

Industry 4.0

Sustainability, security and
new business opportunities



Business

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Introduction

Throughout history there have been major step changes in the way we manufacture and produce goods. These revolutionary periods of change have seen the introduction of major innovations which have transformed productivity and efficiency, while also providing better health and safety for workers.

Business observers and historians have recorded these remarkable steps as different stages of industry:



Industry
1.0

mechanisation, steam
and water power

1784



Industry
2.0

mass production,
assembly line,
electrical power

1870



Industry
3.0

automation, computers,
electronics and robotics

1969



Industry
4.0

cyber physical
systems, internet
of things, networks

Today

Quick read

- Industry 4.0 is a new era in manufacturing, centred around a set of revolutionary new technologies such as the Internet of Things (IoT)
- These technologies are creating an exciting range of business opportunities that provide true competitive advantage, ranging from driving efficiencies to improving resilience in a volatile world
- Smart factories are being created that can better meet future environmental challenges
- The introduction of drones, sensors and other smart devices across industry is revolutionising health & safety, and producing Big Data to underpin better decision-making and continuous improvement

The pace at which new technologies are evolving and being implemented in industry is accelerating the period between these major transitions. This latest stage – Industry 4.0 – is now transforming multiple industry sectors thanks to the industrial application of leading technologies such as the Internet of Things (IoT), Big Data, Artificial Intelligence, Cloud Computing, Blockchain and 5G.

These technologies are being deployed at different levels of maturity across the world's manufacturers, creating a unique period of transition and opportunity for those that adopt and optimise the use of these new technologies before their competitors. Advantages include accelerating time-to-market, opportunities for reduction of operational costs, and tracking parts and demand in real time to minimise losses.

Currently, 94% of companies that have adopted one of the Industry 4.0 technologies state that it has helped their performance. Of those who implemented these technologies prior to the global pandemic, 96% were able to face the crisis with greater assurance. While just 19% that had previously not started to implement Industry 4.0 technologies were able to do so.

Industry 4.0 is the birth of a new era, where connected industry and smart factories are already providing companies new business opportunities. The automation of industry processes, sustainability, security, flexibility, and improvements in decision-making are among some of the most important catalysts.

This flexibility allows us to face situations of change as complex as the global pandemic. It increases the resilience of companies and the ways we can cope with the challenges humanity will face during the next two decades that will impact our way of life. For example, smart factories are proving to be more than capable of adapting to emerging demands. This includes helping to meet the UN Agenda 2030 and its Sustainable Development Goals (SDGs) to improve people's living conditions and curb climate change. Industry 4.0 therefore is offering not just business optimisation opportunities, but the potential for sustainable and flexible solutions that make it easier to adapt to the ever-changing world we live in.



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Exploring new commercial opportunities

As well as the introduction of new technologies in the industrial world supporting unexplored business opportunities through the introduction of drones, sensors and other wireless devices, companies can explore new commercial avenues, without the problems related to having to physically connect everything by cables – allowing for faster deployments and changes to occur within an industrial estate.

The Industry 4.0 concept also advocates improving safety for people working in industrial environments. More accurate sensors and improvements in robotics don't just support better process automation with fewer errors, but also much safer working environments when machines are working in close proximity to humans.

Industry 4.0 is also uniting the physical world with the virtual world to support the search for continual improvement. The use and analysis of large amounts of data allows us to predict and improve decision-making. It allows for just-in-time manufacturing that reduces storage costs and the related rapid reconfiguration of production lines; delivering the right products at the right time to minimise storage and waste.

This also includes being able to modify production processes quickly, adapting and improving output without extensive downtime of production lines. It also covers solutions to help locate equipment or parts within a factory, along with real-time production planning based on real-time supply chain deliveries. Similarly, preventative maintenance which uses sensors to detect vibrations, temperature changes, and other tell-tale signs can lead to a reduction in down-time and costs, all leading to an increase in profitability.

In short, Industry 4.0 is changing every aspect of the industrial sector, including a focus on workers' health and safety as well as the environmental concerns of the communities they operate in.

What are the technologies that are revolutionising the industrial sector?

