material, however, is completely biological, and therefore suitable for uses within the body", explains professor Ehud Gazit, the lead researcher on the project. "For example, a device made from this material may replace a battery that supplies energy to implants like pacemakers, though it should be replaced from time to time. Body movements – like heartbeats, jaw movements, bowel movements, or any other movement that occurs in the body on a regular basis – will charge the device with electricity, which will continuously activate the implant."

76% of Brits would consider technology implants to share vital health data with their physicians to monitor illness and provide diagnosis and treatment.
(Source: Censuswide)



14. GENETIC PREDICTIONS

The discovery of the human genome has ushered in a new era of medical research, allowing us to estimate a person's chances of getting a certain disease by evaluating information contained within their DNA. Prenatal screening is already widely used to detect chromosomal diseases like Down Syndrome or single-gene diseases like Huntington's or Tay-Sachs disease, significantly reducing the number of children born with such conditions.



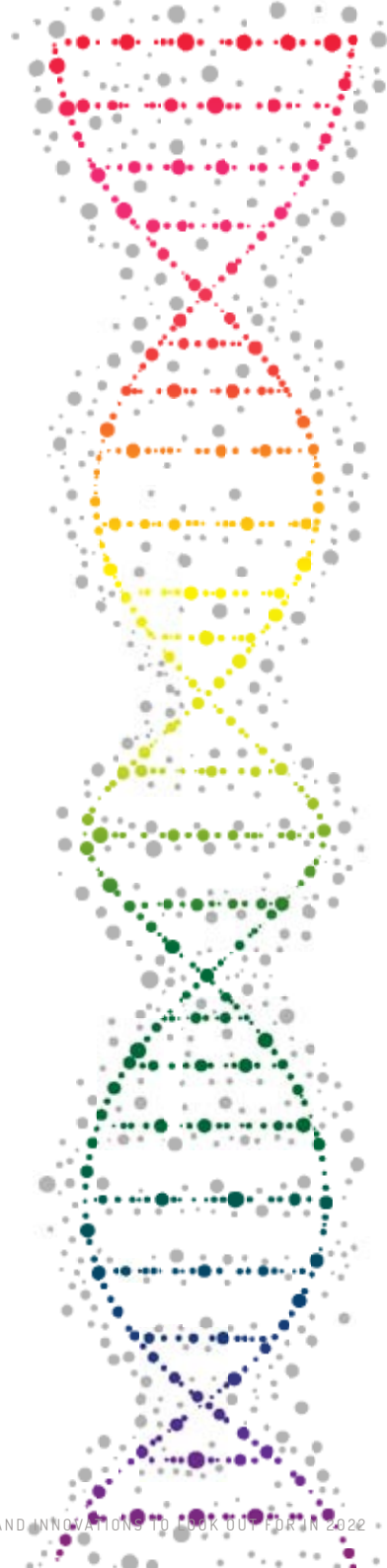
14. GENETIC PREDICTIONS

Not every disease is caused by a mutation in a single gene, though, making it more difficult to accurately assess a person's risk of developing it. This is where polygenic scores come into play. A polygenic score (PGS) evaluates thousands of genes to determine how they impact traits like height, weight, cognitive ability, and skin tone, or the likelihood of developing a condition like diabetes, depression, arthritis, or heart disease.

Stuttering, for instance, is a chronic condition that affects more than 2.5 million Americans. Although it's often downplayed because it doesn't require hospitalisation, persistent stuttering can have a severely negative impact on a person's education, job performance, and employability. What's more, we still don't know how to cure it, and the effectiveness of existing treatments leaves a lot to be desired. However, there is new hope on the horizon. A team of researchers from the Vanderbilt University Medical Centre announced to have discovered new genetic variations associated with the condition. "It's clear that in populations, stuttering is polygenic, meaning that there are multiple different genetic factors contributing to and protecting people from risk", says Jennifer Below, associate

professor of Medicine at VUMC. "That was something that had not been clearly shown before these studies." With the help of BioVU, one of the world's largest repositories of human DNA, the researchers built an AI tool that can detect the presence of stuttering with 80 per cent accuracy just by looking at a person's genetic code. This could potentially enable researchers to identify new avenues of treatment and make life easier for people affected by this condition.

However, this technology has also raised some serious ethical concerns. The problem with polygenic scores is that they are simply not reliable enough yet. While scientists were recently able to predict a person's height to within four centimetres, the accuracy of polygenic scores tends to vary wildly, especially when applied to people of colour. Imagine being denied insurance because your PGS says you are more likely to develop a serious disease, or a couple deciding to terminate pregnancy just because their child's predicted height or IQ is lower than they hoped for. These are serious questions that policymakers will have to address as soon as possible to enable us to make the best of this promising technology in the years ahead.



15. GENETIC ENGINEERING

There are few technologies out there that have attracted as much controversy in recent years as genetic engineering. This technology has found a number of useful applications over the years, ranging from creating crops that produce greater yields or are more resistant to disease and unfavourable weather conditions, to genetically engineering microbes that can produce environmentally friendly biofuels. This is reflected in the rapid growth of the global genetic engineering market, which is predicted to reach \$11.7 billion by 2026, according to a recent report published by MarketsandMarkets.



