# THE FUTURE OF WORK


RICOH
imagine. change.

# Foreword

We're continually being told how life offers few certainties – even less in this era of upheaval. Yet within that uncertainty there's always been a constant backdrop of opportunity in the shape of change. But what hasn't always been the case is the sheer size and scope of change facing us right now. It's no exaggeration to say that the possibilities facing businesses today are monumental.

We live in an age where a teenager can sit in their bedroom and be inspired by a free online video to learn how to code. Within weeks, they are able to develop a product and use free design resources to create illustrations and web designs to start marketing it. Through the cloud, they are able to make their web-based application available across the world, translated into countless languages using free tools. They can accept subscriptions and payments with minimal effort through services requiring no up-front cost. In this small amount of time, through self-education and minimal investment, they've created an enterprise that can disrupt businesses that have long been implementing traditional methods and technologies. This example captures both the opportunity, and the considerable challenges for businesses today, afforded by the digital age.

Success depends hugely on making the right choices. Importantly, these choices don't start and end with technology. It's about understanding how technology impacts people and, most importantly, how people choose to work given the incredible array of options now available.

Workplaces are changing. Employers continue to embrace new digital tools with the ambition of increasing productivity, improving the quality of work and enhancing the user experience. But making the right investments in the future of your work is a continual puzzle for businesses to consider.

With that in mind, we've created this report to draw together the mass of trends that are influencing how, when and where people work. We reviewed more than 100 publications, academic papers, trade journals, print and online articles, videos and podcasts to help bring to life in one short report the tremendous opportunities available to businesses. We've also drawn on our considerable experience from working with more than 1.2 million Ricoh customers worldwide to provide insight and advice.

The following pages have been designed to make sense of the best-in-class thoughts on the future of work and shine a light on what's required to create an organisation that can shape its own destiny in times of change. I hope they excite, inspire and help guide you through the rapidly changing environment we all face.

**David Mills**
CEO, Ricoh Europe

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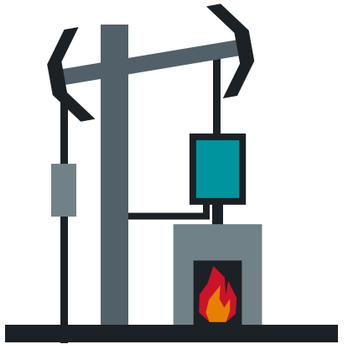


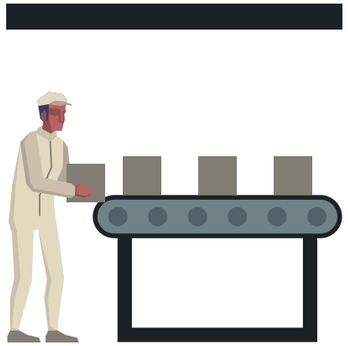
## 1st Industrial Revolution

Mechanisation, steam power, weaving looms

Large scale transportation with steam-powered vessels and railroads

Replacing human and animal power with machines

1870



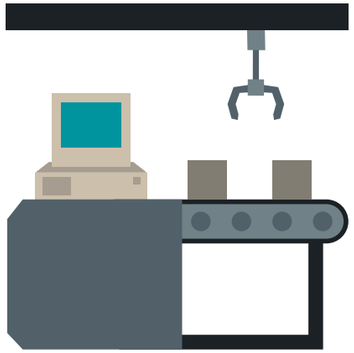
## 2nd Industrial Revolution

Electricity assembly line, mass production

Internal combustion engines, automobiles

Radio and television

1969



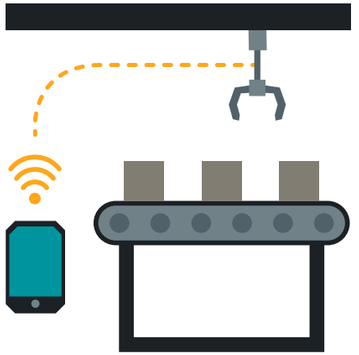
## 3rd Industrial Revolution

Electronics, computers

Automation

Information Technology

Now



## 4th Industrial Revolution

Cyber-physical systems, Internet of Things, sensor networks, advanced robotics, big data, machine learning, cloud computing, driverless cars, 3D/4D printer-based manufacturing, blockchain transaction architecture

# Executive summary

In this report, we consider how we will approach work as individuals (**The Human Future of Work**), how we will interact with machines (**The Human-Machine Interface**) and how machines themselves are going to define work in the future (**The Machine and Augmented Intelligence Future**).

The expansion of a more networked and mobile workforce coexists with a growing skills gap, particularly in emerging fields and specialisms. Attitudes towards work-life balance are changing across multiple generations, as new technologies unlock new possibilities for more agile work patterns. As organisational cultures, processes and teams become more flexible, so will the range of places and spaces in which people undertake paid work. Many workers, both young and old, are looking for purpose and self-fulfilment in the work they choose to do. People expect employers to support their needs, desires and aspirations; they expect their working environment to accommodate their individual working styles and behaviours.

The evolution of interaction between our machines and ourselves has defined work for generations. Today the importance of this relationship continues to grow with the rapid development of new digital technologies and the wider adoption of digital working methods. Workplaces are changing to accommodate new digital tools, while smart wearable technologies and exoskeletons are enabling people to work safely and efficiently beyond their traditional abilities.

The fusion of physical and digital technologies is now defining the unprecedented rate of change in the workplace. Artificial and augmented intelligence are seen as potentially the most disruptive change in the workplace to date. But it is unclear, at present, how positive or negative that impact is going to be. What we see is a coming together of factors, bridging major social, political, economic and environmental topics. For example, how AI will either eliminate or accentuate bias in the workplace, or if augmented intelligence can tackle the most complex of challenges in the climate emergency. What is clear is that level-headed understanding is needed about how these future technologies work and learn.

Society has been through three industrial revolutions and realised the benefits. We are currently experiencing the fourth industrial revolution; how we respond and handle the opportunities it presents will define the future of work. This report, researched and produced by Arup, presents where we are and where we are headed.

# Introduction

Much has been written about the future of work. For years, employers and employees, governments and organisations large and small across every industry have tried to second guess what's next in the ever-changing landscape of work.

This report is our contribution to this ongoing discourse. We have not tried to predict what the future world of work will look like. Instead, we have created a framework that we believe has broad relevance for a wide range of work in the coming decade, based on an in-depth consideration of the many drivers and signals shaping change. We reviewed more than 100 publications including academic papers, trade journals, print and online articles, videos and podcasts, and derived a number of key factors that form the backbone of our narrative.

These are:

- **Technology**
- **Skills, knowledge and capability**
- **Agile work patterns and behaviours**
- **Flexible and remote working**
- **Human and environmental health and wellbeing**
- **Regulation, security and intellectual property**

We analysed the above factors based on the premise that the future of work – just like its history – will be characterised by the interaction between humans and technology.

It is the future evolution of this interaction between humans and machines that led us to distil our findings into a three-part narrative with a focus on the human, cyber-human and cyber elements of work over the next five to ten years. Ultimately, it is this very interaction that will define the tasks, roles and behaviours we undertake and adopt over time. The way in which we leverage technological advancements to augment human capabilities, increase productivity, improve personal wellbeing and find greater meaning and purpose, forms the central theme of this thought piece.

Each part of the narrative is accompanied by a selection of case studies from around the world which portray a global landscape in flux. A workshop including experts from Ricoh and Arup was held to validate the research findings, the selection of case studies and the overall narrative.

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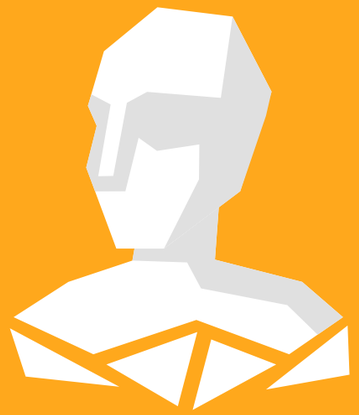


# The Human Future of Work

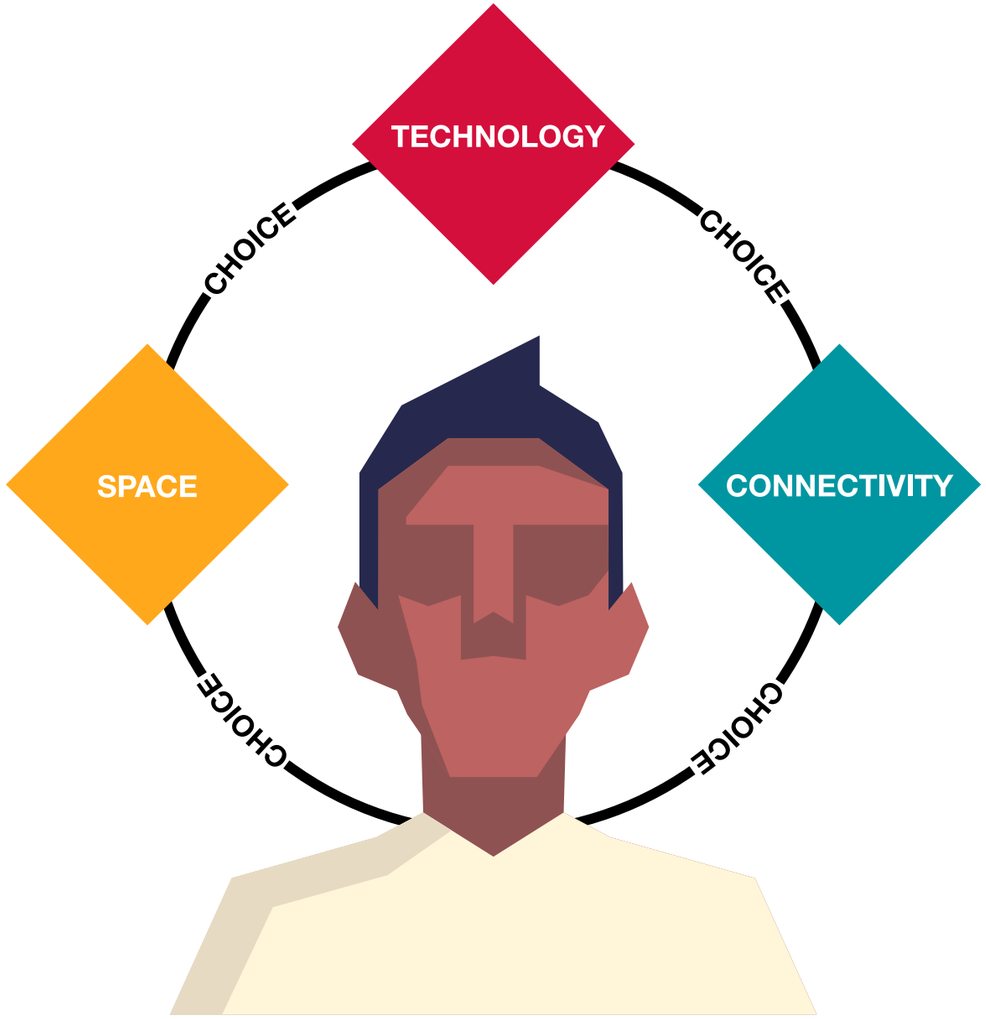
Changes in the way people work, communicate and learn are driving businesses and industry to adopt flexible strategies and adaptive solutions that respond to the needs of their workforce. These changes are spatial, cultural and operational. Human-centred, multi-generational, agile and flexible approaches are needed in the 21st century workplace. Technology provides more choice as to when, where and how we work. Moreover, purpose and value in work is growing in importance.

# Agile working

In recent years, ‘agility’ has been a central aspect of work. Most roles require people to manage a range of tasks and work collaboratively. An agile workplace provides people with everything they need to work in the most efficient way. It provides them with space, technology, connectivity and choice, enabling individuals to carry out tasks in a way that is appropriate and effective for themselves. At the same time, it helps organisations be creative, responsive and efficient.[1]

Behaviour, culture and technology are vital aspects of a successful agile workplace. App-based solutions are providing employers with the ability to optimise their office occupancy and save on their real estate footprint by using real-time information and data on space.[2]

However, investing in spatial and technological solutions and tools will not be enough. Ensuring that people are nurtured, empowered and led in ways that promote trust, delegation and partnership will be the key differentiator.[3] This helps shape a workforce equipped with the ability to change and a workplace able to respond to feedback from users.



# A new work contract

One of the most impactful results of agile approaches to work has been the transformation of recruitment. The gig economy and its enabling platforms have changed the way some professions find and choose to work, as well as enabling employers to restructure their hiring strategies.

