The Kingsbury guide to

Industry 4.0

Kingsbury

What is Industry 4.0?

Industry 4.0 refers to the act of optimising manufacturing through digitisation and factory automation.

Industry 4.0 is the next major advance in the manufacturing industry. The Industry 4.0 meaning isn't tied to any specific technology or software but is rather an all-encompassing term used for the integration of physical and cyber technology in industrial automation. The ultimate goal of Industry 4.0 is the creation of smart factories that are optimised and integrated with emerging technologies or systems like machine learning, sensors, IoT (internet of things) and IIoT (industrial internet of things). These factories will be able to self-monitor and optimise themselves based on data gathered both from human operators as well as integrated sensors.

How Industry 4.0 works

The German institute of technology defines 4 design principles that accurately characterise how Industry 4.0 works as indicated below.

1. Interoperability

Communication between human operators and machines is made easier by making use of a range of sensors and devices. These sensors can communicate directly with human operators via mobile phones or to a centralised computer system. Machines can also communicate directly to each other without any human involvement; these systems are known as M2M (machine to machine). The communication is often handled over IoT architecture.

2. Virtualisation

In a smart factory, a virtual copy of the factory is made via data gathered from sensors/ devices. The virtual factory can store and display all the data related to specific machines and manufacturing processes. If the various systems detect failures, safety concerns or any anomalies, a human operator can be notified or the problem can be solved without human intervention. The more sensors integrated into the factory the more accurate the virtual model.

3. Decentralisation

Low-level decision making on the factory floor by a human operator is reduced or eliminated by using M2M communication. This allows the plant to self-configure in order to adapt to changes in manufacturing requirements. This is ideal in a manufacturing environment that is becoming more focused on producing individual, customer-specific configurations of products.

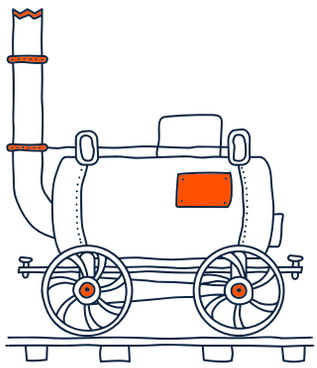
4. Real-time capability

In order for a smart factory to operate efficiently, data needs to be gathered and analysed in real time. This allows unmatched flexibility in the manufacturing process. For example, if a certain machine fails, the system can react by transferring the workload to another, underutilised machine to reduce downtime. These decisions can be made before a human operator has even realised that a fault occurred.

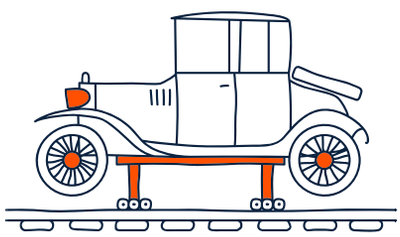
When did Industry 4.0 start?

The Industry 4.0 origin can be traced back to 8 April 2013, the date when the final version of a German government memo was released. The memo was a strategy document that outlined the need to automate the manufacturing industry to remove human intervention where possible.

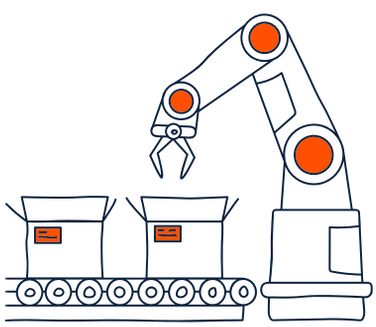
In 2015 the German chancellor spoke of the concept at the World Economic Forum in Davos. Thereafter the term became more prevalent in industrial circles and the implementation thereof was beginning to be adopted by large industry players in an attempt to get ahead of the curve and realise the benefits of Industry 4.0 in their operations.



1. The first industrial revolution was characterised by the movement from an agricultural society to a more mechanised society that harnessed steam energy.