15. GENETIC ENGINEERING

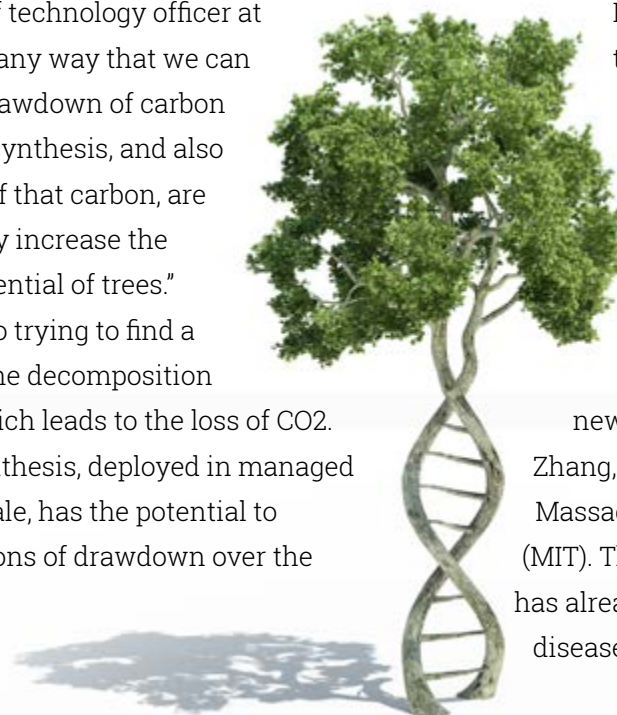
As the world's population continues to grow – the UN predicts that it will increase by 2 billion in the next 30 years – it's becoming increasingly difficult to produce enough food to satisfy the growing demand that accompanies this growth.. Genetic engineering could offer a helping hand by enabling us to produce more resilient and healthier foods. One such example is golden rice, which is genetically modified to contain vitamin A. The Philippines recently became the first country in the world to approve the commercial use of golden rice, which was partly developed by the Philippines-based International Rice Research Institute (IRRI). "With the biosafety permit, DA-PhilRice has now commenced producing seeds for cultivation, which usually takes 3-4 cropping seasons", says Ronan Zagado, the government spokesman for the Golden Rice Project. At first, the genetically engineered rice will only be deployed in areas with high prevalence of Vitamin A deficiency, after which it will also be made available for consumption by the general public.

Genetic engineering could also play a key role in helping us mitigate the effects of climate change. Living Carbon is a US-based company that has managed to genetically engineer trees whose ability to capture and store carbon vastly exceeds that of regular trees. "Planting trees alone is definitely helpful", says Patrick Mellor, cofounder and chief technology officer at Living Carbon. "But any way that we can improve the total drawdown of carbon dioxide from photosynthesis, and also improve retention of that carbon, are ways to quite greatly increase the total drawdown potential of trees." The company is also trying to find a way to slow down the decomposition rate of the trees, which leads to the loss of CO₂. "Improved photosynthesis, deployed in managed forests at a large scale, has the potential to get additional gigatons of drawdown over the current quantities", adds Mellor.

Last but not least, genetic engineering also has the potential to help us discover new treatments for diseases that continue to take hundreds of thousands of lives every year or even eradicate them altogether. Using the CRISPR-Cas9 gene editing technique, scientists can now look for

individual mutations within human DNA that cause a disease and fix them. "You can give it a string in the form of RNA. CRISPR-Cas9 will take the string and search along the genome to find where that mutation, that genetic difference is in the DNA – that's where you can delete sequences and insert

new DNA sequences", explains Feng Zhang, professor of Neuroscience at the Massachusetts Institute of Technology (MIT). This groundbreaking technology has already been used to treat sickle cell disease, for example.



16. SUSTAINABLE TECHNOLOGIES



Consumers have become increasingly aware of the importance of sustainability in recent years. A recent study published by BCG reveals that 70 per cent of people are now more aware of climate issues than they were before the pandemic, while 40 per cent plan to adopt more sustainable behaviours. This newfound awareness is also having a major impact on their shopping behaviour, forcing companies to adopt more sustainable business practices themselves in 2022 and beyond.

16. SUSTAINABLE TECHNOLOGIES



“One of the biggest shifts we are seeing is that the health of the planet is now the top concern of consumers”, says Lu Ann Williams, global insights director at Innova Market Insights. “Personal health has been the big concern for the past few years, but consumers now tell us that this has been surpassed by global issues. Sustainability is no longer just a Wall Street issue. It might not be the top purchase driver for all consumers, but for many it clinches the deal when it comes to choosing between products.”

As one of the biggest offenders in terms of waste, the fashion industry has a lot of room to reduce its environmental impact. To address this issue, Stephanie Benedetto launched the Queen of Raw, a marketplace that allows retailers to sell their unused inventory, rather than burning or burying it. And sportswear giant Adidas has launched a new range of footwear made from recycled fabrics and natural materials as a way to demonstrate its commitment to sustainability.

Another industry with a massive environmental impact is food production, which is responsible for 26 per cent of greenhouse gas emissions. This fact has not escaped the attention of consumers, as evidenced by the recent growth of veganism and plant-based diets, as well as the 140 per cent increase in the sales of meat alternatives. Unilever, one of the world’s largest food producers, recently announced that it expects the sales of its plant-based meat and dairy alternatives to reach €1 billion over the next five to seven years.

17. VERTICAL FARMING

The background image shows a vertical farming setup. It features several tiers of plants, likely leafy greens, growing in a controlled environment. The plants are densely packed and appear healthy. The system includes artificial lighting (LED strips) and a complex irrigation system with white pipes and red-handled valves. The overall scene is brightly lit, emphasizing the green color of the plants.

It's clear that traditional farming techniques alone won't enable us to produce enough food to meet the global population's growing demand. Furthermore, considering the stigma that still surrounds genetic engineering, GMO food may not be the one and only answer either, which is why we need to look for alternative solutions. One concept that has proven particularly promising and will see significant growth in 2022 is vertical farming.