By using data science to match organisational needs with individual skill sets, labour-sharing platforms such as Upwork connect freelancers with employers. Freelancers have always been used to staff projects quickly, plug capacity gaps and cover peak demand, but they are now increasingly employed as a source of key talent and expertise by companies that need to adapt to shifting customer demands.[4]

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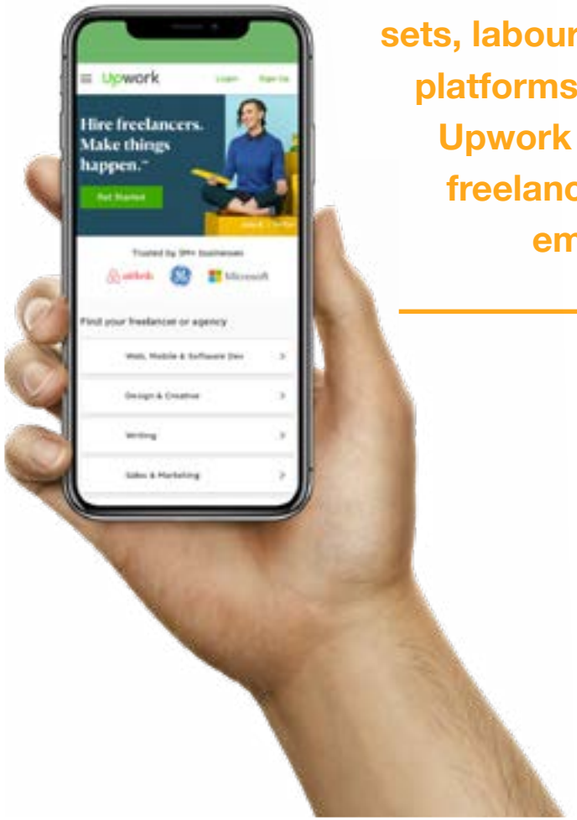



For example, Philips, the Dutch multinational electronics company, has created its own platform – Philips Talent Pool – to attract and maintain a pool of freelancers. Through this, Philips is building a flexible workforce who bring new and diverse skill sets, while growing a reputation and familiarity with the company and its projects.[5,6]

With the boundaries between the traditional contract and gig work becoming blurred, and amid ongoing disputes between lower-skill gig workers and platforms, companies may also face challenges when trying to hire higher-skill staff. Recently, Google required that its partnering staffing companies pay contract workers a minimum wage of US$15 an hour and provide health benefits.[7] For an organisation that employs 120,000 contractors and 102,000 full-time employees,[8] a move like this recognises the value and equality of contract work. Work benefits, career development opportunities, recognition, community and stability are still valued by staff. The gig economy ecosystem will need to respond to this in future.

# The many faces of co-working

**TwoSpace uses restaurants whose doors are closed during office hours as co-working spaces, connecting workers with the local community.**

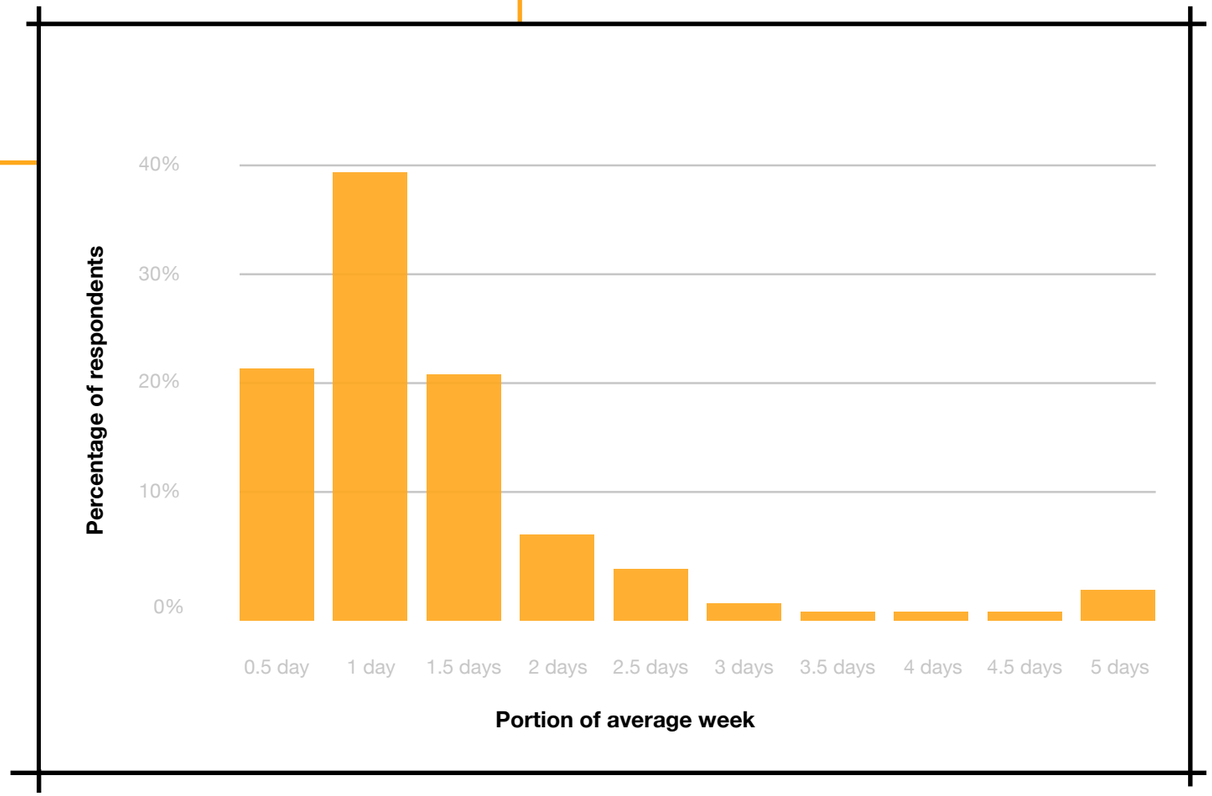
*Casoni Bar and Eatery © TwoSpace*

Flexible approaches to work are not reserved just for staffing. Co-working is another approach growing in popularity that looks to maximise the efficient use of space and resources to support a dynamic workforce. In central London, flexible workplace operators already occupy more than 10 million square feet of space.[9]

Initially responding to the need for affordable, flexible desk and office space for start-ups and SMEs, co-working has rapidly evolved into an important element of the work ecosystem. It provides the potential to challenge traditional business models, shape communities and redraw neighbourhood strategies and city planning approaches. WeWork is one of the largest flexible workplace operators in the world and the largest single provider of office space in London[10] and globally supports US$122.3bn of GDP,[11] illustrating the impact of co-working beyond work.

Models of co-working continue to evolve and present further opportunities to influence how people work, learn, innovate and socialise both inside and outside the office, within or beyond city centres. In Australia, TwoSpace uses restaurants whose doors are closed during office hours as co-working spaces. By not replicating the experience of an office environment, TwoSpace provides a unique alternative. This kind of innovation connects workers with the local community while enabling round-the-clock use of spaces that, under normal circumstances, would remain unoccupied.[12,13]

**Co-working should complement, rather than replace the traditional workplace:** for large companies, co-working spaces are less effective if used more than one day a week.




*Source: Gensler 2019 U.S. Workplace Survey*

**Key Case Study: Vrumi at Home**

Vrumi, a sharing economy online property marketplace, connects professionals in need of space with householders who have vacant rooms (such as sitting rooms and dining areas) available in the daytime. The benefit for professionals is that they can access workspace in areas that they couldn't previously afford, work in a pleasant environment that feels like home, and at the same time avoid the distractions of working from one's own home.[14,15]

According to international architecture and design firm Gensler, co-working is now becoming a valuable alternative work setting across sectors; a high-value amenity that spurs informal collisions and offers variety. A key future challenge, in this case, will be to maintain the balance between co-working and other work settings.[16] Gensler's 2019 *U.S. Workplace Survey* reveals that when large companies offer their employees the option to use co-working, these spaces are associated with a better work experience and higher performance, but are less effective if used more than one day a week.[17] This suggests co-working should therefore complement, rather than replace, the traditional workplace.

# Generations in the workplace

Ageing populations in the developed world are a powerful demographic trend that, together with rapid socio-economic shifts and technological advancements, are creating new workforce challenges.[18] With people working for longer because they have to, or because they want to – and as younger generations enter the workforce, a new dynamic is emerging.

How organisations prepare for an increasingly older workforce will be critical. The future of work will see more openness to flexible hours, roles and positions, as well as knowledge – and experience – transfer programmes where older employees share their expertise with younger colleagues. This will all be part of an agenda that aims for a mutually beneficial transition period from employment to retirement.[19]

How organisations leverage the coexistence of a generationally diverse workforce will also be key to success. A recent study by Ricoh suggested that the presence of Gen Z in the workplace united, rather than disrupted, the existing workforce. According to the study, new perspectives, new skills and new ways of working helped to unify the rest of the workforce around key beliefs. This was especially true around performance, innovation, image and differentiation.[20]

Opportunities will also develop for people to use their time after retirement in novel and productive ways. Senior Planet, a co-working space for seniors in New York, is already supporting the rich lives of people over 60 who either want to learn new skills after retirement or teach their skills to like-minded, information-hungry seniors.[21]

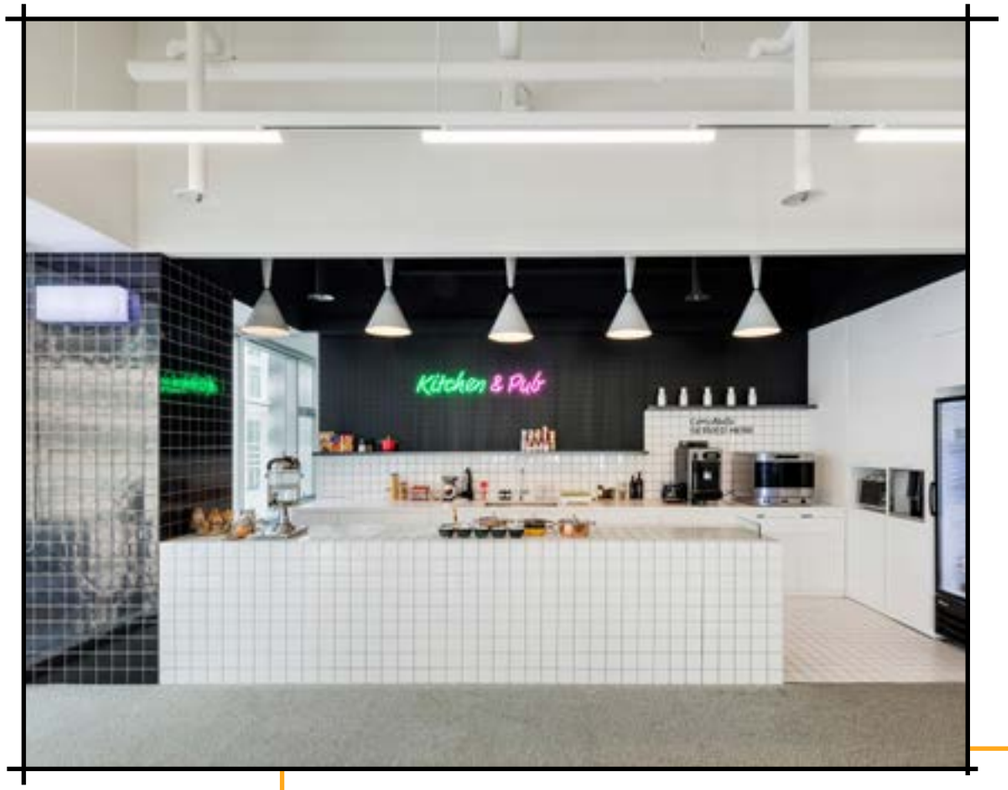
BABY BOOMER

GENERATION Y

GENERATION X

GENERATION Z

# Community and trust




*Hyundai Card Studio Black © Nacasa and Partners/Gensler*

**Firms are dedicating more space to hospitality areas, intending to bring people together and create serendipitous moments and interactions.**

As well as responding to technological, economic and demographic trends, a more flexible and social approach to work can contribute to a healthier work-life balance.

Flexible work patterns and agile work do not negate people's need to come together. According to Raphael Gielgen, head of research at furniture manufacturer, Vitra, fewer companies are investing in classic typologies of workspace. Instead, firms are dedicating more space to hospitality areas, intending to bring people together and create serendipitous moments and interactions in which everyone can easily interact, like cooking and eating together.[22]

Interaction and collaboration lead to happier employees. According to a survey of 4,000 working adults in France, Germany, the UK and the US, nearly 70% of those who describe themselves as satisfied with their job, indicate that they collaborate with five or more people inside their office on any given day and at least once or twice a week with people outside their office, such as clients and partners.[23]

To promote collaboration, organisations will have to provide people with workplaces where choice, integration with technology, and human wellbeing are key characteristics of their design. When workspace design includes things such as a variety of arrangements and amenities, the workforce becomes more productive and engaged, which leads to better business performance.[24]

> "Collaboration will be the key to success in the workplace of the future. Whether this is collaboration between humans, humans and machines, or machines and other machines – businesses creating work environments that are enabling these interactions to happen will outperform their competitors and attract the best talent."