The arrival of new technologies is bringing about a change in almost all industrial processes – leading to new ways of working and new business opportunities. The transformation brought about by some key technologies is so great that almost every aspect of manufacturing opens itself to optimisation and improvement.

A key technology leading to this step change is the Internet of Things (IoT). It allows us to connect, monitor and use devices to provide real-time insights, and enables us to place sensors within a connected industrial environment. With the ability to measure variables for individual parts, entire machines or final assemblies, sensors can help provide insightful information to support not only human decision making, but also for enabling intelligent automation. Overall, IoT is a key step along the path to the digitalisation of industry.

The data that sensors can cover includes:



the location of parts and equipment to allow better inventory management



data on vibration, temperature, humidity, and light exposure to protect or maintain certain production process areas



essential safety aspects such as warning of “unidentified objects” in dangerous areas.

Quick read

- The Internet of Things (IoT) places sensors within a connected industrial environment covering producing data on everything from location of equipment to vibration and temperature
- This data is improving a range of processes including inventory management and maintenance, while also supporting health & safety
- Applying artificial intelligence (AI) and machine learning (ML) to this data is supporting real-time decision-making but also performance optimisation
- AI is also facilitating a new era of intelligent robotics
- 5G's high speed and low latency is enabling these opportunities and reducing our reliance on cabling
- Edge computing and Blockchain are providing the necessary local processing power and secure protection to support Industry 4.0 technologies in an industrial setting

What are the technologies that are revolutionising the industrial sector?

All these data inputs support the monitoring and collection of high-value data that with the right levels of analysis allows management teams to continuously improve processes, while improving productivity, efficiency and health and safety.

The data that is provided by connected sensors can also lead directly to more efficient maintenance. For example, detecting irregular vibrations in a piece of equipment could allow a part to be replaced in an hour, rather than leaving it left unchecked and potentially causing significant damage that results in compounded problems that take days or even weeks to repair. As such, our ability to use AI to analyse and interpret vast amounts of structured and unstructured data (Big Data) is also opening up additional sources of value for manufacturers.

This growing use of AI not only uses complex algorithms to help analyse the huge amounts of data available at any one time for real-time decision making, but machine learning is creating opportunities for optimising performance on set tasks, including iterating on improvements to further improve performance. For example, optimising inventory and demand management in combination with supply chain conditions ensures support of production up-times as well as minimising surplus production.



Intelligent robotics

AI is also driving significant advances in the industrial application of intelligent robotics. This includes the processing of additional sensors such as vision, radar, or LIDAR for enhanced vision, improving the efficiency of processes and the quality of manufactured products while significantly reducing costs. These sensors also ensure dangerous environments can support additional safety measures for both workers, and the robots themselves.

The arrival of high-speed mobile data networks like 5G further removes the limitations of fixed cables to provide access to devices and sensors. 5G provides high speeds, with very little latency, along with low power requirements. For areas with significant “reflective” objects (such as factories with lots of metallic equipment) other wireless standards such as WiFi don’t work as well, and as such many manufacturing estates are looking at 5G Private Networks to provide even more flexibility and control. This ability to further cut cables, providing high levels of flexibility with equipment positioning and re-positioning, is something which is vital to realising the full opportunities Industry 4.0 presents.

Similarly, edge computing – which brings computation and data storage closer to the sources of the data, rather than a central network – allows for local processing, further reducing latency and is further increasing flexibility and improving the performance of IT infrastructure. Yet increasing the efficiency of processes or discovering new business opportunities is only possible if there is a secure environment.

Blockchain might be better known as the protective solution for Bitcoin, but it’s use is wide and varied. It provides security through a distributed database, or ledger, that can store and transact information with cryptographic encryption without the need for intermediaries. This creates a system of recording transactions and tracking of assets. This can include information such as origination, location, ownership, manufacturer date, or anything else of relevance. All the information is duplicated and distributed across the entire network of computers making it extremely difficult to hack and change. This provides greater transparency and reliability in transactions between suppliers and customers, which helps to ensure optimal protection of the entire production chain – both upstream and downstream of any manufacturing process.