17. VERTICAL FARMING



The term vertical farming refers to the growing of crops in vertically stacked layers, whereby temperature, light, water, and carbon dioxide levels are all controlled by artificial intelligence and machine learning technologies to ensure optimal conditions for plant growth. One of the biggest advantages of vertical farming is that it's much more environmentally friendly than conventional farming methods, because it usually doesn't require pesticides or fertilisers and it uses up to 95 per cent less water. It also requires less ground space, with a single square metre of ground in a vertical farm capable of producing the same amount of food as 50 square metres of a typical row farm.

Additionally, since they are usually located in climate-controlled indoor facilities, vertical farms are less vulnerable to extreme weather conditions. That being said, vertical farming is not suitable for all types of crops. Some, like corn and wheat, require a lot of vertical space to grow, which is why they are better suited to traditional row farms. That means that vertical farming is not supposed to replace traditional farming methods entirely, but it could be a very valuable addition to our current options. Investors are also increasingly taking notice, with capital investment for indoor farming reaching \$2.7 billion in 2021.

Willo is a California-based vertical farming and produce subscription service that relies heavily on artificial intelligence technology in its operations. "AI and machine learning are very good at taking lots of data

points and we use those data points to learn how to improve what we grow", says Sam Bertram, the co-founder of Willo. "We use sensors to look at the length of the light wavelengths, the intensity of the light, irrigation schedule, humidity, temperature, and pH in the nutrients." The company also announced plans to launch a new app in 2022, which will give members more control over the whole experience. "Members will be able to design their own farms on their phones, deciding what type of crops they want us to grow for them", explains Bertram. "It's Farmville come to life." Once they choose the type and the amount of crops they want, the company will plant the crops and notify them through the app once they are grown.

And in China, the famous architect Carlo Ratti is planning to take the concept of vertical farming to the next level by building a 51-story skyscraper in Shenzhen, whose facade will house a vertical hydroponic farm that spans the entire height of the building. The Jian Mu Tower, as this magnificent structure is called, will dedicate 10,000 square metres of its space to the cultivation of crops and will be able to produce 270,000 kgs of food annually that can feed up to 40,000 people. "Small-scale urban farming is happening in cities all over the world – from Paris to New York to Singapore. Jian Mu Tower, however, takes it to the next level. Such approach has the potential to play a major role in the design of future cities, as it engages one of today's most pressing architectural challenges: How to integrate the natural world into building design", explains Ratti.



Vertical farming uses **99%** less land, **95%** less water, and no chemicals, yet it produces 240 times more crop yield.

(Source: MarketsAndMarkets)



By 2050, approximately **80%** of the global population will live in urban areas. As demand for food in these areas will significantly increase, vertical farming will be an important tool for addressing this challenge.

(Source: Arab News)

18 HUGE LEAPS IN QUANTUM COMPUTING



Computers have become increasingly sophisticated over the years and capable of solving ever more complex problems. However, as powerful as they are today, there are still certain kinds of problems normal computers struggle to solve, such as those that involve a large number of variables that interact with each other in complicated ways. That's because these computers use units of information called bits to perform their operations. A bit can only have one of two values: one or zero, which restricts the computer's ability to solve problems with a high degree of complexity.

18. HUGE LEAPS IN QUANTUM COMPUTING

This is where quantum computers come in. Quantum computing employs the principles of quantum theory to solve problems that exceed the abilities of traditional computers. Quantum computers use quantum bits or qubits, which can exist in multiple states at once, to run multidimensional quantum algorithms. In addition to being faster and smaller than traditional computers, they also require less energy to operate. Quantum computers have a wide range of potential applications, ranging from developing new drugs and designing new materials to combating climate change. Investment in this field has increased steadily over years, reaching \$5 billion in 2021.

The first commercial-grade quantum computer, according to Google, could be available as soon as 2029, which is when the tech giant expects to have its own quantum computer ready. The machine will have one million qubits, which will enable it to solve some problems millions



of times faster than a conventional computer and perform large-scale business and scientific calculations without errors. "Quantum computing represents a fundamental shift, because it harnesses the properties of quantum mechanics and gives us the best chance of understanding the natural world", says Google's chief executive Sundar Pichai.

The UK startup Orca Computing recently announced that it made a breakthrough in quantum computing by building one of the world's smallest quantum devices. Unlike quantum computers developed by the likes of

Google and IBM, which are made by freezing qubits down to near absolute zero, the new approach uses single photons, which could make the technology more commercially viable.

"We're completely changing the way people view quantum computers", says Richard Murray, chief executive at Orca Computing. "Firstly, it's not cryogenically cooled, it's all at room temperature. And you'll also see it looks a lot like a normal computer would – it's a rack-mounted system, it looks very unspecialist. Our approach uses single photons, so single units of light. And the great thing about single photons is that they don't interfere with the outside environment." At this stage of its development, Orca's quantum computer only has four qubits, though, which makes it about as powerful as a thermostat. Obviously, that limits its potential applications, but the company is working on scaling the technology up, which they expect to accomplish in the next two years.



Some **95.7%** of US respondents believe quantum computing will create performance breakthroughs, and more than **60%** said quantum computing will be a leading tech trend in the next five to 10 years.