**Ed Hamilton**
Vice President of Communication Services, Ricoh Europe

# Stigma-free work

When it comes to employee wellbeing, organisations are gradually engaging in discussions and working towards normalising the awareness of mental health. For example, Buffer, a social media management software company, operates on the belief that the future of work is stigma-free. To tackle the issue of mental health at work, Buffer encourages its employees to talk openly and share experiences regarding therapy and mental health medication, and strives to build trust. It respects both introverts and extroverts by enabling both socialising and time and space to recharge, as well as leveraging the benefits of both synchronous (everyone-at-the-same-time-zone) and asynchronous (Trello, Slack, etc.) communication.[25,26]

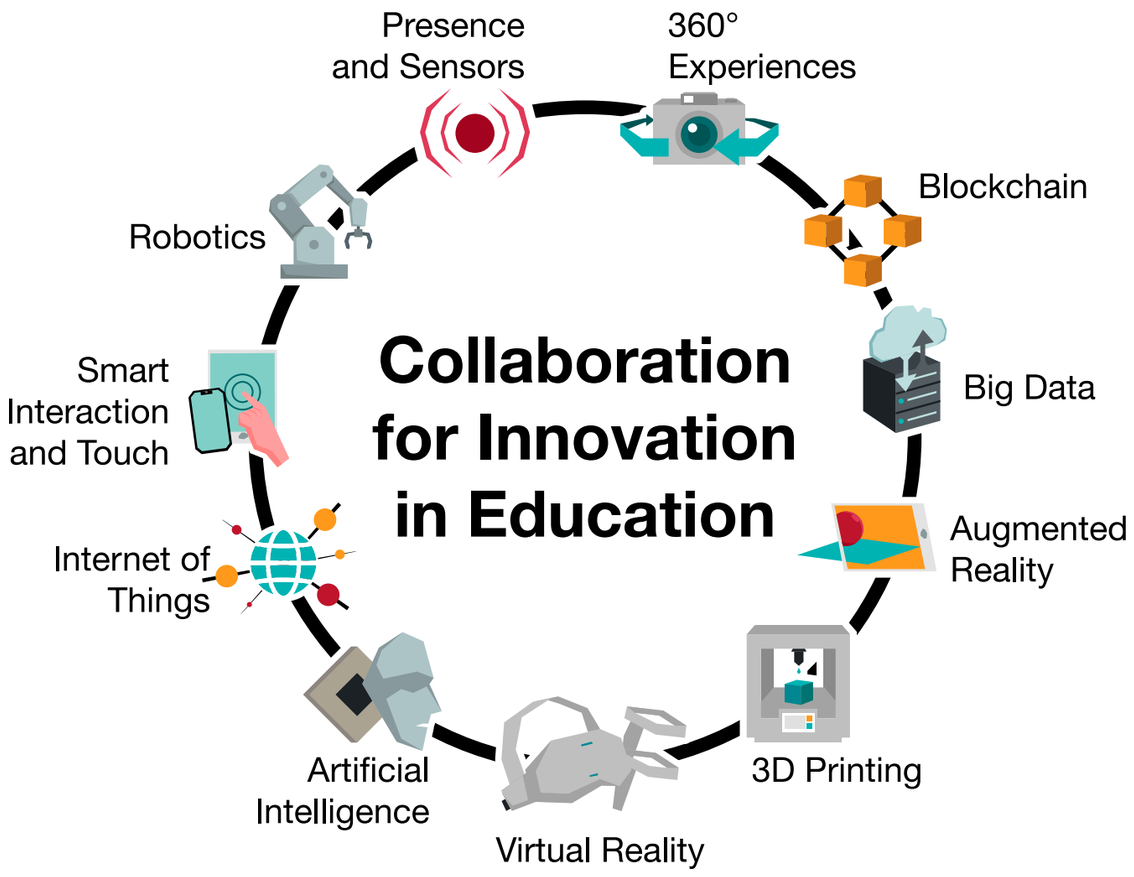
**Buffer encourages its employees to talk openly and share experiences regarding therapy and mental health medication, and strives to build trust.**

### Key Case Study: Ultra Testing and Autism

Ultra Testing, a New York-based software start-up, has a staff of 60, 75% of whom are on the autism spectrum. By creating a working environment that welcomes neurodiverse employees, Ultra Testing not only understands the importance of accommodating people with different needs but also turned neurodiversity into a competitive advantage. According to co-founder and CEO Rajesh Anandan, individuals on the autism spectrum are more likely to have strengths around pattern recognition, logical reasoning ability and enhanced focus, traits that computer engineering or quality assurance employers seek.[27]

Future discussion around inclusivity in the workplace and the work ecosystem overall will benefit from the consideration of people's natural talents rather than trying to improve or introduce skills that they are lacking.

# Skills, knowledge and capability




© *Utrecht University*

As the world of work demands more diverse digital and human skills, understanding, anticipating and meeting new skill needs will be key to learning in the workplace. Part of this will involve breaking away from traditional, front-loaded accreditation and siloed certificates, to a system with lifelong learning at its core.[28] As an example, Ricoh Digital Services has removed the historic requirement of needing a degree to apply for positions. Today, the opportunities and frameworks for learning are vast, with free and paid online courses and programmes available. This has given Ricoh Digital Services the confidence, for the first time, to take on an employee directly from high school.

New learning methods and partnerships can keep employees motivated and engaged as they grow and make progress, and helps people to shift from being specialists to generalists. By taking on different tasks, changing roles and switching between multiple areas of responsibility, individuals can also enjoy variety and collaborative opportunities throughout their careers.

**Key Case Study: Utrecht University and Ricoh**

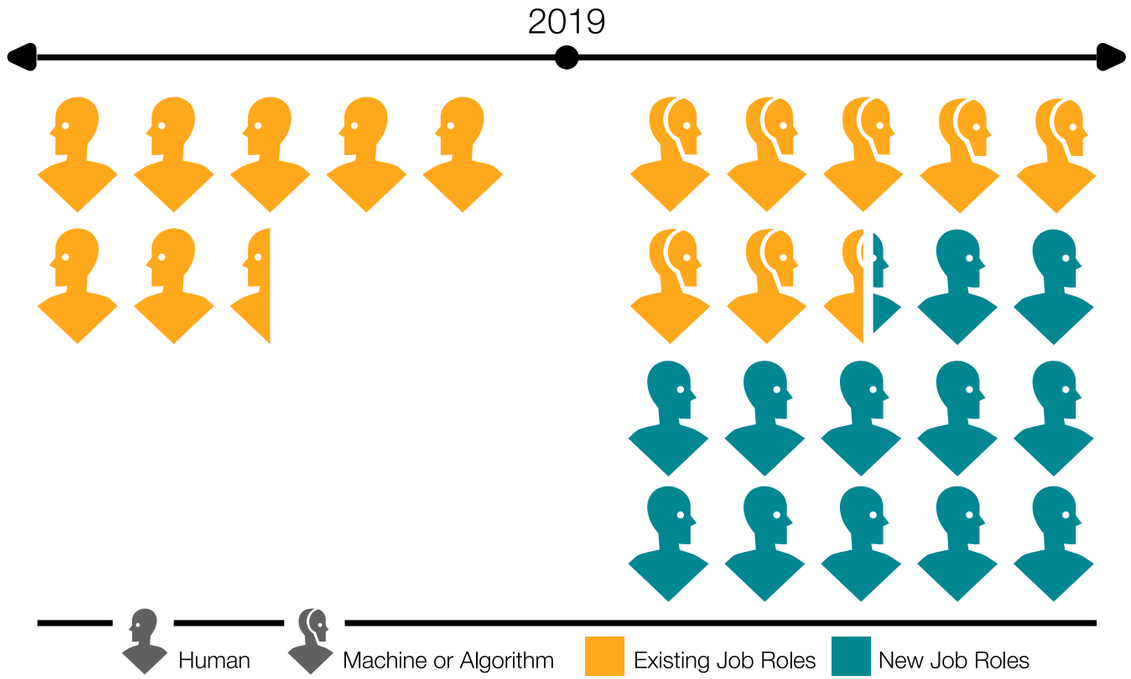
Utrecht University partnered with Ricoh to develop a Teaching and Learning Lab to test the latest innovations in learning, develop applications and measure their impact. This works beyond blended learning – a method of teaching through a mixture of classroom-based, online and self-guided techniques. The lab utilises the latest technology and modular spatial design to rethink the way students interact and collaborate. It also uses technological solutions such as internet-connected whiteboards, devices and applications to promote more physical interactions, transforming lecturers into facilitators and curators of knowledge, information and skills. Utrecht University is also using the lab to pilot new ways of distance learning (for example, medical students in the Netherlands being taught by a surgeon in Japan), distant collaboration between students and universities, and to bridge the gap between workplaces and academic environments. For example, by testing workplace productivity tools such as Ricoh Intelligent Workplace in lab spaces.[29,30,31]

# Setting the future skills agenda

Advances in technology, and how humans and machines interface, will reveal some of the stark ways in which people will have to evolve their skills.[32] According to some World Economic Forum estimates, 75 million job roles may be disrupted by machines and algorithms over the next three years. While on the face of it, this presents a great challenge for workers, it also presents a great opportunity. The same report estimates that 133 million new job roles will emerge during the same period.[33]

General Assembly, an education organisation with 20 campuses around the world and an alumni body of more than 40,000 graduates, provides classroom and online programmes that help people transform their careers through upskilling and reskilling. The organisation's curriculum is informed by an ongoing conversation with employers about the skills they believe their workforce will need in the future, highlighting the importance of a broader, coordinated approach between industries, academia and workers to tackle the future challenges and opportunities of the new skill landscape.[34]

These emerging jobs will require skills that are both traditional and digital, responding to the increasing requirements set by technological advances and also human expectation. Emotional intelligence, creativity, critical thinking and social awareness are all increasing in importance. The World Economic Forum research suggests that some of the key emerging skills for the coming years will include analytical thinking, innovation, creativity, originality, leadership and reasoning.




**75 million job roles may be disrupted by machines and algorithms over the next three years. However an estimated 133 million new job roles will emerge during the same period.**

*Source: World Economic Forum*

Across almost every sector, people are a business' most valuable asset. Organisations should consider carefully how workspaces and working methods respond to individuals' needs and working styles. Each generation has faced different challenges as technology has evolved, but the need for a responsive and accommodating workplace remains the same.

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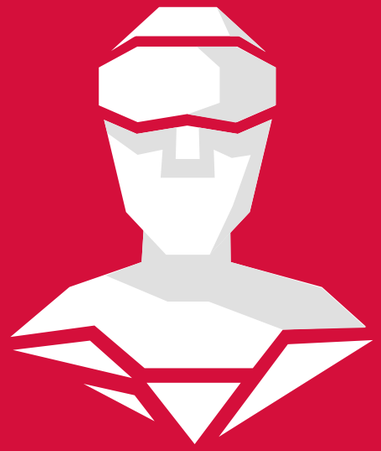
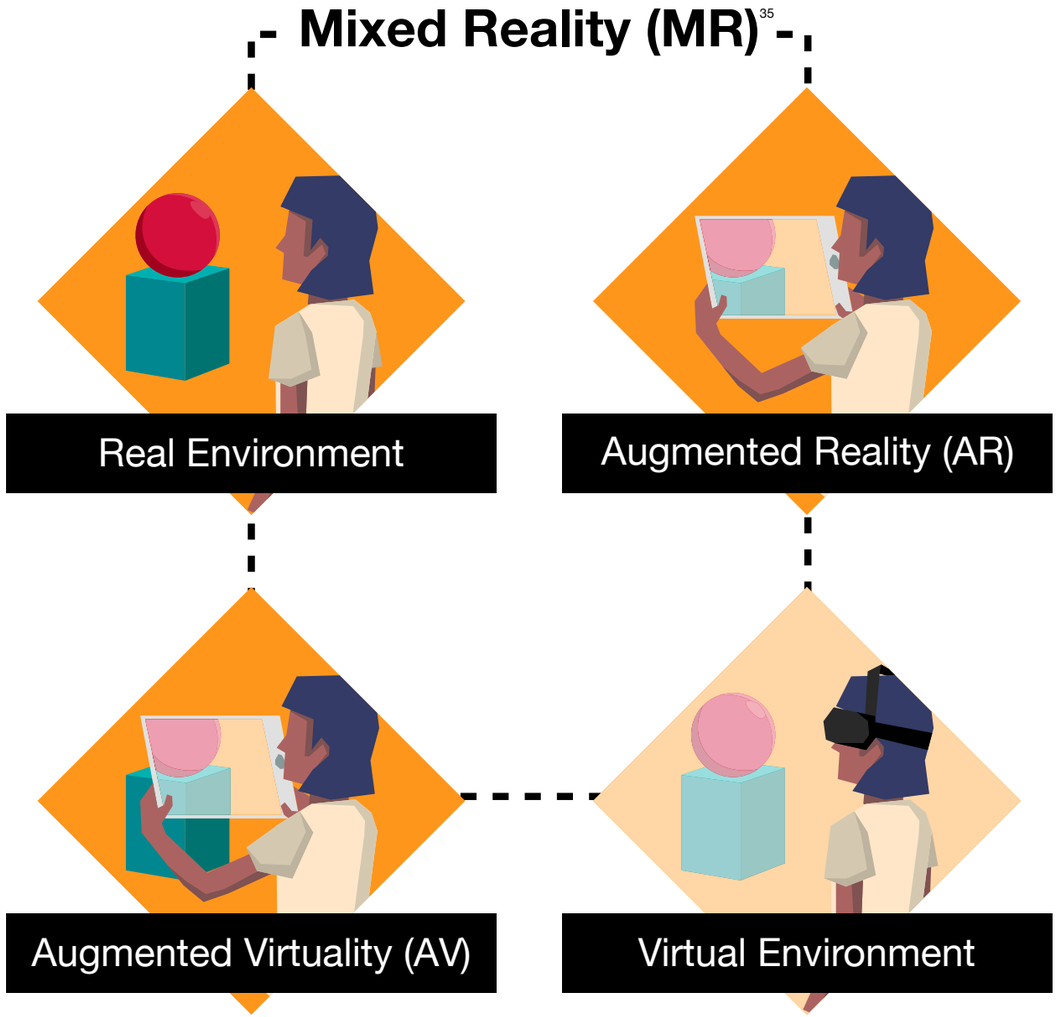


# The Human-Machine Interface

Humans have worked with technology for millennia. This is not the first time that innovations in technology have radically changed the way we work. The first industrial revolution, at the end of the 18th century, saw water and steam provide powerful mechanised production. The second industrial revolution used electricity to deliver mass production. While the third industrial revolution across the 20th century combined electronics and information technology to enable computing, automate production and shrink the world through communication.

The plethora of digital interfaces between humans and these new technologies – from tablets, to virtual reality (VR) headgear and wearables – mark the beginning of further changes. Boundaries between humans and technology will become more blurred and seamless as the fourth industrial revolution – one based on machine intelligence – matures. Workplaces are changing as employers continue to embrace new digital tools to increase productivity, improve the quality of work and to enhance the user experience.

# Augmenting the human




Human senses and physical abilities are being augmented through the proliferation of new technologies. These interfaces overlay virtual elements on to the real world, using data and machine intelligence to enhance human capabilities. A spectrum of mixed reality (MR) is emerging.