All these technologies are just beginning to realise their vast potential, yet each is accelerating at unprecedented rates due to the opportunities they unlock. New technologies are making a new world possible. One in which industrial processes are more sustainable and safer – for individuals, organisations, society, and the planet.



How 5G, robotics and edge computing are revolutionising industry

There is a common factor among all the leading technologies of Industry 4.0: fifth generation mobile networks, or colloquially referred to as 5G. Introducing 5G across industry puts an end to the era of dependence on data being transmitted by cables. And in removing the obstacles to creative and technical processes those cables also represented, we've been able to introduce a whole range of new technologies that support opportunities for dynamic, flexible environments that are well suited for new cost effective and safer working environments.

Until 5G, wireless communications did not have the quality of service and performance characteristics necessary to be able to implement Industry 4.0 technologies in the most demanding scenarios. 5G looks to solve many of the issues such as low energy transmission, as well as massive improvements to sending and receiving in highly reflective environments – a typical environmental consideration for factories with concrete and metal structures throughout. In addition, 5G enables guaranteed quality of communications services, an uplift in transfer speeds (of several Gbps), and almost non-existent latency. These characteristics mean that 5G can support thousands of simultaneous connections, helping maintain communications between devices and operators, while offering much better energy efficiency to support IoT, especially when directly compared to previous generations.

Introducing 5G across industry puts an end to the era of dependence on data being transmitted by cables.

5G makes it possible to connect production systems and high-performance machinery in smart factories. It also allows us to work with advanced robotics and automate industrial processes – opportunities that were, until now, impossible to achieve at scale. By removing the data cable connections, we also now have factories able to reconfigure production lines quickly, and with far less fuss as connection to power becomes the only limitation to repositioning or replacing equipment.

Quick read

- 5G is a common enabling factor across all the leading Industry 4.0 technologies
- Previous wireless communications like WiFi didn't have the requisite service and performance characteristics for industrial settings
- Human-robot collaboration is becoming a reality, for example with the introduction of smart Autonomous Mobile Robots (AMR), and "cobots" that support closer and safer collaboration between man and machine
- Intelligent indoor and outdoor drones are performing a range of tasks including stock location, outdoor surveillance and even transporting goods
- Augmented, virtual and mixed reality (AR/VR/MR) offers opportunities around training in simulated environments and experts providing remote assistance to staff
- Along with 5G, the local computational power of edge computing is another enabler of successfully applying 4.0 technologies in industrial spaces



Through AGV, AMR and cobots, human-machine collaboration is already a reality

Human-machine collaboration is already a reality. Already robots are used to do the jobs humans found difficult or dangerous, such as lifting larger components, or managing activities at high speed. Today's robots can be "shown" how to do a task by a human, and then replicate that activity, in sequence or unison with other robots to more accurately, consistently, and rapidly achieve the same results that humans can.

A clear example of the evolution of robotics in Industry 4.0 is in guided vehicles. Initially automatic guided vehicles (AGVs) would typically perform logistics or transport tasks inside or outside the factory – moving parts and completed assemblies from one station to another. But despite their usefulness, the intelligence of AGVs is limited. They are not capable of making complex decisions and must be guided by markings or an operator, only stopping if they detect obstacles.

However, robots are becoming increasingly autonomous and intelligent as computational power increases and sensors become more accurate. Increasingly manufacturers are deploying autonomous mobile robots (AMR). These smart devices use AI and data analysis to make decisions that improve logistics efficiency, overcome obstacles, or scan the space around them to establish safe workspaces. They can also be controlled remotely in those cases where human intervention is necessary.

The use of 5G for connectivity and computational power supports interaction between machines. Especially when sensors and monitoring such as radar and video cameras make it possible for the machine's AI to identify an issue and create real-time and appropriate alerts; these can alert, minimise, and even support coordination of other automated processes to stop a problem before it escalates.

Another concept born from 5G and its data transmission speeds and low latency is collaborative robotics ("cobots"). Cobots are capable of performing repetitive or dangerous tasks while easily interacting with their environment, even when it is changing – enabling closer and safer human-machine collaboration that considers the external environment it is operating in. Not only does this optimise productivity, but also supports health and safety as the robots become more "conscious" of their surroundings.