(Source: Classiq)

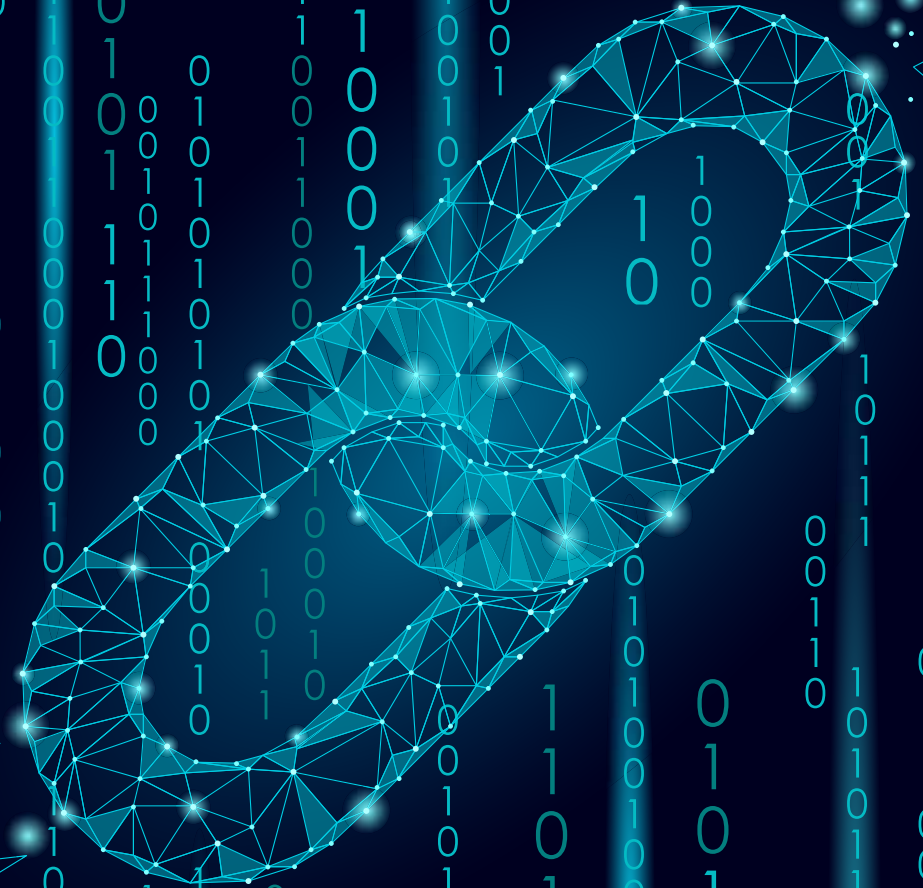


The four most important use cases for quantum computing identified by HPC centres are: searching databases **(59%)**, investment risk analysis **(45%)**, molecular modelling **(41%)**, and asset management.

(Source: IDC)

19 BLOCKCHAIN ENTERS THE MAINSTREAM

While Bitcoin and other cryptocurrencies remain the most well-known implementations of this exciting technology, blockchain has a wide range of other potential applications, including smart contracts, protection against identity theft, and logistics and supply chain provenance and security, to name just a few. As a result, spending on blockchain solutions is predicted to grow significantly over the coming years, reaching \$11.7 billion in 2022 alone.



19. BLOCKCHAIN ENTERS THE MAINSTREAM

Unsurprisingly, banking leads the way when it comes to the adoption of blockchain technology. Other notable adopters include telecommunications, media, entertainment, manufacturing, healthcare and life sciences, retail and consumer goods, and government. The French public financial institution Caisse des Dépôts et Consignations was one of the first companies to recognise blockchain's immense potential. In addition to launching LaBChain, a consortium that aims to explore potential applications of distributed ledger technology in the financial services sector, Caisse des Dépôts also founded a startup called Archipels. Established in collaboration with the French postal service and two energy companies, the startup provides document certification services and allows energy providers to submit the hash of their certified bills, which can then be verified by banks or administrators to reduce the risk of fraud.



One of the most notable developments involving blockchain technology in 2021 was the growing acceptance thereof among national governments. For instance, El Salvador became one of the first countries in the world to adopt Bitcoin as a means of payment for goods and services. Experts believe that many other countries will do the

same in 2022. A number of countries have also launched their own national cryptocurrencies or are planning to do so in the near future, including the UK, China, Singapore, Tunisia, Ecuador, Japan, Sweden, Estonia, and Russia.

However, increased adoption is also likely to lead to increased concern about the environmental impact of blockchain technology, which is known to consume a lot of energy and is responsible for large amounts of carbon emissions. As a result, we could see a number of new initiatives that aim to greenify blockchain. For instance, Ethereum plans to move from its current proof-of-work to a proof-of-stake model, which is less energy-intensive. On the other hand, Cathy Wood, the CEO of tech-focused hedge fund Ark Invest, believes that increased adoption of blockchain will actually be good for the planet, as it will lead to increased investment in solar power and other sources of renewable energy.



Globally, the banking sector alone could generate up to **\$1 billion** in revenue from blockchain-based cryptos.

(Source: Medium)