Smart wearable technologies and exoskeletons are pushing the boundaries of human ability, allowing work to be carried out more safely and efficiently, and with a much reduced margin for error. Exoskeletons – a form of robotic suit or armour – are highly suitable for repetitive tasks that require physical strength and endurance. Ford Motor Company introduced weight-supporting vests across a number of its assembly lines, where workers lift their arms an average of 4,600 times a day to perform overhead tasks.[36] Manufactured by Ekso Bionics, the vests provide 5-15lbs of lift assistance per arm.[37] As a result, Ford has hugely increased productivity while minimising the risk of staff fatigue, injury or discomfort.[38]

Our sensory capabilities, most commonly hearing and vision, are also being augmented. Connected hearables and voice-controlled wearables allow hands-free access to information as well as triggering an array of actions via the Internet of Things (IoT). However, these audio technologies have not yet reached their full potential. Future advancements will mean that our interactions will become more conversational, personalised and convenient. For example, the seamless detection and interpretation of human speech in real-time will enable more sophisticated, technical, bilateral conversation across multiple languages. Currently, Google's Assistant Google Home supports only 13 languages[39] and Amazon's Alexa supports seven languages.[40]

Numerous augmented sensory capabilities are being brought together to build a more sophisticated augmented reality (AR). For example, smart headsets or smart glasses introduce visual information into an employee's line of sight, while at the same time an audio instruction can be given. Incorporating bone-conducting earphones allow users to remain aware of their external surroundings while listening to audio, transmitting sound by vibrating the cheek-bone and hence bypassing the outer and inner ear. Such devices, or combinations of devices, can also respond to voice commands and gestures.

Google has developed a second edition of its smart glasses, Google Glass Enterprise Edition 2. The first edition, announced in 2012, was withdrawn in 2015 due to limited product success. Since then, Google has focused attention on a new version designed for use in the workplace, targeting the growing market for wearables in industries such as manufacturing, logistics and healthcare. The solution helps employees stay focused by removing distraction and using voice commands, improves accuracy by giving access to guidance and instructions, and enables collaboration in real-time with co-workers.[41]

There are a growing number of examples of successful application of smart glasses in the workplace. Boeing's engineering team piloted an AR solution, which used Glass Enterprise Edition and Skylight enterprise software from Upskill, to wire their new airplanes. The solution gives technicians the instructions they need in their viewfinder, whereas previously they needed to use a laptop. This solution has cut wiring production time by 25% and lowered error rates to nearly zero.[42]

*© Google*

### Key Case Study: DHL, Ricoh and Google Glass

Most warehouses in the developed world still use a pick-by-paper approach in their supply chain operations, which is relatively slow and prone to errors. In 2015, DHL tested a hands-free AR solution with innovation partner Ricoh, utilising Google Glass and Ubimax's interface. This hardware solution known as 'vision picking' has a heads-up display, voice recognition capability and hands-free barcode scanning. Due to the success of the pilot, DHL now uses smart glasses in most regions and will be one of the first customers worldwide of the second generation of Glass Enterprise Edition.[43] DHL says that 'vision picking' has resulted in an average increase of 15% in picking productivity.[44]

Smart headsets and audibles are highly effective in industrial environments. They greatly reduce the time required for employees to access information or instructions, while allowing the user to focus on core tasks and maintaining awareness of potential safety risks. However, organisations need to think carefully about how such technologies are implemented. For example, employees could interpret the introduction of these new technologies as a way for employers to monitor and track individual performance and productivity, or as a means to micromanage.

# Creating real-life experiences

Immersive environments use VR to create experiences that simulate real life. VR immerses the user in highly realistic but entirely artificial digital worlds. In the workplace, this technology has been shown to be highly effective for training purposes, to help users prepare for real-life situations. Founded in 2015, the company STRIVR offers a VR-based immersive learning and development platform. Having tested an early prototype with Stanford University's football team, the technology company now works with multinationals. In some cases, STRIVR's clients have seen training times reduce by 40% when compared with their previous methods such as using photos or videos, and customer satisfaction scores increase by 10% in six months.[45,46]

The ability to create fully immersive environments is rapidly progressing. For example, the use of haptic gloves allows the wearer to perceive the temperature, weight and size of virtual objects. Employees at Nissan, the Japanese auto manufacturer, are using HaptX gloves to manipulate and interact with 3D models virtually. This has enabled immersive design reviews that would previously require costly physical prototypes.[47]

As the technology advances further, hyper-real digital simulation will only strengthen the user's emotional engagement with virtual environments. The same can be said for the way in which we interact with artificial intelligence (AI). Recent developments in this space include Google's digital voice assistant, which can carry out 'real-world' tasks such as booking an appointment with a hairdresser over the phone, without the attendant realising they are conversing with a machine.[48] Going a step further, Soul Machines has collaborated with IBM Watson to create lifelike, emotionally responsive AI-powered 'artificial humans' with personality and character.[49] One of the most promising use cases is 'face to face' interactions with customers in industries such as banking, utilities, technology and healthcare. This will enable organisations to communicate with customers more efficiently at scale.

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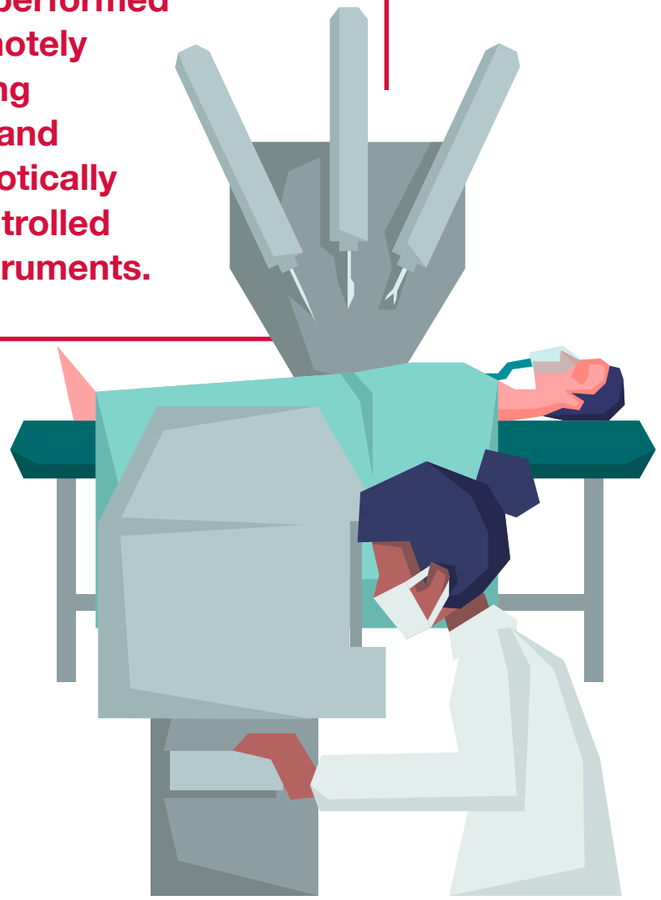
*© Patrick Schneider*

# Driving productivity

SoftBank Group Corp. is continuing to develop an AI-powered humanoid robot, Pepper, having secured backing from investors including Apple Inc. and Goldman Sachs.[50] Pepper can engage with people through conversation and touch screen, and can be used in the workplace to greet customers, provide administrative services and act as a sales associate in multiple languages.[51] Robots will likely become more common in the workplace, as employers look to drive efficiency gains, boost productivity and capture valuable data. A 2018 study of robots at work looked at the relationship between industrial robots and economic outcomes across much of the developed world. It found that increased use of industrial robots has led to a 15% rise in economy-wide productivity growth.[52]

Organisations are also welcoming a variety of new cloud-based applications that enable more collaborative, productive, agile and mobile work. These interfaces range from visual project and task management tools such as Trello, knowledge management tools such as Evernote, communication tools such as Cisco Webex and collaboration tools such as Slack.[53] These tools enable teams to collaborate and communicate around the world, efficiently sharing information and working simultaneously on tasks. The growth of these tools is significant. For example, since its formation in 2013, Slack now has around 10 million daily active users. This growth is expected to continue, with research and advisory firm Gartner projecting that worldwide public cloud service revenue will increase exponentially through to 2022.[54] Additionally, these tools have shifted towards being interoperable, seeking to garner further efficiency and collaboration, rather than trying to be all things to all users.

**Complex surgery can be performed remotely using 5G and robotically controlled instruments.**



Human-to-machine technologies can overcome geographical barriers to access knowledge and skills, particularly those that are in short supply. For instance, complex surgery can be performed remotely using robotically controlled instruments. Visual, auditory, tactile and other real-time information is provided electronically to a surgeon located elsewhere. Until recently, the challenge has been around latency, or the lag that occurs in the transmission of data over a network. However, in 2019, a Chinese surgeon successfully performed brain surgery on a patient with Parkinson's disease 3,000km away, using a 5G connection.[55]

> "Collaboration between human and machine will enrich our work lives and ultimately make us happier to turn up to our jobs every day. Technology and smarter workflows will automate the more tedious and monotonous tasks and free us up to do more valuable, fulfilling and interesting roles."

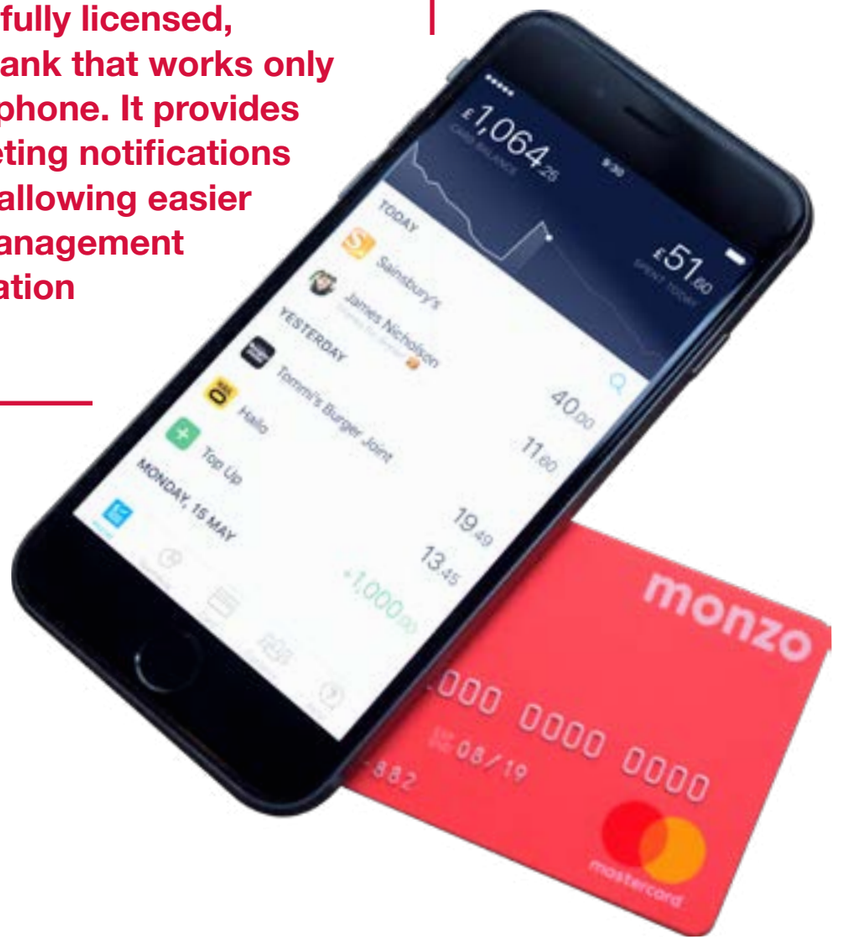
**Edward Gower-Isaac**
Vice President of Business Process Services and Application Services, Ricoh Europe

# Designed for humans

Successful human-machine interfaces are designed with humans in mind. In the workplace, machine learning and AI can contextualise or personalise information for employees. Blue Collar AI™ uses an AI algorithm and connected devices through IoT to extract previously inaccessible data for analysis, curate the relevant information and deliver instructions customised to the individual to improve performance and eliminate error.[56] This provides the employee with the right information at the right time, and via the most appropriate device. It provides employees with an 'intelligent personal agent' or trainer and differs from the traditional top-down approach driven by predefined workflow optimisation.

The UK fintech disrupter Monzo is a fully licensed, regulated bank that works only via a smartphone. Formed in 2015, it has more than three million customers.[57] Its customer popularity is underpinned by an ambition to deliver simple, intuitive interfaces and functionality that fits with users' lifestyles. The Monzo application provides auto-budgeting notifications and alerts, allowing easier financial management and information on-the-go. Monzo combines this with an agile design thinking approach, including holding regular talks and collaborative events to openly discuss issues and ambitions with its customers.

**Monzo is a fully licensed, regulated bank that works only via a smartphone. It provides auto-budgeting notifications and alerts, allowing easier financial management and information on-the-go.**




*© Monzo*

# Health and wellbeing

**VR can be a solution that immerses individuals in a calming experience designed to boost individual wellbeing.**

Healthcare apps, smart wearables and other technology interfaces are powerful tools to manage health, receive advice and support, and incentivise healthy behaviours. For instance, many large organisations now offer remote medical services that deliver consultations by video or telephone. New interfaces are also creating valuable sources of workforce health intelligence for insurance companies and employers. Fitness and activity trackers, tracking physical activity, sleep, heart rate and other critical metrics, are the most popular wearable devices.[58] These are not only incentivising healthy behaviour but gathering vast health data sets that can inform organisational health policies and programmes.

VR can be used as a mechanism to help employees relax or build self-esteem. Happinss (sic) is a VR solution that immerses individuals in a calming, imaginative and introspective experience designed to boost individual wellbeing.[59] Established by a team of developers, psychologists and neurologists based in San Jose, California, it combines visualisation of natural landscapes with therapeutic music and guided meditations.[60]

While MR technologies could be used to create positive experiences for health, there may be concerns about 'screen time' and negative impacts on mental health. The evidence base for such concerns is contested.[61] Research by the University of Oxford in the UK has found little evidence of a relationship between screen time and wellbeing in adolescents. Based on data from 17,000 teenagers, the study casts some doubt on the widely held perception that spending time online, gaming or watching TV can damage young people's mental health.[62] Meanwhile, South Korea has a 'shut down' law, a regulation put in place in 2011 to prevent children under 16 from playing online video games between midnight and 6am.