Industry 4.0 robotics has managed to make tasks that were previously complex easier and more flexible. 5G is a clear advantage for accelerating the updating for existing factory estates, or supporting new, space and technology optimised estates.

The impact of drones on Industry 4.0

Drones are another clear example of how autonomous robots are providing innovative solutions both inside and outside factories. Indoor drones, both airborne and land-traversing can move intelligently and on their own within the factory using a combination of sensors that include vision, temperature, and proximity detection. These can be used to improve logistics processes, perform routine safety checks, or even help complete stock location and counting tasks.

Outdoors, drones can perform perimeter surveillance, inspection, and security tasks. They are also being used in transporting goods across an estate, and in the future are expected to be able to take advantage of self-driving vehicles for delivery to distribution centres or even directly to end-user customers, which may prove to be a game-changer in transforming customer service.

Drones are not only facilitating automated tasks quickly and with high rates of accuracy, but also shortening the time to complete tasks, and removing risks to humans, especially in highly dangerous jobs. Combining advances in Big Data and AI, supported by 5G and high-speed data transmission in real-time, has created a technological environment in which drones can become a valued member of the workforce.





How virtual, augmented and hybrid reality is offering new approaches

5G is supporting another key technology within factories that is beginning to take off – augmented, virtual, and mixed reality (AR/VR/MR). These immersive and versatile technologies are gaining prominence in Industry 4.0 because they can make an impact in many different ways.

Expert guidance via remote assistance is a popular area of focus. Remote experts can support workers anywhere within the factory by using augmented reality (AR). These experts could be at the same factory or be centralised and providing support to several different estates. By providing their expertise while remote they can provide their experience and guidance to complete many more jobs in a day than if they had to travel to each location. This reduces travel times between jobs (whether it's the same site, or between cities or countries) and improve response times. It also provides better access to knowledge, meaning staff can learn from experts as they receive instructions in visual and audio format through the head mounted equipment.

Virtual Reality (VR) is also being seen as a great tool for training purposes. Both operator and maintenance crews can learn to use and repair machinery using virtual glasses that display a digital space that replicates the one found in the work environment. Through recorded tutorials, processes can be explained step by step and performed.

VR provides a safe environment to train in, removes the need for any downtime for equipment or costly dedicated training equipment, and allows for multiple training sessions to occur at any one time. Reducing the time and resources dedicated to training, it also allows for tracking and playback of performance along with evaluation. This new approach to training is safer, more cost-effective, and more flexible – it can easily accommodate updates and refresher courses for staff as needed for compliance needs.

AR is also being employed as a navigation tool for logistics. Using AR glasses, or even a tablet, it's possible to improve the speed of picking tasks by guiding operators through a warehouse to make it easier and faster to find what's needed. More practical, robust, being developed, specifically designed for industrial environments and compatible with 5G networks.

Similarly, the arrival of more accessible and practical VR headsets is also accelerating with new options that make it simpler to develop relevant scenarios for training, as well as even modelling complete layouts for new factories and production lines. These digital twins even facilitate the operation and control of equipment from within a VR environment.