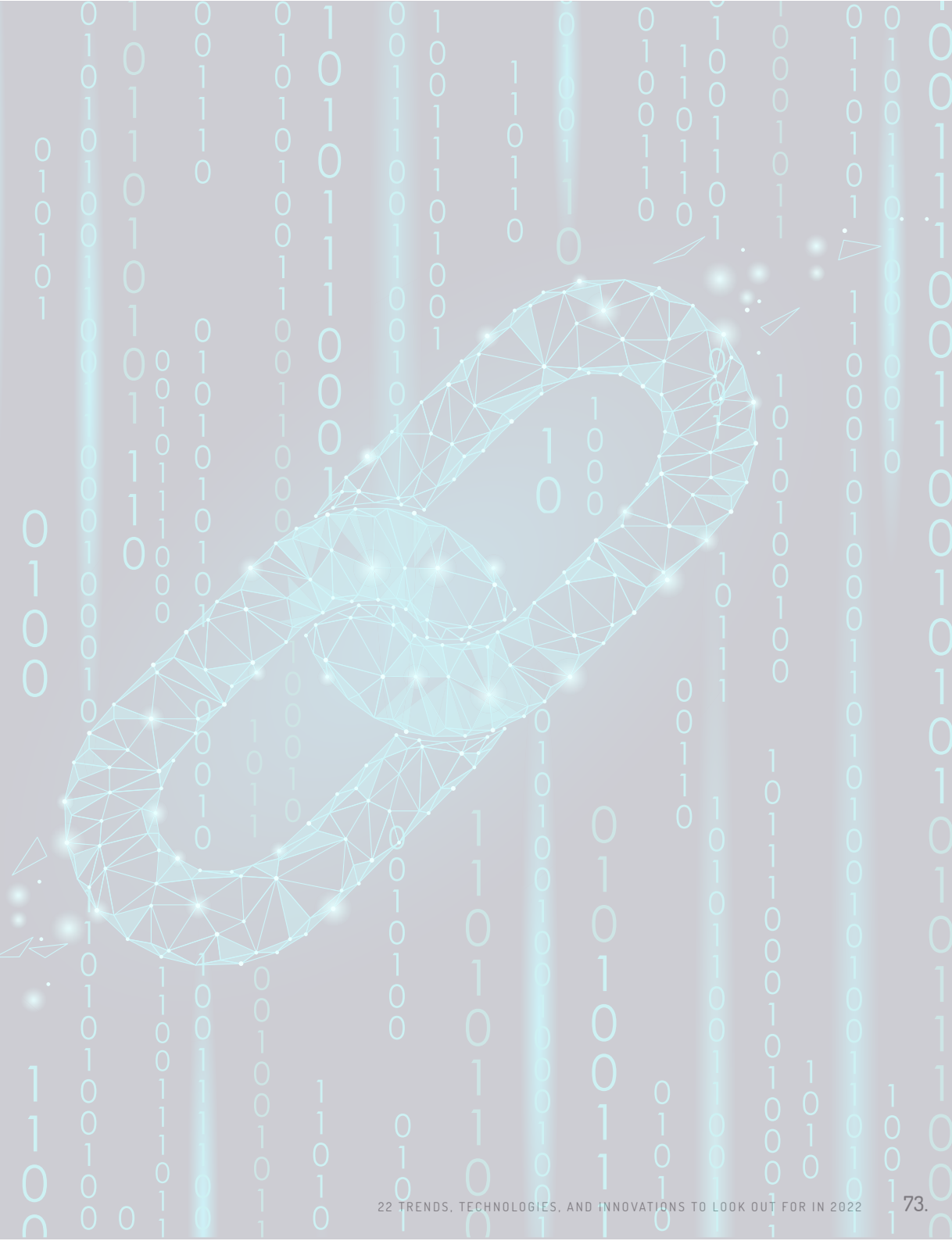
By 2025, **55%** of healthcare applications worldwide will have adopted blockchain for commercial deployment.

(Source: TechJury)



At the end of 2020, **60%** of CIOs worldwide were on the verge of integrating blockchain into their infrastructure.

(Source: TechJury)



20 THE INTERNET OF BEHAVIOUR (IOB)

Internet-connected devices are everywhere around us and you'd be hard-pressed to find a person who doesn't interact with them on a daily basis. The International Data Corporation (IDC) estimates that Internet of Things (IoT) devices will generate more than 90 zettabytes of data by 2025. Furthermore, an average connected person will interact with a digital device nearly 4,800 times per day, or once every 18 seconds. This proliferation of internet-connected devices has permeated almost every aspect of our lives, changing the way we live, work, learn, shop, and more. It has also forced companies to rethink their business practices and adopt innovative technologies to be able to meet their clients' changing needs.



20. THE INTERNET OF BEHAVIOUR (IOB)



By 2023, individual activities will be tracked by the IoB to influence benefit and service eligibility for **40%** of people worldwide. By 2025 this percentage will have risen to **50%**.

(Source: Gartner)

But how do we make sense of all this data generated by IoT devices and use it to our advantage? That's where the 'Internet of Behaviour' (IoB) comes in. IoB can be defined as: "the process of IoT networks capturing and analysing data to influence human decision-making and behaviour." It expands upon the IoT's original functionalities to provide companies with valuable insights about our habits, interests, and preferences. The IoB can help companies revolutionise how they interact with both their clients and their employees by providing them with a smarter, more personalised experience. Gartner predicts that more than half of the world's population will have their behaviour tracked through the IoB by the end of 2025.

For instance, the software company GBKSOFT has developed a wearable device accompanied by an app that can help golfers improve their skills. As players strike the ball while wearing the device, the app records and analyses their technique and offers suggestions on how to improve it. Another

example is Uber, which has utilised the IoB to transform the passenger experience. Rather than conducting a survey at the end of a trip to evaluate the experience, Uber now uses the IoB to automatically track the driver's behaviour and interpret the passenger's reactions. This provides the company with valuable insights, which can then be used to enhance the passenger experience.