# Data and privacy

The propagation of technologies across MR will likely trouble some employees and trade unions, concerned with issues of data ownership and privacy. Technologies can gather unimaginable volumes of data. For example, VR headsets can gather information about users' locations, physical movements and emotional responses to virtual experiences. This data is valuable for organisations and increasingly important to competitiveness. A 2018 study by IBM and Forrester Consulting found that 58% of firms acknowledge that data and analytics are very important to business competitiveness and that their importance is going to increase over the next few years.[63]

Some jurisdictions around the world have regulations to protect consumer and personal data. The European Union (EU) has the General Data Protection Regulation (GDPR) which aims to create more consistent protection across EU member states. This includes requiring the consent of subjects for data processing and anonymising collected data to protect individual privacy. London's Heathrow Airport is introducing facial recognition on a trial basis, bound by GDPR rules to not sell-on the data.[64]

The use of facial recognition technology is also causing much debate around privacy. One of the first legal challenges to the use of facial recognition by police was brought forward in May 2019 in the UK, on the grounds that it is a breach of the Human Rights Act 1998.[65] While the High Court ultimately deemed its use to be legal, the civil rights group Liberty claimed that current use of facial recognition in public places is equivalent to the taking of DNA or fingerprints without that individual's consent.[66] Transparency and regulation will provide some reassurances to the public. The city of San Francisco, on the other hand, has banned facial recognition technology until regulations are in place, due to widespread objections by its citizens.[67]

Organisations that do not effectively manage data privacy issues expose themselves to reputational and financial risk. Under the new GDPR regulations, companies that fail to comply with certain requirements may be fined 2-4% of their total global annual turnover or €10m-20m, whichever is greater.[68] Despite these risks, the 2018 annual report of The Global Privacy Enforcement Network, an informal network of members from OECD countries, found that only 46% of the 287 organisations assessed had adequate processes in place to assess the risks associated with new products, services, technologies and business models.[69]

# Cyber security

While the explosion of machine interfaces is creating positive outcomes such as increased productivity and collaboration, it is also creating new security risks and vulnerabilities as more and more devices capture and store sensitive data about our activities. This is evidenced by the growing global cyber security market, likely to expand at a compound annual growth rate of 11% between 2019 and 2025.[70] Recognising the scale and global nature of the cyber security challenge, the World Economic Forum has set up a Centre for Cybersecurity. This network of governments, businesses, academia and international organisations develops initiatives and offers a global, neutral, public platform to enhance and consolidate security and develop global standards.[71]

# What is next for human-machine interfaces?

It is not just humans and machines that will interface in the future. Massachusetts Institute of Technology (MIT) is developing the concept of bio-interaction design, allowing digital interaction with living plant systems. Plants have bio-electrical signals and response mechanisms that make them very similar to our electronic devices. This means that plants can integrate both sensing and display capabilities, hence making them bio-directional in nature. MIT has used electrodes to pick up the weak bio-electrical signals produced by plants in response to light and other environment changes, to trigger them to move closer or further away from the light sources. The researchers suggest this manipulation of leaves or stems could communicate notifications or messages to those in proximity, essentially turning a plant into a digital display.[72] Currently, our interactions are centred around screens that require our full attention and can induce cognitive overload.[73] Interacting with plants is subtle and would bring interaction back into the natural world.

**Plants can integrate sensing and display capabilities, and the manipulation of leaves or stems could communicate notifications and turn a plant into a digital display.**

New technology is going to have a significant impact on how we all work, and businesses are going to have to respond rapidly to stay ahead. Flexible approaches as to how things are done in the future will be needed. Businesses should consider how they can swiftly and effectively evaluate the opportunities these technologies afford them, in order to maintain their relevance and competitiveness.

# 03

# The Machine and Augmented Intelligence Future

The world of work in the 21st century is being remoulded by a fusion of technologies that are blurring the lines between the physical and digital. New innovations are evolving rapidly, and the pace of change shows no sign of abating.

This fourth industrial revolution eclipses previous revolutions for several reasons. Current breakthroughs have no historical precedent in terms of impact or scale. When compared with previous industrial revolutions, the fourth is evolving at an exponential rather than linear rate. This is no more acute than in the realm of cyber technology. Today, entire systems of production, management and governance have the potential to be disrupted.[74]

As in the past, the benefits of an industrial revolution will not be felt by everyone. Furthermore, the transition will not be free of glitches or friction. In 2018, Amazon scrapped an AI recruiting tool that was shown to be biased against women.[75] In Las Vegas, a Culinary Workers Union threatened to put 50,000 of its members on strike unless employers signed up to protection against automation. The workers demanded six months' severance pay for anyone who loses their job to a machine.[76] In this febrile context, cyber innovation needs to be explored and understood in greater detail.

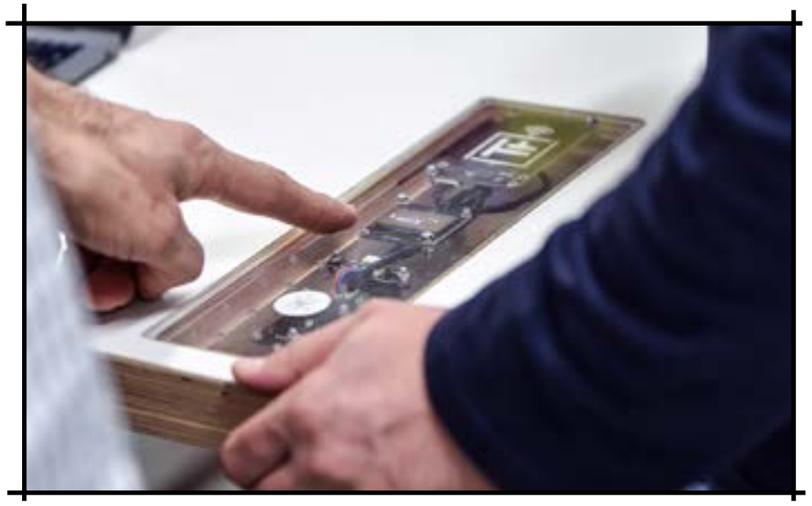
# Internet of Things

The Internet of Things (IoT) – a vast network of objects that are connected to the internet – provides a key foundation to the fourth industrial revolution. A mobile phone in your pocket can now control the smart LEDs in your home. However, the complexities and opportunities grow when IoT also includes connected cars and smart traffic lights. At scale, the impacts can be huge.

The number of internet-enabled devices has grown in the past decade, reaching nearly 30 billion objects that now generate five quintillion bytes of data every day. To grasp that number, if every byte was a penny, and you stacked the pennies into a cube, just one quintillion pennies would equal the size of Mount Everest.

However, some studies have estimated that less than half of structured data are actively used in decision making, and less than 1% of unstructured data are analysed or used at all.[77]

Still, there are many examples of where IoT is being used. US railway company Union Pacific uses track sensors to monitor the integrity of train wheels, prevent derailments and focus maintenance work on where it is most needed. Car insurance providers are asking customers to install a geo-locator in their car to monitor their mileage and price premiums more accurately.[78] These highly personalised insurance products, which take into account distance covered, average speed and frequency of braking, would have required an army of insurance actuaries to deliver in years past.



*Arup's IoT Desk © Daniel Imade/Arup*

Low-cost networks and fast web connectivity, combined with open-source software, allow employees to control their immediate working environment. This helps to optimise personal comfort levels, individual performance and productivity.

### Key Case Study: IoT Desk

Arup's IoT Desk communicates with its surrounding environment giving its users the option to control – through internet protocols – lighting, temperature, fan coil units and other aspects of building services that have a direct impact on their levels of comfort, wellbeing and performance. The IoT Desk has focused discussions around how to modernise building services design and controls, to enable commercial buildings to catch up with technology.

Synergistic advances in micro-sensors and wireless technologies will shrink IoT devices and systems, enabling them to become embedded and ubiquitous. Everything could be tracked, monitored and analysed in order to improve economic, societal or environmental outcomes. This will be scaled through cloud computing and AI.

# Cloud computing

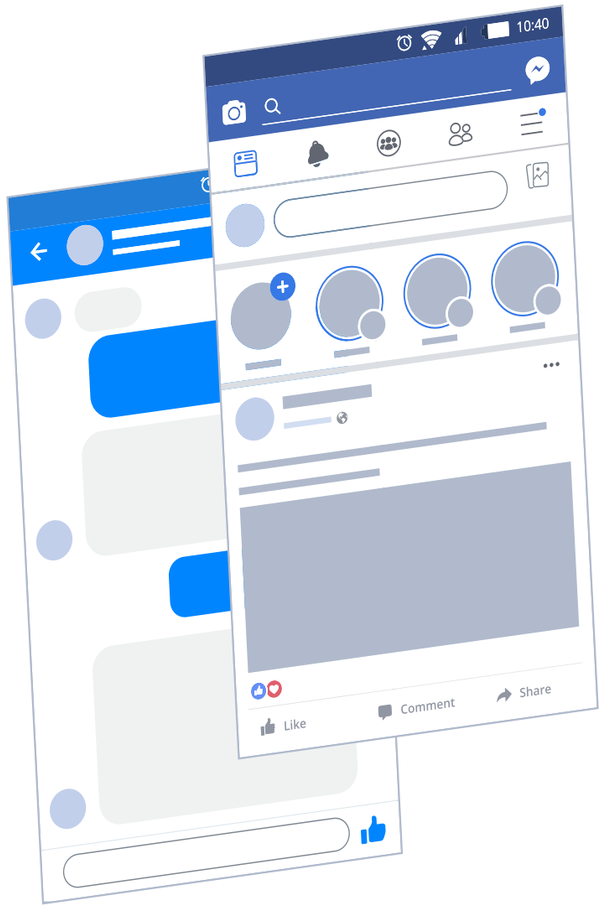
The third industrial revolution meant that many workers are familiar with sitting at desks, working with data, with a computer to hand that does the processing in order to generate information of value. But being tied to a desk is no longer desirable, and one's data sources are increasingly disparate and scattered. Cloud computing bundles a range of computing services, including processing, storage, databases, networking, software and analytics, and delivers these to the user through servers over the internet.[79] This enables a much more flexible approach to resource access and usage. It passes the benefits of economies of scale to the customer or client organisation. It is also faster and more responsive to innovation.

By only paying for the processing capacity they require, businesses have been reducing their operating costs. In addition, cloud computing enables flexible working and connectivity for workers, irrespective of location. The combination of a sensor that autonomously captures data constantly, and a worker that can access captured data remotely, is driving massive efficiencies across most economic sectors. Meanwhile, the processing of information and insight will increasingly be carried out by the machines themselves.

> "If we're currently in the information age, the next evolution will be the collaboration age. The focus will be on making it easier for people, organisations and technology to work together. It will be the end of the closed ecosystem – technology will need to work seamlessly and intuitively across devices, platforms and providers."

**Ed Hamilton**
Vice President of Communication Services, Ricoh Europe

# Artificial Intelligence



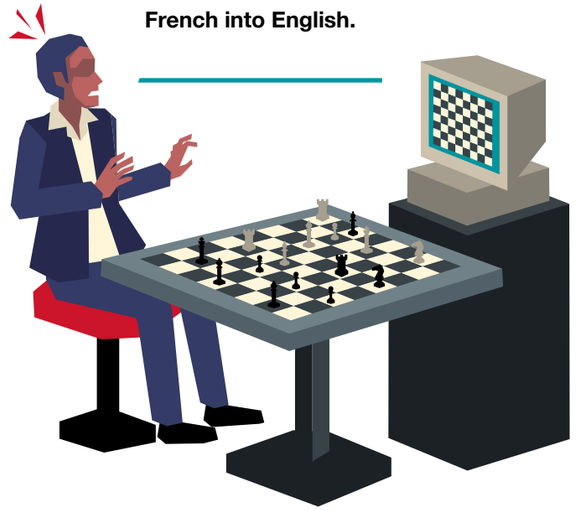

Despite being a term coined in the middle of the third industrial revolution, artificial intelligence (AI) I remains one of the most hotly anticipated and eagerly talked-about technologies lacking definition. This could be in part because as John McCarthy, who coined the term in 1956 said, “as soon as it works, no one calls it AI anymore”.[80]

Google Search and Facebook’s Newsfeed can be described as AI; both use sophisticated methods for ranking pages and identifying results and content tailored to the user. Automatic braking systems – standard in cars for decades – are AI systems that calculate when the anti-lock brakes should kick in as a human driver attempts an emergency stop. The world’s best players of chess, checkers, Scrabble, backgammon, Othello, Go and Jeopardy are all AI systems.

Despite the multitude of applications, AI remains in its relative infancy and is used as a broad concept. One way to gain an understanding of AI is to think about it in terms of level of sophistication, or calibre:

1. Artificial Narrow Intelligence (ANI): This is an AI that specialises in a single area or task. This AI is hugely productive, but sits in its own solitary silo. Just about every AI application we use in the workplace today is an ANI system.