2. The second industrial revolution was characterised by the advent of the assembly line to efficiently produce large quantities of consumer goods for an ever-growing market.



3. The third industrial revolution was characterised by the use of computerised systems such as robotics.

4. Did Industry 4.0 start in the new millennium? The answer is yes and it is characterised by the integration of cyber-physical systems to optimise manufacturing.

Benefits of Industry 4.0

Increased productivity

Due to the fine level of optimisation, resources are precisely allocated and tracked. This allows for highly efficient operations in which any inefficiencies are immediately evident and can be quickly handled.

Improved customer experience

The higher efficiency of a smart factory will result in a higher level of customer satisfaction. Orders will arrive on time in good condition as there is little room for human error. Furthermore, a smart factory is able to produce a single, custom product just as easily as a batch of a million products.

Cost reduction

The reduction of cost can be attributed to a few key drivers, these are listed below;

1. Efficient allocation of resources.
2. Higher pace of manufacturing.
3. Reduced production downtime.
4. Reduced waste through improved quality control.
5. Lower labour and operating costs.

Industry 4.0 challenges

Data security

Data security is one of the most significant risks to smart factories. This risk is potentially even more detrimental to large corporations who rely on their intellectual property to maintain a market advantage. However, with Industry 4.0, even machinery is at risk of being damaged by security breaches.

Skills

As factories evolve so will the jobs required to operate them. Unskilled labour will be replaced by robots, and even some administrative jobs will be lost as a result of AI and machine learning being implemented.

Infrastructure

The sensors and equipment needed to maintain the functionality of a smart factory need to be robust, as any unexpected failure can result in significant downtime and financial loss.

Capital

The capital investment required to transform a modern factory to a smart factory is significant. The benefits are well understood but the actual financial analyses of the economic benefits are not well published as yet. It would be very easy to over-automate and be worse off than when you started.

Key Industry 4.0 technologies

Big data analytics

A natural by-product of transforming a factory into a smart factory is terabytes of data. This data can reveal a wealth of valuable information that can indicate where there are inefficiencies and issues in the factory. However, to extract this information, Industry 4.0 data analytics methods must be used. Machine-learning algorithms can be used to learn which patterns are normal in the data and which are anomalous. The more data being fed into the algorithm, the more accurate it will become at predicting machine failures, raw material bottlenecks and possible cyber security breaches. This is the data-driven future of the digital Industry 4.0.

Robotics and automation

Where big data is the brains, Industry 4.0 robotics are the muscle. It is the robots that will be doing the work in the automation-driven smart factory and they will be doing so more efficiently than ever before. This is down to Industry 4.0 robotics being different from their current counterparts due to their ability to communicate both to each other and to a centralised control. It is this ability which will enable the next evolutionary leap for industrial automation and robotics. Robotics will continue to get faster and more accurate, but it is their integration with communication systems that will truly transform the manufacturing industry and industrial automation companies. Robots will be able to communicate their operational status to a central control or even to a localised control which will then use that feedback to decide whether maintenance is required, or if the machine needs to be taken offline immediately and its task delegated to another robot.

Additive manufacturing

Industry 4.0 additive manufacturing will be one of the defining technologies of the fourth industrial revolution. Due to its versatility, additive manufacturing plays a key role in Industry 4.0 as it saves time and reduces cost.

Sharing some key parallels with Industry 4.0, it's decisive for process efficiency and reduces complexity as well as being highly customisable and energy efficient. All of which allow for rapid prototyping and a decentralised production process.

Additive manufacturing technologies integrate seamlessly with the internet of things. A part can be designed and set up for 3D printing, the file can be sent over the network to the printer and the part will be made with minimal human interaction.

Additive technologies are also unique in their ability to manufacture parts generated entirely from computer algorithms, like generative design. This means that parts can be designed by machines, manufactured by machines and – in the near future – even be delivered by machines without ever coming into direct contact with a human... until in the hands of the customer.