The IoB can also be used to help people suffering from chronic diseases like diabetes, hypertension, or chronic obstructive pulmonary disease (COPD) better manage their conditions. This could go a long way towards improving public health and alleviating healthcare spending. An astounding 60 per cent of US adults today have one or more chronic conditions, with nearly 90 per cent of healthcare spending going to their treatment. Chinese-American multinational technology company Lenovo offers a virtual care solution that comes with a customisable, in-home kit. The kit consists of a tablet equipped with customised

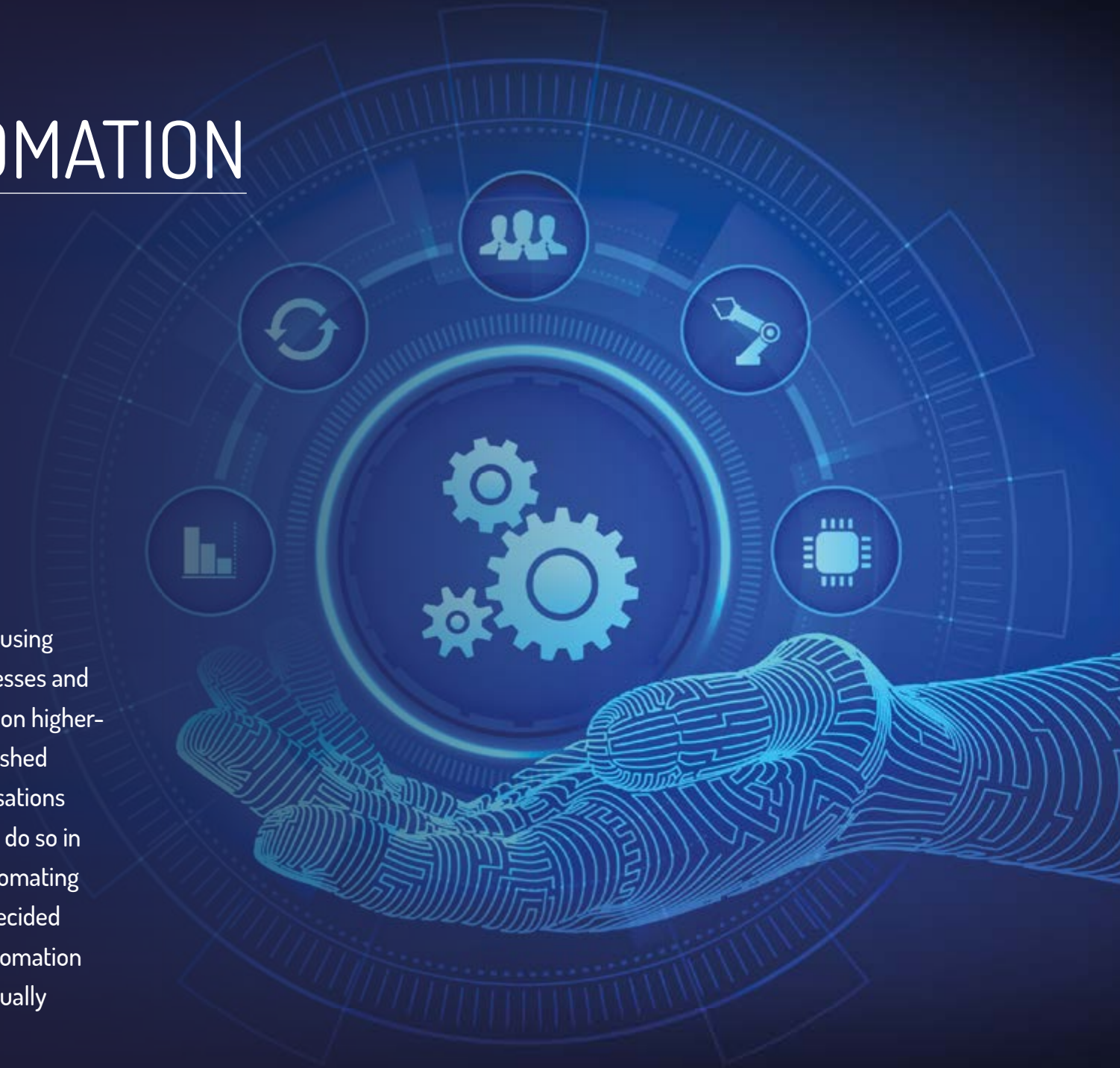


gbksoft.com

software, as well as peripheral biometric devices like glucose monitors and blood pressure cuffs. The built-in digital assistant guides patients through a personalised care plan and forwards their vital information to their healthcare providers on a daily basis. With doctors unable to be with their patients around the clock to make sure they practise good behaviour, solutions like the one offered by Lenovo could significantly improve medication adherence among patients and decrease the rate of return hospital visits and ER admittance.

21 HYPERAUTOMATION

Companies around the world are increasingly using automation to streamline their business processes and operations, allowing their employees to focus on higher-value tasks. According to a recent report published by Mulesoft, as many as 93 per cent of organisations are either already using automation or plan to do so in the near future. However, rather than just automating individual processes, some companies have decided to take it to another level and scale up the automation across their entire business. This process is usually referred to as 'hyperautomation'.



21. HYPERAUTOMATION

"Organisations increasingly want to automate anything that can be automated", explains Rahul Pahuja, director at the consulting firm Slalom. "Hyperautomation promises to deliver on that need by driving greater efficiencies, improve productivity, and reduce costs in everything from streamlined sales operations to accelerated customer case resolution." For instance, one large European hospital recently contracted UiPath, a leading robotic process automation (RPA) software company, to help it undergo a successful RPA transformation. With approximately 70,000 emergency visits and 300,000 outpatients per year, the hospital's 2,000-strong staff had major difficulties achieving the desired results, especially while almost every process was paper-based. Unfortunately, the long-awaited transition to a digital system didn't go as planned, with the hospital experiencing serious issues with



the manual input of paper files into a digital database and inventory management. That is why the hospital decided to implement RPA, which turned out to be a good decision, as it was able to streamline workflows and activities, optimise inventory management, and significantly reduce claim processing costs.