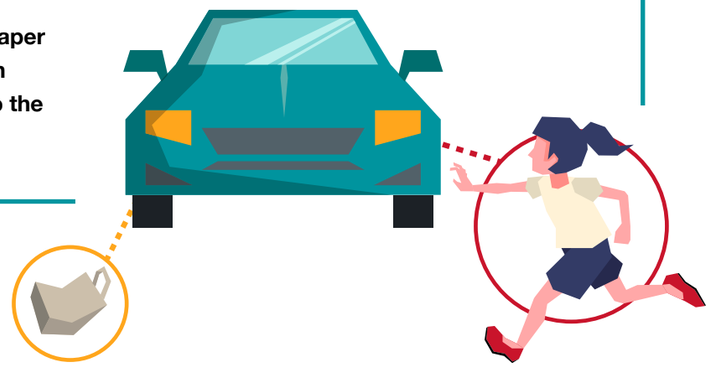
**Example: AI technology that can beat the world chess champion, but cannot translate French into English.**



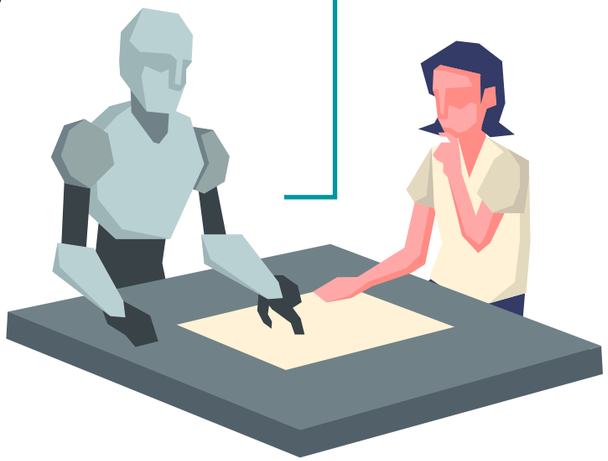
**2.** Artificial General Intelligence (AGI): This is seen as an AI reaching a human level of ability, i.e. a machine that can perform multiple intellectual tasks, like a human being. Cognitive computing is another term used to describe this ability. AGIs are much harder to develop than ANIs, and many computer scientists argue that we are yet to achieve this level of sophistication. To simulate human thought processes, self-learning algorithms use data mining, pattern recognition and natural language processing.

Autonomous vehicle systems currently being trialled are pushing the boundaries. They have to interpret physical and visual inputs, make instantaneous judgements and perform multiple actions simultaneously. AGIs offer a clear and compelling opportunity to replace the mundane tasks performed by humans, such as menial factory work or driving. However, few have reached the mainstream, and the legislative environment has not been established to define who is responsible when the AI is left to act independently.

**Example: An AI system in an autonomous vehicle that simultaneously controls the vehicle's speed, while distinguishing between a paper bag blowing across its path and a child running out into the street.**



**3.** Artificial Super Intelligence (ASI): Defined as an intellect that is much smarter than the best human brains in every field or domain, including scientific creativity, wisdom and social interaction. Given the scaling ability of computer technology, ASI could one day range from a computer that is just a little smarter than a human, to one that is trillions of times smarter. While ASI is still seen as science fiction, it informs much of the debate around AI challenges in the workplace and broader existential concepts for AI as a whole. Still, the exponential growth of computing power – driven by developments in quantum computing, for instance – leads many to see ASI as an inevitability rather than a possibility.



Today's world of work is one that runs on ANI.[81] ANI systems can operate smart and autonomous devices or machines that play a key role in boosting productivity, leaving humans to use their skills as supervisors, coordinators or decision-makers. The benefits this can deliver are already significant at this early stage.

### Key Case Study: Warehouse Robotics

Cainiao, a Chinese logistics firm owned by Alibaba, launched the country's biggest automated warehouse in 2018. More than 700 automated robots pick up and transport parcels throughout a vast warehouse. The routes they take and the organisation of the stock are not defined. Instead, an AI system identifies the most efficient paths and structures on a minute-by-minute basis and as orders come in. Due to this combination of IoT, AI and automation, the efficiency gains have seen the warehouse process 50% more orders than previous systems.[82]


*© Cainiao*

The economic potential of AI is immense. A 2017 PwC study forecasts that AI will add more than US$15 trillion to the world economy by 2030.[83] However, the number of jobs AI will replace, change or create depends on how new cyber-human interfaces develop and how human skills evolve.[84]

At the same time, AI's impact will not be felt evenly; some sectors of the economy will find suitable roles for AI before others. Nor will AI be infallible. The financial industry has been one of the earliest adopters. But as was seen in the 2010 Flash Crash, the impact can be negative and severe. When an ANI program reacted incorrectly to an unexpected situation it did not understand, it caused the US stock market to briefly plummet. It took US$1 trillion of market value with it and was only prevented from going further when human traders intervened.[85]

# Machine learning

*© Christian Wiediger*

The way in which AI learns illustrates the challenges that AI's developers face. Machine learning is the ability for AI to learn and accomplish a given task without explicit programming or logic. Both humans and AI are pattern-seeking machines, whether it is the human marketing manager who can spot the correlation between an active lifestyle choice and a new brand of energy drink, or the Amazon recommendation algorithm connecting one purchase preference with another.

For AI, machine learning comes by having these connections demonstrated thousands or millions of times, then applying the findings through trial and error. Studies have shown how a supervised deep-learning algorithm achieves acceptable accuracy and understanding with around 5,000 labelled examples per category. However, as many as 10 million labelled examples are required for that same algorithm to reach human-level performance.[86] One of the many roadblocks in AI's future development is the limited availability of accurately labelled, large datasets. This explains the proliferation of secure online log-in procedures that require human users to identify objects within an image. Before AI can take our jobs, there is a lot of work to be done in teaching it what a job even is.

# Augmented intelligence

Much of the work in advanced nations is dominated by the service industries. This knowledge-based economy is rapidly developing and depends on a combination of data, knowledge, creative thinking and complex skill sets.[87] The extent to which technological innovation and AI, in particular, will disrupt work remains uncertain. Some argue the extent to which it will eliminate jobs has been exaggerated in the media.[88]

As demonstrated in the case studies, and in each of the previous industrial revolutions, repetitive, menial or inefficient tasks have been reconciled, while new ways of work with technology have provided greater opportunity for productive work. Augmented intelligence is a way to conceptualise the future of work, focused on technology's assistive role, emphasising the fact that cognitive technology is designed to enhance human intelligence rather than replace it.

Augmented intelligence provides a way to address systemic problems in novel and inventive ways, particularly when data and processing power are trained on a clear task, agenda or desired output.

### Key Case Study: Scheduling the World Cup

United 2026 was a successful bid to co-host the 2026 World Cup, bringing together Canada, Mexico and the United States. This will be the first World Cup to be hosted in three countries and the first-ever 48 team tournament. The group stage alone will see 48 matches played in 16 different cities. The scheduling of matches is a significant challenge, as each team must have three days of rest between matches, while the entire tournament will be completed in just 13 days. Minimising travel for the teams is desirable from both a practical and environmental standpoint. Arup was tasked to develop a genetic algorithm to come up with an optimal game schedule. The approach is one based on natural selection, with a human inputting a robust dataset that captured a multitude of drivers. Previously, this exercise would have taken more than a month to complete. But Arup's algorithm devised an optimum schedule in just two hours. Environmental modelling showed that the algorithm's solution provided up to 90% reductions in greenhouse gas emissions, when compared against a randomised workable schedule. FIFA cited the algorithm as a reason it awarded the tournament to United 2026.

“Humans are, and will continue to be, vital to the future of work – technology is not a magic bullet for business success. Organisations still need to make the right decisions and implement the right technology to work smarter, more effectively and suit their business needs.”

**Edward Gower-Isaac**
Vice President of Business Process Services and Application Services, Ricoh Europe

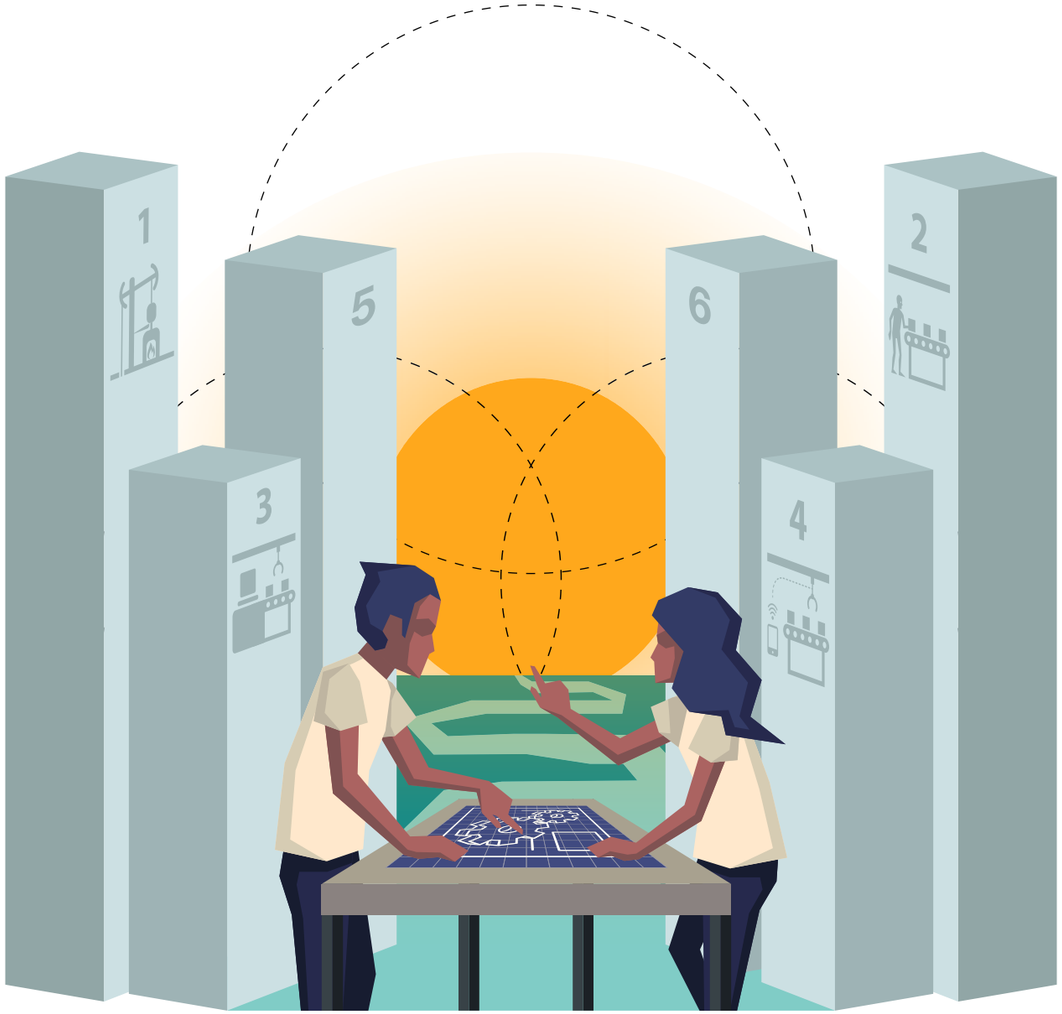
*Flooding in Port Arthur, Texas on August 31st 2017. An AI application that combined satellite imagery with object detection software enabled rescue workers to identify safe access and escape routes.© Staff Sgt. Daniel Martinez*

The global climate crisis represents a challenge the likes of which humanity has not yet faced. The scale of the challenge will require new ways of working and a much deeper insight into the complexity of earth’s interconnected systems – our atmosphere, oceans and rivers, biodiversity and natural carbon sinks. The opportunity for technology to help us mitigate the negative effects is very real. AI is already being used in work responding to natural disasters. In 2017, the aftermath of Hurricane Harvey in the southern states of the US saw flooded streets impede the work of rescue workers. Satellite imagery was processed by an AI with object detection abilities to identify safe access routes through the flooded city. As a result, rescue workers were able to work safely and with greater efficacy.[89]

AI and augmented intelligence can provide applications that help us work to address the root causes of climate change and to support the United Nations’ Sustainable Development Goals (SDGs). The McKinsey Global Institute has identified 160 AI programs in use or in development that have a clear non-commercial benefit to society. These range from computer vision to natural language processing and include case studies that map on to all 17 of the SDGs.[90]

In the context of greater focus by business and industry on corporate social responsibility and environmental, social and governance investment, cyber innovations will play an increasingly important assistive role.

# The importance of purpose




The fourth industrial revolution has the potential to be unlike anything we have known before in the workplace. Restrictions of geography, time, scale and synergy are all ebbing away. To be successful, however, the development of AI, machine learning and IoT must be integrated.[91]

Businesses, governments, citizens, consumers and investors all hold influence over how the future of work evolves. Decisive action is needed by governments, tech companies and organisations that oversee significant amounts of data. Legislation needs to be put in place to manage the transition and ensure that security and mutual benefits are guaranteed.

Technological innovation will continue to drive value creation in money terms, but what other aspects of value might society demand in the years ahead? University College London and the Institute for Innovation and Public Purpose (IIPP) have led much of the thinking around these questions. One of IIPP's key work programmes has been the development of a 'mission orientated industrial strategy' for the UK government, focused on solving big societal challenges, rather than short-term gains. This also recognises that implementing a new, government-wide approach to innovation, technology and new ways of working will require a different policy framework.[92]

The 21st century is being defined by the need to respond to deeply complex social, environmental and economic challenges. These problems require systemic, interconnected and urgent responses, building on insight from multiple perspectives and specialist domains. For example, poverty cannot be tackled without understanding the relationships between nutrition, infrastructure, governance, education and economics.

Today, we can see the technology, tools and processes coming forward that may well make it possible to tackle the key challenges of the 21st century.

The potential of AI and augmented intelligence has captured people's attention right from early sci-fi novels, through to the way we interact daily with tools such as virtual personal assistants on our smartphones. Businesses are keen to capitalise on the opportunities, while employees consider how best they can mitigate the risk of being replaced. The reality is that we all need to think critically about how we want to use these tools as a society. Businesses must ensure that we make the most of these opportunities during the fourth industrial revolution, and potentially shape an even better fifth industrial revolution, whatever form that may take.