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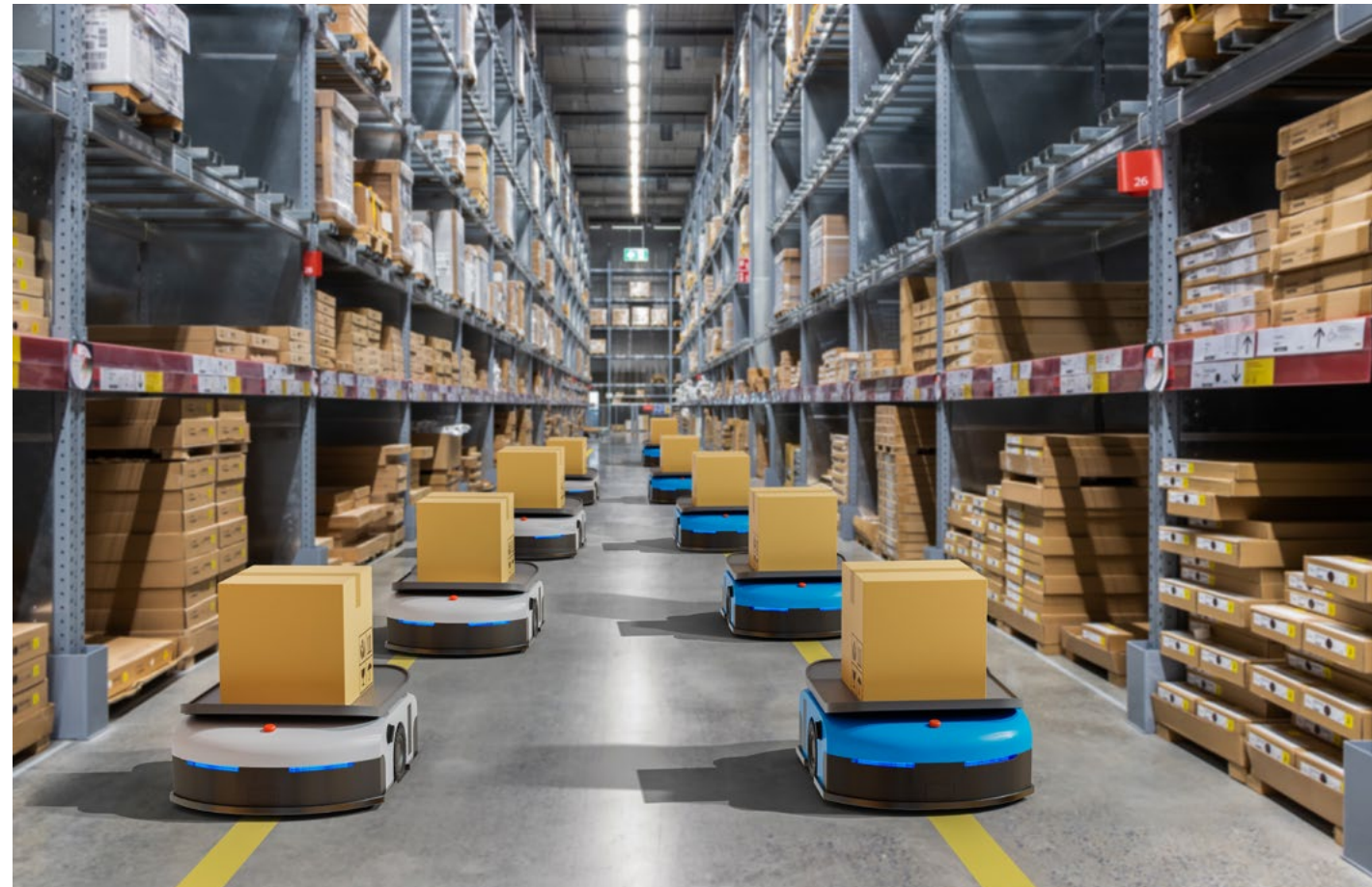
Edge computing and 5G: a new way of processing data

Most Industry 4.0 technologies will be improved by better transmission speeds, computational performance, and latency. All of which is difficult to achieve when using traditional cloud servers hosted far away. As mentioned earlier, edge computing brings together the computational power and elasticity of the cloud with the same latency as if it were running locally within the factory. Software for industrial robots, drones or AR can be run through edge computing to process data at the necessary speed. The flexibility of edge computing also introduces additional security opportunities, limiting how much data is transmitted outside to general networks or the internet.



Success stories: Industry 4.0 in action today

Industry 4.0 is not a distant vision for the future. It's happening today. There are many examples where it is already delivering value through the implementation of new technologies. Technologies that are constantly evolving and becoming more and more profitable for those that are using them.