Silverwork Solutions is a Chicago-based company that develops role-based software robots that help mortgage companies automate their processes, reduce costs, and improve the customer experience. "We are currently taking

advantage of hyperautomation to automate everything that can be automated in our clients' organisations", says Michael Kaysen, the CEO at Silverwork Solutions. "Automating what people do at work is challenging and requires us to build and integrate state-of-the-market technologies in the areas of document recognition, decisioning and workflow. The gains we've helped our clients realise to date from applying intelligent automation, and now hyperautomation, in this fashion have been strong, and we think this trend is still in the early stages of realising its potential."



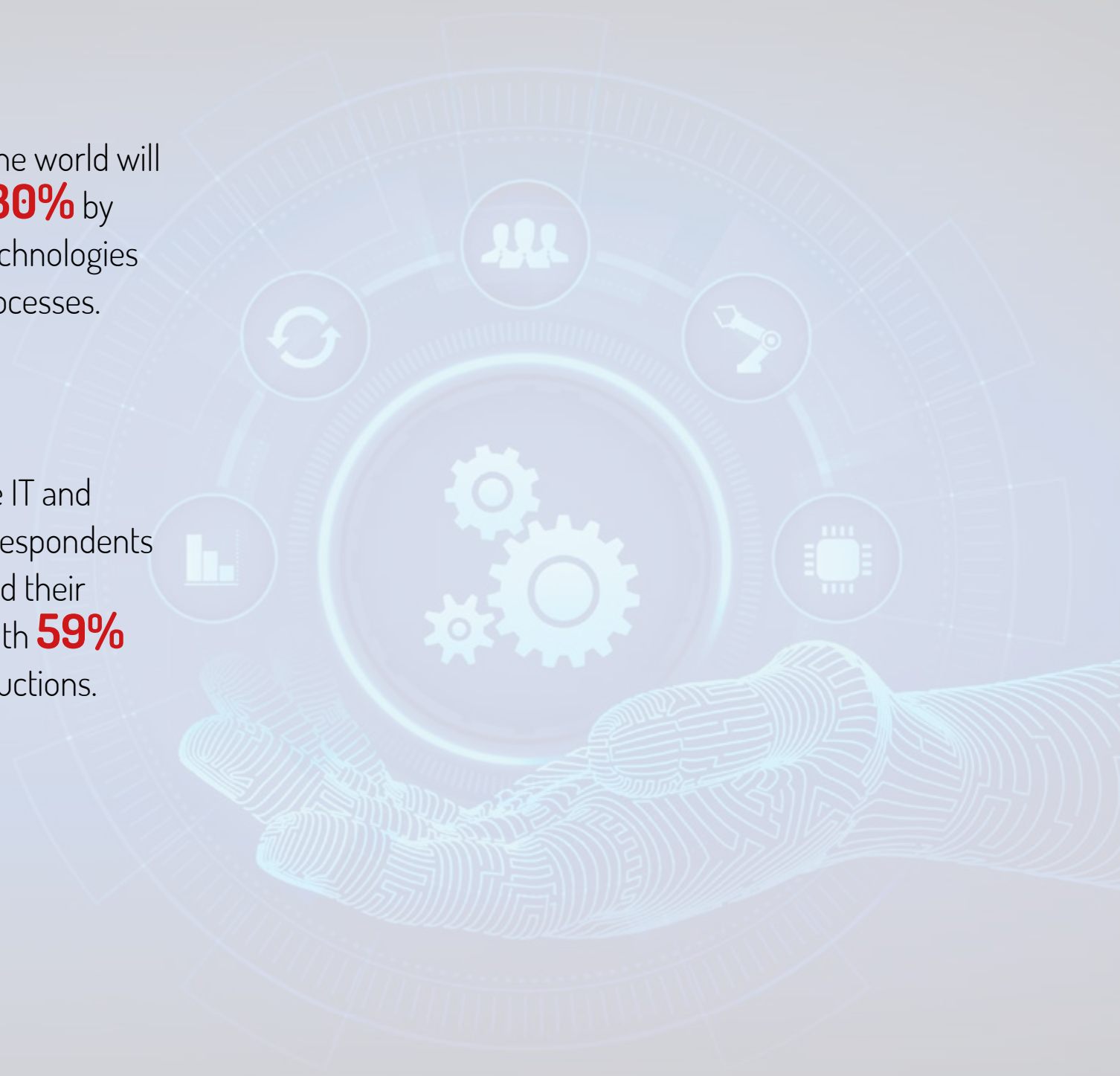
By 2024, organisations across the world will decrease operational costs by **30%** by combining hyperautomation technologies with redesigned operational processes.

(Source: Gartner)



In a recent survey of worldwide IT and engineering leaders, **74%** of respondents said that automation had helped their workforce be more efficient, with **59%** reporting up to **30%** cost reductions.

(Source: Gartner)



22 DIGITAL PLATFORMS @

The needs of consumers have changed drastically over the years. Today, consumers spend a large portion of their time online, interacting with the world through various digital platforms. This has also significantly altered their expectations from service providers, who are required to connect with consumers through digital channels. As a result, companies across industries are now increasingly coming out with digital platforms of their own to deliver a more convenient and personalised customer experience. In fact, digital platforms are expected to become the dominant business model in the upcoming period, forever changing how companies interact with their customers.



22. DIGITAL PLATFORMS

A digital platform allows companies to connect the supply and demand sides of their operations. Rather than just offering their own products and services, companies can use digital platforms to partner with others and create a larger ecosystem that will be able to attract a much wider audience and address the needs of their customers at an individual level. Digital platforms facilitate collaboration, accelerate the pace of innovation, and enable companies to lower their costs. They also enable companies to combine data from various business applications and identify complex relationships between them, such as the relationship between a specific product's market performance and the associated

marketing campaign. Furthermore, by collecting vast amounts of data about customer behaviour, companies will be able to meet their needs more effectively and generate valuable insights that may not have been available to them without a digital platform.