Thanks to the Internet of Things, smart factories of the future will be interconnected, have all the processes in place to incorporate greater flexibility and allow for individualization of manufacturing processes.

This is the future of manufacturing.

Horizontal and vertical integration

Vertical integration is about controlling manufacturing from the most basic level of raw materials all the way to the final assembly of the product. Vertical integration is notoriously capital intensive and sometimes it is easier to leverage the skills and expertise of an existing vendor instead of trying to bring the manufacture of those components in-house. However, a well-implemented vertical integration strategy has many benefits such as supply chain security and cost savings. Industry 4.0 vertical integration eliminates some of the risks involved by means of efficient and flexible controls.

Horizontal integration is basically the spreading out of a company by having multiple business units that develop the same type of components. This allows large cost savings due to marketing, R&D, production and delivery synergies. Industry 4.0 horizontal integration can leverage the data gathered and efficiencies gained from other smart factories in the network. Even machines that are in different factories can be utilised across factories.

Cyber security

As mentioned previously, cyber security is one of the biggest concerns in an Industry 4.0 environment. This is due to risks from putting sensitive company data onto potentially vulnerable networks that can be accessed. Not only can the data be accessed but so can actual hardware such as production-line machinery. Cyber attacks on these systems can cause untold damage to a company through production loss, defective products and the resulting financial losses of these types of attacks. As such, new cyber security technologies and regulations are needed to protect industry from the cyber security threats unique to Industry 4.0.

Which sectors should embrace Industry 4.0?

Energy industry

The energy industry can be broadly classified as industries which are involved with the technologies and systems that directly impact the production and distribution of energy. Industry 4.0 can be easily applied to the highly regulated oil and gas industry. This is due to the fact that many of the technologies required for full Industry 4.0 implementation are already used in this industry. All that is required for Industry 4.0 oil and gas is the merging and integration of all these technologies in a homogenous system.

Medical industry

The medical industry is known for pushing the boundaries of material science, engineering and manufacturing. The increasing need for patient-specific medical devices and medication puts strain on traditional manufacturing techniques because medical products are rarely a one-size-fits-all affair. Certain products must be manufactured to integrate seamlessly with the patient's body and still maintain extremely high levels of quality. The flexibility of Industry 4.0 enables the manufacture of highly customised devices without the hefty price tag that characterises these types of components, resulting in a new-age Industry 4.0 pharma.

Transport industry

The transport industry is probably the fastest moving towards industry 4.0. A good example of this high pace of adoption is Tesla. With the rising popularity of electric vehicles, there is a complete shift in the traditional workflow of manufacturing a vehicle; factories need to be completely retooled to be able to efficiently make electric cars. This is what has kept some of the larger companies out of the EV race for so long. Tesla built their production line from the ground up and thus were able to incorporate Industry 4.0 transportation principles into their process seamlessly. Many other automakers are following this example, so expect the auto industry to be at the forefront of Industry 4.0 development and implementation.

Aerospace industry

The aerospace industry is highly complex as there are millions of components in a modern airliner. Each of these components is designed to a high level of precision and repeatability. The monitoring of these complex projects can benefit massively from Industry 4.0 technologies like big data, smart component tracking and smart inventory management systems. Industry 4.0 aerospace can dramatically improve manufacturing quality and repeatability.