Quick read

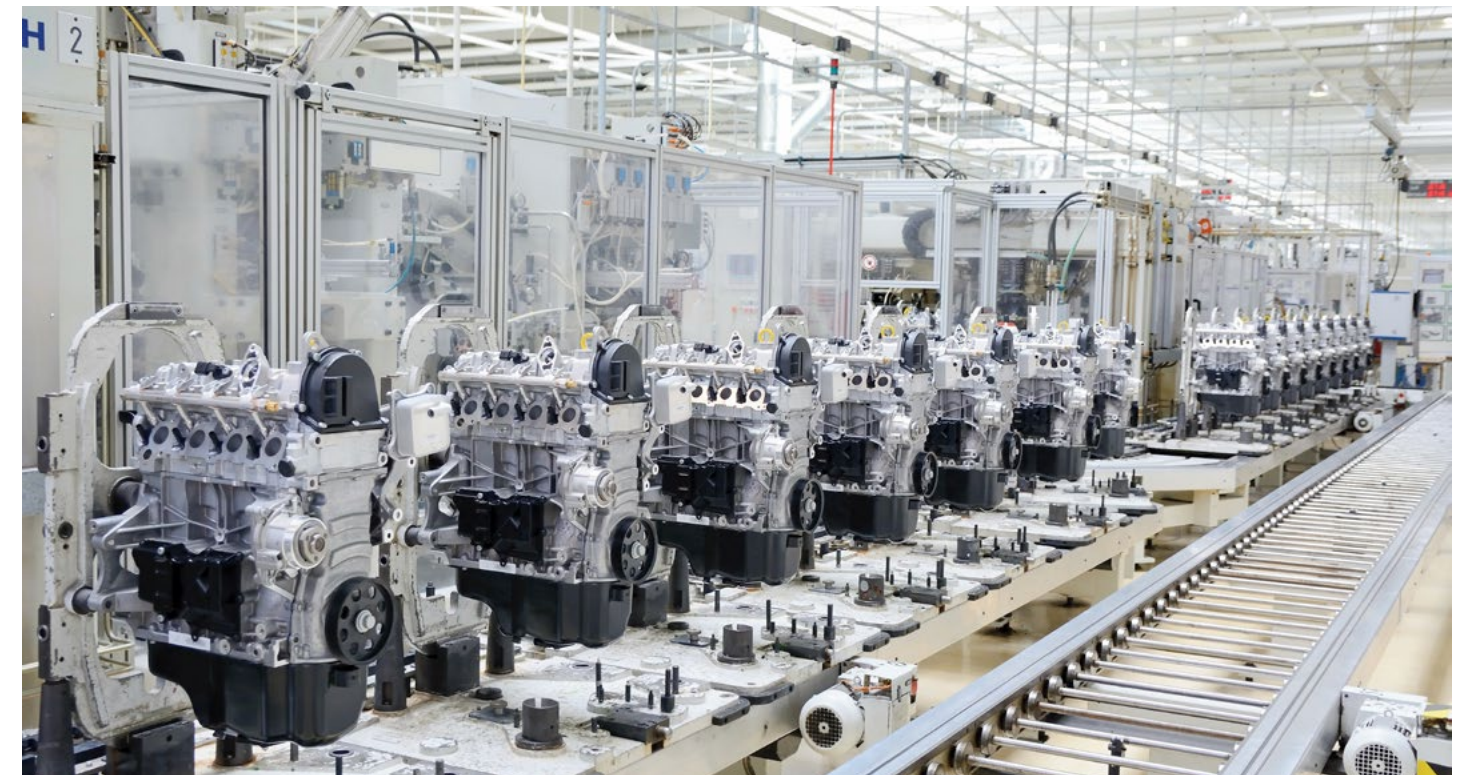
- There are many examples of industry 4.0 technologies driving value today
- One manufacturer of motor vehicle components used a 5G private network to simulate scenarios using data from its welding robots, helping to reduce and test for errors
- One automotive group used a 4G private network to gather data from 200 Automated Guided Vehicles (AGV) to improve quality and reduce production delays
- One high-tech shipping manufacturer is using 5G coverage to enable remote assistance and introduce VR and MR to reduce risks across its design and build processes.

A perfect union between the physical and the virtual worlds

One multinational company engaged in the design and manufacture of components for motor vehicles is using a 5G private network for industrial processes and opening new commercial possibilities.

The 5G network is being used to capture and process real-time data from the company's welding robots. With the help of edge computing, data produced by these machines can be analysed quickly and efficiently. And by creating a digital twin of its work environment, the company can simulate scenarios using the real-world data from the welding robots.