One of the best examples of a successful digital platform is Amazon. Starting as an online bookstore, the company has since expanded its portfolio to include all sorts of products and services, including digital streaming, autonomous vehicles, satellite internet, and artificial intelligence. Amazon has also become the world's largest cloud computing provider



through its subsidiary Amazon Web Services (AWS), which offers various on-demand cloud computing services and accounts for more than 60 per cent of the company's revenue. As other companies strive to emulate Amazon's success, we can expect digital platforms to really take off in 2022.



Some **66%** of sales leaders across the world consider digital platforms to be vital for contact, while **34%** of respondents view traditional sales conversations as more crucial.

(Source: ZapUp)



By 2025, driven by volatile global conditions, **75%** of business leaders will leverage digital platforms and ecosystem capabilities to adapt their value chains to new markets, industries, and ecosystems.

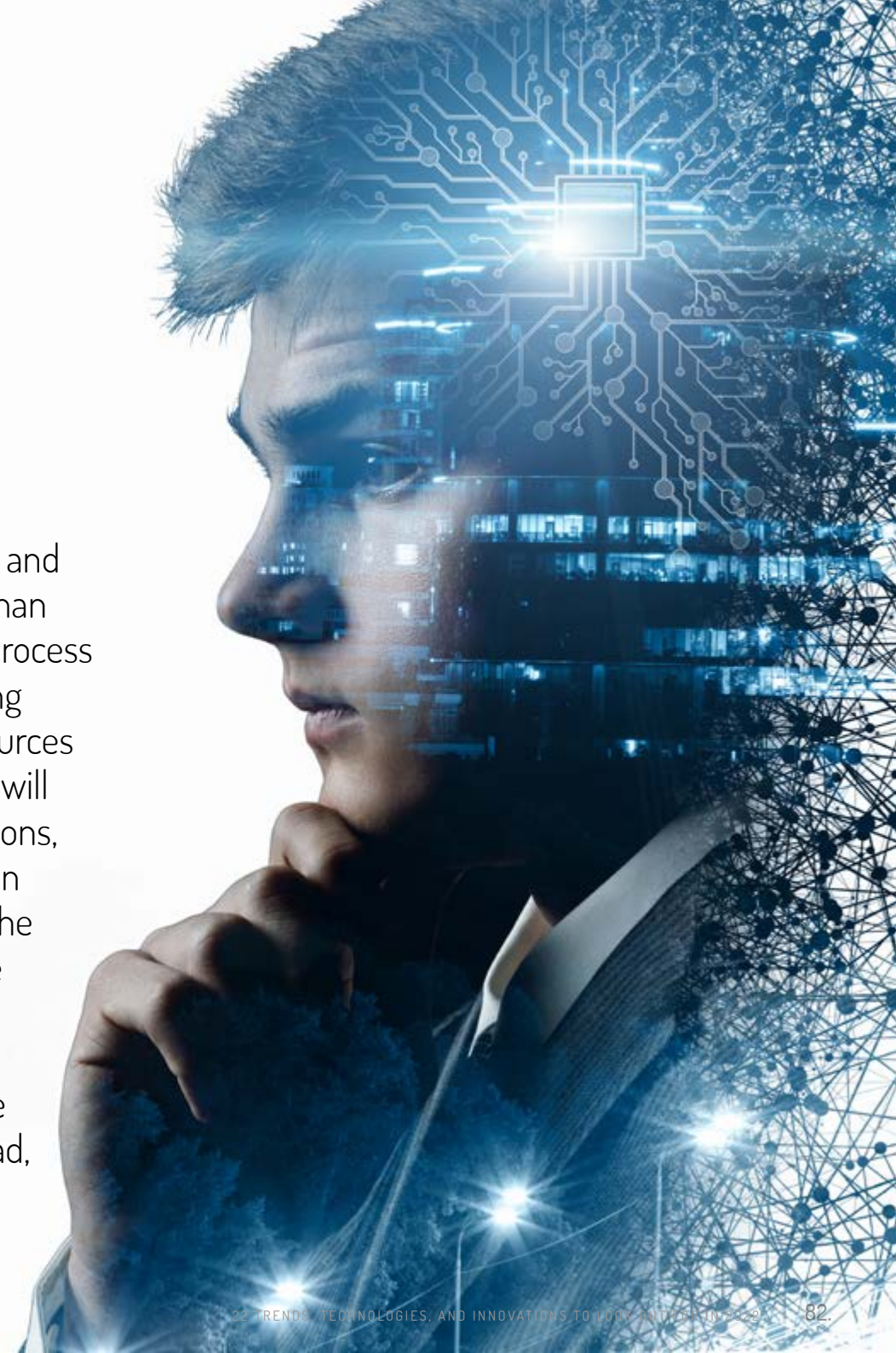
(Source: IDC)



In closing

The technology trends of this past year will spill over into 2022 and beyond, and leading to a more data-filled and digitised world than we have ever experienced. We'll also see a lot of RPA (robotic process automation) taking place, and a vast improvement in computing capabilities via quantum computing and other computing resources that automate complicated processes. Ubiquitous connectivity will help us transition from smart spaces to smart cities, smart nations, and ultimately toward an increasingly smart world. Our focus on cybersecurity will see a significant increase, and as a result of the growing demand for digitalisation and virtualisation we will see more and more businesses offering digital solutions.

Advancements and innovations in autonomous systems, extended reality, and artificial intelligence will take centre stage and usher in a new era of virtual living. A bright future lies ahead, with a focus on technology as a force for good.



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