# Conclusion

The future of work looks to be a challenging place. Geopolitical and environmental trends offer no signs of stability. There are answers, however. On 1 January 2016, the 17 United Nations' Sustainable Development Goals (SDGs) of the 2030 Agenda for Sustainable Development officially came into force. How the world responds over the next decade will define the century ahead.

The SDGs are a call for action by all players, in all countries, to achieve a range of fundamentally important social and environmental goals. Ending poverty must go hand-in-hand with strategies that build economic growth and prosperity. To remain relevant, all organisations that employ a workforce will need to contribute to the SDGs. Addressing social and environmental challenges are sure to become as important as financial performance. It may well be that financial performance will increasingly depend on the degree to which business are successful in meeting these wider challenges.

As people look to their work as an opportunity to find purpose and meaning, adding the SDGs to how we frame the value of work will enable us to achieve a triple bottom line.

The future of how we work will support individual needs and aspirations, enabling new generations to feel empowered in the workplace. Technology, and how we interface with our tools, will continue to enable us to be more effective and impactful in delivering the work we do. And technology itself will continue its evolution to augment and enrich just about every interaction we have and each task we face. With the correct collaborations and partnerships in place, the future of work is to be embraced.

# Glossary

## A

**Active Learning**
A method of learning which puts the active involvement of the participants at the forefront of the process. This learner-centred method can be activity - based, technology - and play - enabled, and can also involve group work.

**Agile Working**
Refers to the tools, processes, work settings and culture that allow people to complete tasks in a way that is most appropriate and effective for their own working standards. Agile working inherently focuses on the 'what' (guidelines of the task) instead of the 'how' (boundaries of how one achieves the task).

**Artificial General Intelligence (AGI)**
Artificial Intelligence (AI) that reaches a human-level of ability, i.e. a machine that can perform multiple intellectual tasks that a human being can. Cognitive computing is another term used to describe this ability.

**Artificial Intelligence (AI)**
The theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision-making and translation between languages.

**Artificial Narrow Intelligence (ANI)**
Artificial Intelligence (AI) that specialises in a single area or task. This AI is hugely productive, but sits in its own solitary silo. Just about every AI application we utilise in the workplace today is an ANI system.

**Artificial Super Intelligence (ASI)**
An intellect that is much smarter than the best human brains in every field or domain, including scientific creativity, wisdom and social interaction.

**Asynchronous Communication**
A situation in which two people communicate (exchange and consume information) without the requirement of both being present at the same exact moment in time (an e-mail, a message in Slack or Trello).

**Augmented intelligence**
An alternative conceptualisation of Artificial Intelligence (AI) that focuses on AI's assistive role and emphasises the fact that technology will augment rather than replace human intelligence and capability.

**Augmented Reality (AR)**
The blending of computer-generated elements across different sensory modes (visual, auditory, haptic, etc.) into real-world environments.

**Automation**
The use or introduction of automatic equipment or technology in a process or facility in order to control and monitor the production and delivery of goods and services.

## B

**Baby Boomers**
Also known as Boomers. The demographic cohort following the Silent Generation and preceding Generation X that is often defined as those individuals born between 1946 and 1964.

**Blended Learning**
Educational approach that combines online interaction methods and materials with traditional, face-to-face and classroom methods.

## C

**Cloud Computing**
The on-demand availability of computer system resources (especially data storage, management and processing) and computing power through a network of remote servers hosted on the internet rather than a local server or a personal computer.

**Co-creation**
Bringing different parties together (for example a group of different teams within an organisation or a company and a group of users) with the aim to jointly produce a mutually-beneficial outcome.

**Co-working**
A collaborative, agile and synergistic way of working that is based on mutual trust and involves the sharing of a workplace.

## F

**Flexible Working**
Way of working that allows employees to choose where and when they work. Working from home and flexible start and finish times are two examples of flexible working.

**Fourth industrial revolution**
Describes a series of social, political, cultural and economic upheavals that will unfold over the 21st century. These upheavals will be driven by a range of new technologies such as mobile supercomputing, intelligent robots, self-driving cars, neuro-technological brain enhancements and genetic editing and they will be characterised by the fusion of the physical, digital and biological worlds.

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| **Gen X** | Also known as Generation X. The demographic cohort following Baby Boomers and preceding Generation Y that is often defined as those individuals born between 1965 and 1980. |
| **Gen Y** | Also known as Generation Y or Millenials. The demographic cohort following Generation X and preceeding Generation Z that is often defined as those individuals born between 1981 and 1995. |
| **Gen Z** | Also known as Generation Z. The demographic cohort following Millenials that is often defined as those individuals born after 1996. |
| **Gig Economy** | A labour market characterised by the prevalence of short-term contracts or freelance work as opposed to permanent jobs. |
| **Haptics** | Any form of interaction involving touch. |
| **Internet of Things (IoT)** | The interconnection via the internet of computing devices embedded in everyday objects and other forms of hardware such as sensors, enabing them to send and receive data. These devices can communicate and interact with others over the internet and they can be remotely controlled and monitored. |
| **Lifelong Learning** | A learning method that is not confined to childhood or in the classroom but takes place throughout life and in a range of situations. |

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**Machine Learning (ML)**

The scientific study of algorithms and statistical models that computer systems use in order to perform a specific task effectively without using explicit instructions, relying on patterns and inference instead.

**Mixed Reality (MR)**

The merging of virtual and real worlds where digital and physical objects co-exist and interact in real time.

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**Sharing Economy**

A system of distributing assets, goods and services between private individuals through sharing or renting, usually by the means of the internet.

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**UNSDGs**

United Nations Sustainable Development Goals. A collection of goals set by the United Nations General Assembly in 2015 for the year 2030. They are the blueprint to achieve a better and more sustainable future for all and address global challenges related to poverty, inequality, climate, environmental degradation, prosperity, and peace and justice.

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**Virtual Reality (VR)**

A computer-generated simulation of a three-dimensional image, environment or experience that can be interacted within a seemingly real or physical way by a person using special electronic equipment such as a head-mounted display, gloves fitted with sensors or through multiple large screens placed in specially designed rooms.

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**Wellbeing**

The state of being comfortable, healthy and happy.

# References


1 Agile.org.uk. (2019). What is Agile Working?. [online] Available at: https://www.agile.org.uk/what-is-agile-working/ [Accessed 1 Aug. 2019].

2 Gensler. (2019). *Data and the Intelligent Workplace | Dialogue 34 | Gensler*. [online] Available at: https://www.gensler.com/research-insight/publications/dialogue/34/data-and-the-intelligent-workplace [Accessed 1 Aug. 2019].

3 Allsopp, P. (2010). *The Agile Agenda*. [online] Agile.org.uk. Available at: https://www.agile.org.uk/2010/06/29/the-agile-agenda/ [Accessed 1 Aug. 2019].

4 https://www.bcg.com. (2019). *The New Freelancers: Tapping Talent in the Gig Economy*. [online] Available at: https://www.bcg.com/publications/2019/new-freelancers-tapping-talent-gig-economy.aspx [Accessed 1 Aug. 2019].

5 Philips.talent-pool.com. (2019). *Philips Freelance platform | Start freelancing at Philips today*. [online] Available at: https://philips.talent-pool.com/ [Accessed 1 Aug. 2019].

6 https://www.bcg.com. (2019). *The New Freelancers: Tapping Talent in the Gig Economy*. [online] Available at: https://www.bcg.com/publications/2019/new-freelancers-tapping-talent-gig-economy.aspx [Accessed 1 Aug. 2019].

7 Forbes.com. (2019). *Google Just Predicted The Future Of The Gig Economy*. [online] Available at: https://www.forbes.com/sites/laurelfarrer/2019/04/05/google-just-predicted-the-future-of-the-gig-economy/#5e01808d5268 [Accessed 1 Aug. 2019].

8 Passy, J. (2019). *Google has more temp and contract workers than actual employees — but they have far fewer rights*. [online] MarketWatch. Available at: https://www.marketwatch.com/story/google-has-more-temp-and-contract-workers-than-actual-employees-but-they-have-far-fewer-rights-2019-05-30 [Accessed 1 Aug. 2019].

9 Cushmanwakefield.co.uk. (2018). *Boom in UK Co-working as Flexible Workspace Take-up Triples in Top Cities*. [online] Available at: http://www.cushmanwakefield.co.uk/en-gb/news/2018/01/coworking-report [Accessed 1 Aug. 2019].

10 Ft.com. (2018). *WeWork's take-up of London office space almost halves | Financial Times*. [online] Available at: https://www.ft.com/content/994a60ea-02cf-11e9-9d01-cd4d49afbbe3 [Accessed 1 Aug. 2019].

11 Newsroom. (2019). *2019 Global Impact Report*. [online] Available at: https://www.wework.com/newsroom/posts/2019-global-impact-report [Accessed 1 Aug. 2019].

12 Sharma, M. (2016). *TwoSpace turns closed restaurants into start-up co-working spaces*. [online] The Sydney Morning Herald. Available at: https://www.smh.com.au/technology/twospace-turns-closed-restaurants-into-startup-coworking-spaces-20161006-grw0uf.html [Accessed 1 Aug. 2019].

13 Twospace.com.au. (2019). *TwoSpace - Affordable & unique co-working spaces*. [online] Available at: https://twospace.com.au/ [Accessed 1 Aug. 2019].

14 Cameron, A. (2016). *Interview with Vrumi: The Airbnb for Workspace | Business Comparison*. [online] Business Comparison. Available at: https://www.businesscomparison.com/uk/blog/interview-with-vrumi-the-airbnb-for-workspace/ [Accessed 1 Aug. 2019].

15 Bloomfield, L. (2016). *Rent out your home while you're at work and earn up to £150 a day*. [online] Homes and Property. Available at: https://www.homesandproperty.co.uk/property-news/renting/rent-out-your-home-while-you-re-at-work-and-earn-up-to-150-a-day-a100141.html [Accessed 1 Aug. 2019].

16 Gensler. (2019). *Managing a Work Anywhere Culture | Dialogue 34 | Gensler*. [online] Available at: https://www.gensler.com/research-insight/publications/dialogue/34/managing-a-work-anywhere-culture [Accessed 1 Aug. 2019].

17 Gensler. (2019). *U.S. Workplace Survey 2019 | Research & Insight | Gensler*. [online] Available at: https://www.gensler.com/research-insight/workplace-surveys/us/2019 [Accessed 1 Aug. 2019].

18 Linkedin.com. (2018). *Are you preparing for what different generations want from work?*. [online] Available at: https://www.linkedin.com/pulse/you-preparing-what-different-generations-want-from-work-barleggs [Accessed 1 Aug. 2019].

19 Marks, G. (2018). *Employers must prepare for an aging workforce – or face unexpected costs | Gene Marks*. [online] The Guardian. Available at: https://www.theguardian.com/business/2018/dec/30/aging-workforce-retirement-older-employees-benefits-costs [Accessed 1 Aug. 2019].

20 Workforce United. (2019). Ricoh Europe. [online] Available at: http://thoughtleadership.ricoh-europe.com/eu/workforce-united/ [Accessed 1 Aug. 2019].

21 Fast Company. (2019). *See inside a co-working space for seniors*. [online] Available at: https://www.fastcompany.com/90344172/see-inside-a-coworking-space-for-seniors [Accessed 1 Aug. 2019].

22 Hitti, N. (2019). *The office of the future "will only be a place where people come together" say Barber and Osgerby*. [online] Dezeen. Available at: https://www.dezeen.com/2019/05/08/future-office-meeting-place-barber-osgerby/ [Accessed 1 Aug. 2019].

23 Newsroom. (2018). *Survey Finds That Collaboration Is Key to Employee Happiness - Newsroom*. [online] Available at: https://www.wework.com/newsroom/posts/survey-finds-that-collaboration-is-key-to-employee-happiness [Accessed 1 Aug. 2019].

24 Gensler. (2019). *U.S. Workplace Survey 2019 | Research & Insight | Gensler*. [online] Available at: https://www.gensler.com/research-insight/workplace-surveys/us/2019 [Accessed 1 Aug. 2019].

25 Fast Company. (2019). *7 things this tech company does to improve mental health in the workplace*. [online] Available at: https://www.fastcompany.com/90355287/7-ways-this-tech-company-does-to-improve-mental-health-in-the-workplace [Accessed 1 Aug. 2019].

26 Open. (2015). *Working Across Multiple Time Zones: Tools and Strategies*. [online] Available at: https://open.buffer.com/working-across-multiple-time-zones-tools-strategies-help-us-connect/ [Accessed 1 Aug. 2019].

27 Fast Company. (2019). *75% of staff at this successful IT company are on the autism spectrum*. [online] Available at: https://www.fastcompany.com/90339945/75-of-staff-at-this-succesful-it-company-are-on-the-autism-spectrum [Accessed 1 Aug. 2019].

28 World Economic Forum & Willis Towers Watson (2019). *Strategies for the New Economy Skills as the Currency of the Labour Market*.

29 Quartz. (2018). *The Dutch university that is shaping the campus of the future*. [online] Available at: https://qz.com/1221867/the-dutch-university-that-is-shaping-the-campus-of-the-future/ [Accessed 1 Aug. 2019].

30 Ricoh (2019). *Ricoh collaborates with Utrecht University to support educational innovation*. [video] Available at: https://youtu.be/VOsvjYLvR2w [Accessed 1 Aug. 2019].

31 Ricoh (2019). *Ricoh facilitates global research at University Medical Centre Utrecht*. [image] Available at: https://youtu.be/AK0u0XyeM2E [Accessed 1 Aug. 2019].

32 World Economic Forum in collaboration with Willis Towers Watson (2019). *Strategies for the New Economy Skills as the Currency of the Labour Market*.

