

Industry 4.0

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First there were humans, then machines and, some time later, electronics and information technologies that transformed them into mechatronic equipment and paved the way for the dominance of digital data. Today we live in a digital universe where barriers between atoms and bits tend to blur, machines talk to each other and to their human counterparts, and big data are the fundamentals of manufacturing intelligence. Welcome to the age of the fourth industrial revolution: Industry 4.0.

The way we now produce has evolved from a situation where craftsmen were in direct contact with their customers, to one dominated by advanced forms of work organisation

and mechanisation. The first industrial revolution dates from the end of the 18th Century following the introduction of water and steam powered mechanical manufacturing facilities. Machines alleviated the burden of human labour allowing higher throughput and better efficiency. This source of power, however, could not be transported or distributed easily which posed severe limitations on the locations of factories and their internal organisation.

At the turn of the 20th Century, electricity fostered the second industrial revolution based on mass production and the division of labour as typified by Henry Ford's production line for the Model T automobile. Electrical power is

easily distributed and can be delivered to each machine individually thus allowing a much higher level of flexibility in defining the best manufacturing layout for efficient organisation and production. The Modicon 084 programmable logic controller (PLC), released in 1969, ushered in the third industrial revolution in the form of the first examples of automation.

Now, in the first decades of the 21st Century, we are witnessing the dawn of the fourth industrial revolution: Industry 4.0. This goes hand in hand with the digital transformation of manufacturing and relies on a new breed of assets called Cyber Physical Systems (integrations of computation, net-



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working and physical processes). Here, embedded computers and networks monitor and control the physical processes, with feedback loops where the latter affect computations and vice versa. As can be seen, it is all about digital data, their gathering, transmission and interpretation.

DISRUPTIVE POWER OF DIGITISATION

Digitisation can have a disruptive power on business as, for example, with taxis. In the past when you needed one you either dialled the number of a taxi company or walked to the nearest stand. We all know how frustrating this can be with long waits at the phone, no cars at the stand and expensive fares. Then Uber came along. Wherever its service is available, it is enough to open the app on your smartphone to call the nearest driver, monitor where he is, how long it will take him to arrive and how much the trip will cost. What is going to become the largest taxi company in the world owns no cars and employs no drivers, hence it can offer a better service at very competitive prices. Its success comes from harnessing the potential of the sharing economy and the power of the digital transformation of processes and business.

The risk for companies is therefore one of waking up one morning and having been 'uberred' by other companies from completely different industries. It is a fact that the possibilities opened up by digital media will bring dramatic change to companies, their strategies, processes, structures, products and also their cultures. In the future, people, machines and resources will communicate with each other directly and in real time. Rigid value chains will become dynamic value-added networks, because value will no longer be added sequentially and subject to time lags, but within a network of units that constantly communicate and respond flexibly to each other, and largely organise themselves. The enablers of the digital transformation of industry include the Internet of Things, high-quality broadband networks and the increasing automation and autonomy of production. All these technologies and propositions prepare the ground for disruptive developments and make them more likely to happen.



Cooperative robots can fully integrate with humans in performing a wide range of tasks.

CREDIT: ABB

LOGIC OF DIGITISATION

In effect, digitisation is accelerating the process of evolution towards Industry 4.0. To be able to assess the risk of being 'uberred', companies must first understand the logic of digitisation. In a special report issued in Germany by Roland Berger two years ago we can see that digital transformation takes effect via four levers.

Digital data – capturing, processing and analysing digital data allows better predictions and decisions to be made.

Automation – combining traditional technologies with artificial intelligence is increasingly giving rise to systems that work autonomously and organise themselves. This reduces error rates, adds speed and cuts operating costs.

Connectivity – interconnecting the entire value chain via mobile or fixed-line high-bandwidth telecom networks, synchronises supply chains and shortens both production lead times and innovation cycles.

Digital customer access – the (mobile) Internet gives new intermediaries direct access to customers to whom they can offer full transparency and new kinds of services.

The availability of digital data, automation of production processes, interconnection of value chains and creation of digital customer interfaces is transforming business models and reorganising entire industries. Just how

far-reaching this will be is exemplified by pioneering industries such as media, music, retail and tourism. Signs of similarly disruptive changes are already appearing in the automotive and logistics sectors, too.