This is allowing the company to test, reduce errors and optimise decision-making virtually, without compromising the operation of the production chain.



A new kind of flexible factory

For one automotive group, the use of ultra-fast and secure communications via a 4G private network is supporting the use of a flexible, automated, and fully mobile factory. The network enables the rapid collection and transmission of data associated with more than 200 AGVs (Automatic Guided Vehicles) present in the factory.

It is increasing visibility so that the production line does not suffer delays that compromise productivity or safety. And enabling the analysis of Big Data that is essential to ensuring the quality of engines and the correct operation of facilities.

The wireless connectivity provided by the high-speed virtual private network is essential to the adoption of other Industry 4.0 technologies. When combined, these are resulting in set-change improvements in the quality and safety of production and putting technology at the service of people.

A new business model based on new technology

For one company building high-tech ships, the deployment of 5G coverage in its shipyards has delivered a real revolution in its manufacturing processes. Together with edge computing, augmented reality, and virtual reality, it is exploring exciting new opportunities.

Thanks to the data transmission speed and low latency provided by 5G, the company is exploring the added value of remote assistance (RA). Ship operators receive expert RA to carry out complex repairs that few specialists can offer. This avoids unnecessary travel, speeds up repair and reduces production downtime.

The use of mixed reality has also introduced the visualisation of virtual parts in real environments. Now, the company's specialists can check how a part still under design will look in a real environment before actually making it. This way, they can verify whether the part meets the specification with great precision and improve the early detection of design errors to save time and resources.

Thanks to the 5G network and 3D scanner technology, the company is also able to test the value of scanning ships still in the process of being built. By bringing together the wide bandwidth of 5G and the high processing power of edge computing, teams can transmit point-by-point the large amount of information generated by 3D scanners on ships under construction. This information can be viewed by experts to confirm that everything is in order before proceeding with the assembly. A process that would normally take days is now done in real time and without the need to travel.



Advantages of Industry 4.0 and smart factories

Industry 4.0 is undeniably changing the way we understand factories today. This set of technologies together with the intelligent automation of industrial environments is increasing the value, quality and efficiency of the production chain while further reducing manufacturing costs.

New technological applications are creating more resilient environments that offer the ability to quickly adapt to constant changes in the market, benefitting companies and customers alike. The flexibility provided by these new solutions, underpinned by 5G connectivity, is bringing about changes that were unachievable until now.

Industry 4.0 has also arrived at precisely a time when sustainability has become a top priority for companies, governments, and citizens. Thankfully, new and emerging technological applications will help us reduce the impact of industry on the environment and integrate smart factories into a more sustainable social model. The new possibilities for factories will place them at the heart of sustainable living by reducing travel and integrating with Smart City concepts in both urban and rural areas.

As the Fourth Industrial Revolution continues, we will see new solutions that create safer work environments for people. The most repetitive or dangerous tasks will be carried out by intelligent robots in collaboration with humans and easy-to-use interfaces.

The flexibility provided by these new solutions, underpinned by 5G connectivity, is bringing about changes that were unachievable until now.

Quick read

- Industry 4.0 is creating more resilient and flexible environments
- These technologies are also supporting sustainability through creating “smart factories” and reducing the need to travel
- They are also helping foster constant improvement, new business opportunities and innovation for the future.



New technologies in industrial environments will also continue to open new unexplored business opportunities. The development of more efficient and economical processes enables companies to create value by quickly launching or redeveloping products that meet new market demands – often on a pay-per-use or personalised basis.

Technologies from AR and VR to Big Data and AI are fostering opportunities for constant process improvement. Digital twins help to simulate real work environments to experiment with new ideas and demonstrate their potential impact. The support for predictive maintenance and improvements in decision making using insights from a huge amount of data rather than gut feelings also is leading to cost savings and efficiency gains.

Industry 4.0 is already transforming our lives. It is enabling more efficient, safer, and highly sustainable processes that are capable of adapting to changes in the digitalised and ultra-connected world we live in. And the profound changes brought around by Industry 4.0 technologies and intelligent robotics will only increase, delivering new concepts for factories. Ones that offer production methods capable of satisfying the needs of modern society but also placing innovation at the heart of everything we do.

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