33 World Economic Forum (2018). *The Future of Jobs Report 2018*.

34 Arup (2018). *Campus of the Future*. London.

35 Milgram, P., Takemura, H., Utsumi, A. and Kishino, F. (1995). Augmented reality: a class of displays on the reality-virtuality continuum. Telemanipulator and Telepresence Technologies. [online] Available at: http://etclab.mie.utoronto.ca/publication/1994/Milgram_Takemura_SPIE1994.pdf [Accessed 1 Aug. 2019].

36 Ekso Bionics. (2019). EksoVest and Ford - Reducing the Strain on Workers | Ekso Bionics. [online] Available at: https://eksobionics.com/eksoworks/ford/ [Accessed 1 Aug. 2019].

37 Ekso Bionics. (2019). EksoVest and Ford - Reducing the Strain on Workers | Ekso Bionics. [online] Available at: https://eksobionics.com/eksoworks/ford/ [Accessed 1 Aug. 2019].

38 Crowe, S. (2018). Ford Adding EksoVest Exoskeletons to 15 Automotive Plants. [online] The Robot Report. Available at: https://www.therobotreport.com/ford-eksovest-exoskeletons-automotive/ [Accessed 1 Aug. 2019].

39 Support.google.com. (2019). Talk to the Google Assistant in multiple languages - Google Nest Help. [online] Available at: https://support.google.com/googlenest/answer/7550584?hl=en [Accessed 1 Aug. 2019].

40 Developer.amazon.com. (2019). Develop Skills in Multiple Languages | Alexa Skills Kit. [online] Available at: https://developer.amazon.com/docs/custom-skills/develop-skills-in-multiple-languages.html [Accessed 1 Aug. 2019].

41 Glass. (2019). Discover Glass Enterprise Edition. [online] Available at: https://www.google.com/glass/start/ [Accessed 1 Aug. 2019].

42 Upskill. (2019). Boeing Augmented Reality Secret: Skylight For Assembly | Upskill Boeing. [online] Available at: https://upskill.io/landing/upskill-and-boeing/ [Accessed 1 Aug. 2019].

43 DHL. (2019). DHL Supply Chain deploys latest version of smart glasses worldwide. [online] Available at: https://www.dpdhl.com/en/media-relations/press-releases/2019/dhl-supply-chain-deploys-latest-version-of-smart-glasses-worldwide.html [Accessed 1 Aug. 2019].

44 DHL. (2019). DHL Supply Chain deploys latest version of smart glasses worldwide. [online] Available at: https://www.dpdhl.com/en/media-relations/press-releases/2019/dhl-supply-chain-deploys-latest-version-of-smart-glasses-worldwide.html [Accessed 1 Aug. 2019].

45 STRIVR. (2019). STRIVR named to Fast Company's list of World's Most Innovative Companies for 2019 - STRIVR. [online] Available at: https://www.strivr.com/fastco-mic-2019/ [Accessed 2 Aug. 2019].

46 Strivr.com. (2019). Disrupting L&D with Immersive Learning. [online] Available at: https://www.strivr.com/wp-content/uploads/2019/02/LD_STRIVR_ebook.pdf [Accessed 1 Aug. 2019].

47 Reed, V. (2019). Nissan Design collaborates with HaptX to bring realistic touch to vehicle design | HaptX. [online] HaptX. Available at: https://haptx.com/nissan-collaboration/ [Accessed 1 Aug. 2019].

48 Solon, O. (2018). Google's robot assistant now makes eerily lifelike phone calls for you. [online] The Guardian. Available at: https://www.theguardian.com/technology/2018/may/08/google-duplex-assistant-phone-calls-robot-human [Accessed 1 Aug. 2019].

49 Ibm.com. (2019). Soul Machines. [online] Available at: https://www.ibm.com/case-studies/soul-machines-hybrid-cloud-ai-chatbot [Accessed 1 Aug. 2019].

50 Hope, L. (2019). SoftBank Looks to Goldman, Apple for Sequel to $100 Billion Vision Fund. [online] WSJ. Available at: https://www.wsj.com/articles/softbank-to-greenlight-40-billion-investment-in-second-vision-fund-11563993379 [Accessed 1 Aug. 2019].

51 Softbankrobotics.com. (2019). Pepper and NAO in the service of Banks and Insurers | SoftBank Robotics EMEA. [online] Available at: https://www.softbankrobotics.com/emea/en/industries/finance [Accessed 1 Aug. 2019].

52 Graetz, G. and Michaels, G. (2018). Robots at Work. The Review of Economics and Statistics, 100(5), pp.753-768.

53 Statista. (2019). Slack - total and paying user count 2019 | Statista. [online] Available at: https://www.statista.com/statistics/652779/worldwide-slack-users-total-vs-paid/ [Accessed 1 Aug. 2019].

54 Gartner. (2019). Gartner Forecasts Worldwide Public Cloud Revenue to Grow 17.5 Percent in 2019. [online] Available at: https://www.gartner.com/en/newsroom/press-releases/2019-04-02-gartner-forecasts-worldwide-public-cloud-revenue-to-g [Accessed 1 Aug. 2019].

55 Zhihua, L. (2019). Digital health technology empowering doctors, patients - Chinadaily.com.cn. [online] Chinadaily.com.cn. Available at: http://www.chinadaily.com.cn/a/201906/26/WS5d12d6afa3103dbf1432a507.html [Accessed 1 Aug. 2019].

56 contextere. (2019). What We Do | Contextere. [online] Available at: https://contextere.com/what-we-do/ [Accessed 1 Aug. 2019].

57 Monzo.com. (2019). 3,000,000 people are now using Monzo. [online] Available at: https://monzo.com/blog/2019/09/16/three-million [Accessed 08 Oct. 2019].

58 www.statista.com. (2019). Topic: Fitness & activity tracker. [online] Available at: https://www.statista.com/topics/4393/fitness-and-activity-tracker/ [Accessed 1 Aug. 2019].

59 Virtual Reality Society. (2019). Happinss Virtual Reality: The Future of Corporate and Personal Wellness? - Virtual Reality Society. [online] Available at: https://www.vrs.org.uk/happinss-virtual-reality-future-corporate-personal-wellness/ [Accessed 1 Aug. 2019].

60 Unbouncepages.com. (2019). Happinss. [online] Available at: http://unbouncepages.com/happinss/ [Accessed 1 Aug. 2019].

61 RCPCH. (2019). The health impacts of screen time - a guide for clinicians and parents. [online] Available at: https://www.rcpch.ac.uk/resources/health-impacts-screen-time-guide-clinicians-parents [Accessed 1 Aug. 2019].

62 Ox.ac.uk. (2019). Study finds screen time – even before bed – has little impact on teen wellbeing | University of Oxford. [online] Available at: http://www.ox.ac.uk/news/2019-04-05-study-finds-screen-time-–-even-bed-–-has-little-impact-teen-wellbeing [Accessed 1 Aug. 2019].

63 Forrester. (2018). Unlock The Power Of Data To Transform Your Business. [online] Available at: https://www.ibm.com/downloads/cas/1NOA5OXZ [Accessed 1 Aug. 2019].

64 Skapinker, M. (2019). Frequent flyer: should travellers cheer or fear facial recognition?. [online] Ft.com. Available at: https://www.ft.com/content/af35ff12-892b-11e9-a028-86cea8523dc2 [Accessed 1 Aug. 2019].

65 Ft.com. (2019). How London became a test case for using facial recognition in democracies | Financial Times. [online] Available at: https://www.ft.com/content/f4779de6-b1e0-11e9-bec9-fdcab53d6959 [Accessed 1 Aug. 2019].

66 Coleman, C. (2019). Shopper challenges facial recognition surveillance. [online] BBC News. Available at: https://www.bbc.co.uk/news/uk-48315979 [Accessed 1 Aug. 2019].

67 Ft.com. (2019). How London became a test case for using facial recognition in democracies | Financial Times. [online] Available at: https://www.ft.com/content/f4779de6-b1e0-11e9-bec9-fdcab53d6959 [Accessed 1 Aug. 2019].

68 GDPR.eu. (2019). What are the GDPR Fines? - GDPR.eu. [online] Available at: https://gdpr.eu/fines/ [Accessed 1 Aug. 2019].

69 Information Commissioner's Office, UK. (2018). GPEN Sweep 2018 'Privacy Accountability'. [online] Available at: https://ico.org.uk/media/about-the-ico/documents/2614435/gpen-sweep-2018-international-report.pdf [Accessed 1 Aug. 2019].

70 Grandviewresearch.com. (2019). Cyber Security Market Size and Share | Industry Report, 2019-2025. [online] Available at: https://www.grandviewresearch.com/industry-analysis/cyber-security-market [Accessed 1 Aug. 2019].

71 World Economic Forum. (2019). Centre for Cybersecurity. [online] Available at: https://www.weforum.org/centre-for-cybersecurity/ [Accessed 2 Aug. 2019].

72 Aouf, R. (2019). MIT researchers engineer "cyborg" plants for motion-tracking and sending notifications. [online] Dezeen. Available at: https://www.dezeen.com/2019/06/17/mit-researchers-engineer-cyborg-plants/ [Accessed 1 Aug. 2019].

73 MIT Media Lab. (2019). Project Overview Cyborg Botany: Augmented plants as sensors, displays, and actuators – MIT Media Lab. [online] Available at: https://www.media.mit.edu/projects/cyborg-botany/overview/ [Accessed 1 Aug. 2019].

74 Schwab, K. (2016). The Fourth Industrial Revolution: what it means and how to respond. [online] World Economic Forum. Available at: https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/ [Accessed 30 Jul. 2019].

75 Dastin, J. (2018). Amazon scraps secret AI recruiting tool that showed bias against women. [online] Reuters. Available at: https://www.reuters.com/article/us-amazon-com-jobs-automation-insight/amazon-scraps-secret-ai-recruiting-tool-that-showed-bias-against-women-idUSKCN1MK08G [Accessed 30 Jul. 2019].

76 Merchant, B. (2018). This Was the Year the Robot Takeover of Service Jobs Began. [online] Gizmodo.com. Available at: https://gizmodo.com/this-was-the-year-the-robot-takeover-of-service-jobs-be-1831233632 [Accessed 30 Jul. 2019].

77 Stack, T. (2018). Internet of Things (IoT) Data Continues to Explode Exponentially. Who Is Using That Data and How?. [online] Cisco Blogs. Available at: https://blogs.cisco.com/datacenter/internet-of-things-iot-data-continues-to-explode-exponentially-who-is-using-that-data-and-how [Accessed 1 Aug. 2019].

78 The Four Futures of Work. (2019). RSA. Available at: https://www.thersa.org/globalassets/pdfs/reports/rsa_four-futures-of-work.pdf [Accessed 1 Aug. 2019].

79 Azure.microsoft.com. (2019). What is cloud computing? A beginner's guide | Microsoft Azure. [online] Available at: https://azure.microsoft.com/en-gb/overview/what-is-cloud-computing/ [Accessed 1 Aug. 2019].

80 Vardi, M. (2012). Artificial Intelligence. Communications of the ACM, [online] 55(1), pp.5-5. Available at: https://cacm.acm.org/magazines/2012/1/144824-artificial-intelligence-past-and-future/fulltext [Accessed 30 Jul. 2019].

81 Urban, T. (2015). The Artificial Intelligence Revolution: Part 1 - Wait But Why. [online] Wait But Why. Available at: https://waitbutwhy.com/2015/01/artificial-intelligence-revolution-1.html [Accessed 1 Aug. 2019].

82 Hu, B. (2018). Alibaba launches China's biggest robotic warehouse ahead of Singles Day · TechNode. [online] TechNode. Available at: https://technode.com/2018/10/30/alibaba-new-robotic-warehouse [Accessed 2 Aug. 2019].

83 PWC. (2017). Sizing the prize: What's the real value of AI for your business and how can you capitalise?. [online] Available at: https://www.pwc.com/gx/en/issues/analytics/assets/pwc-ai-analysis-sizing-the-prize-report.pdf [Accessed 1 Aug. 2019].

84 Shapiro, G. (2019). Ninja innovation and the future of work. [online] World Economic Forum. Available at: https://www.weforum.org/agenda/2019/03/ai-ninja-future-work-new-era-of-innovation-gary-shapiro/ [Accessed 1 Aug. 2019].

85 Salmon, F. and Stokes, J. (2010). Algorithms Take Control of Wall Street. [online] Wired. Available at: https://www.wired.com/2010/12/ff-ai-flashtrading/ [Accessed 1 Aug. 2019].

86 The Four Futures of Work. (2019). RSA. Available at: https://www.thersa.org/globalassets/pdfs/reports/rsa_four-futures-of-work.pdf [Accessed 1 Aug. 2019].

87 Directorate, O. (2005). OECD Glossary of Statistical Terms - Knowledge-based economy definition. [online] Stats.oecd.org. Available at: https://stats.oecd.org/glossary/detail.asp?ID=6864 [Accessed 1 Aug. 2019].

88 Shapiro, G. (2019). Ninja innovation and the future of work. [online] World Economic Forum. Available at: https://www.weforum.org/agenda/2019/03/ai-ninja-future-work-new-era-of-innovation-gary-shapiro/ [Accessed 1 Aug. 2019].

89 Chui, M., Chung, R. and van Heteren, A. (2019). Using AI to help achieve Sustainable Development Goals. [online] UNDP. Available at: https://www.undp.org/content/undp/en/home/blog/2019/Using_AI_to_help_achieve_Sustainable_Development_Goals.html [Accessed 1 Aug. 2019].

90 McKinsey Global Institute (2018) Notes from the AI Frontier: Applying AI for Social Good.

91 Schwab, K. (2016). The Fourth Industrial Revolution: what it means and how to respond. [online] World Economic Forum. Available at: https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/ [Accessed 30 Jul. 2019].

92 UCL IIPP (2019) A Mission-Oriented UK Industrial Strategy.

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