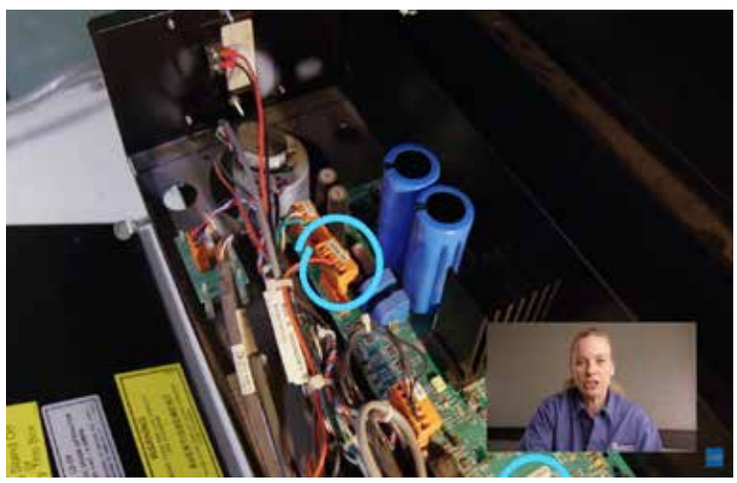
Industrial manufacturing

Industrial manufacturing refers to the fabrication of parts or products from raw materials using various manufacturing technologies and machinery. The impact of Industry 4.0 in manufacturing is very easily observed in an industrial manufacturing plant. A typical facility can benefit from Industry 4.0 manufacturing in a large number of ways. CNC machines can have raw materials loaded into them by robots. Once the parts are complete, these items can be removed from the CNC by the same robot, loaded onto automated carts which then take these parts to the next step in the manufacturing process. Manufacturing 4.0 technologies can decide which parts are the most in need upstream, and the CNC can be tasked with producing these parts until a predetermined condition is met.

Future trends for Industry 4.0 for 2019 and beyond

The future of Industry 4.0 is continuously evolving as existing technologies mature and new technologies emerge. There is no doubt that Industry 4.0 is the next logical step for manufacturing.

Burkhardt-Weber – Hololens



Many large companies are already making use of Industry 4.0 techniques. The rest of the market will be forced to implement these techniques or risk being left behind and becoming irrelevant in their industry. The benefits from Industry 4.0 are just too significant to ignore despite the risks identified earlier. Some of the key Industry 4.0 trends are listed below.

Increased adoption of Industry 4.0

Companies that are not able to make the jump to complete Industry 4.0 will begin to implement chunks of these systems in areas of their businesses that can most easily produce immediate financial benefit. Companies that make use of ERP (Enterprise Resource Planning) and MRP (Material Requirements Planning) systems can already see the benefits of automating their administrative processes and will therefore be in a position to implement similar methods on the shop floor.

Improved human-machine cooperation

Human to machine interaction will be further improved to allow for an almost seamless integration. Technologies that will enable this integration include augmented reality, better sensors that allow machines to sense humans working around them and improved AI systems that enable machines to anticipate human movements and actions, allowing these machines to better work alongside humans.

Industry 4.0 consultants

Companies that offer Industry 4.0 consultation services will be on the rise. There is still a fair amount of confusion regarding Industry 4.0 and how to cost-effectively implement it into existing businesses. This is where consultants will fill the gap, providing services that analyse existing companies and advising how they can implement Industry 4.0 systems into their factories without damaging their business.

Accessible sensor technology

Industrial sensors will continue to drop in price. Consumer sensor technology has become extremely cheap and this will continue trickling down into the industrial space as more competition in the market appears.

Machine self-analysis

Machines will be augmented with sensors that will allow them to monitor their state and be able to measure key machine performance markers. This data will be analysed by machine-learning algorithms, and predictive maintenance plans will be developed from this data. This will drastically reduce downtime due to unplanned maintenance and as a result increase company profit and production efficiency.

Internet of systems

The internet of systems will enable companies to leverage vast amounts of data gathered from all their factories. Lessons learnt and optimisations made can be shared across smart factories. Even machines can be shared on the network to truly create an autonomous supply chain. For example, if one factory is not able to meet production demand for a certain product, another factory that is underutilised can be autonomously roped in to assist with production. The logistics network can also be reconfigured to account for the change in manufacturing location.

Artificial intelligence

Although true artificial general intelligence is still far off, rudimentary AI and machine-learning systems will become more common in smart factories due to the large amounts of data that needs to be collected, analysed and presented in a clear and concise format. This will allow a human to further optimise processes within the factory. AI systems will be able to point out inefficiencies in the system and will even be able to autocorrect those efficiencies with limited human interaction.