ENABLING TECHNOLOGIES

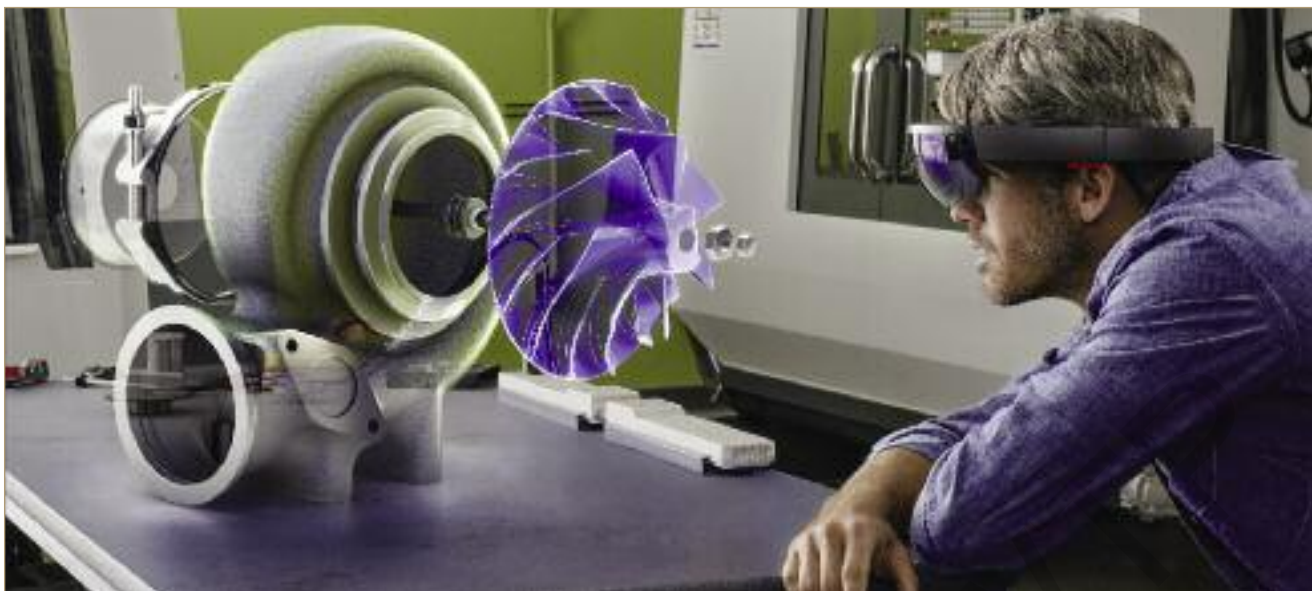
Industry 4.0 is built on a set of enabling technologies that make up the recipe for migration towards digital manufacturing. In a study published in 2013 by the McKinsey Institute, some of them were described and were considered to have a disruptive impact on manufacturing and our lives in general.

Internet of Things – networks of sensors and actuators for data collection, monitoring and decision making that together can be used for process optimisation. When applied to the manufacturing environment it becomes the Internet of Machines.

Advanced Robotics – increasingly capable robots with enhanced senses, dexterity and intelligence used to automate tasks and augment the activities of humans.

Augmented Reality – where digital information is superimposed on to a real world view to augment the capabilities of workers and enhance their skills.

3D Printing – additive manufacturing to create objects by depositing layers of materials based on digital models.



If these are the main components of Industry 4.0, other technologies such as simulation, horizontal and vertical system integration, cyber security, the cloud, big data and analytics are just as important and contribute to the full implementation of the concept and the digital transformation of modern industries. A new world is appearing, made of smarter machines, interconnected, capable of communicating their status and their needs for a more proactive and efficient handling of manufacturing processes.

OPTIMISING MANUFACTURING EFFICIENCY

Industry 4.0 does not simply look at fixing machine problems when they appear, but conceives the equipment so that it can proactively monitor its own status and anticipate possible failures. In addition, by regularly recording operating conditions, working parameters and machine behaviour, these data can be used to provide machine users with a performance optimising service to improve overall manufacturing efficiency. No more 'just maintenance' but performance optimisation is sold as a service to the footwear companies of the future.

There is a caveat, however, in that while connected machines and sensors provide an enormous wealth of data, they are at the same time both a value and a problem if we cannot put order in the chaos. Data generate knowledge and knowledge is the basis of intelligence as long as we have the methods and the tools to master them. These are other key ingredients of the Internet 4.0 recipe: big data and analytics.

ROBOT ASSISTED MANUFACTURING

2015 was a record year for the sale of robots worldwide with a number of units sold that broke all previous records—and with China the leading buyer. Data for 2016 are not available yet but it is very likely that the growth rate in terms of installation will be maintained. We are at the dawn of the age of robots or, perhaps more accurately, advanced robots with all the positive and negative implications that brings. These robots are, however, not quite the same as those we see in factories today.

In the past we have been used to so called 'industrial robots', confined to work in secluded areas where human

Wearable augmented reality (AR) devices allow the operator to view additional information while remaining focussed on the assigned task.

CREDIT: MICROSOFT

operators were not allowed to enter for safety reasons. They were big intimidating machines that required great skill to be programmed and used, inhabitants of so called 'dark factories' that, some time ago, many thought would be the future of manufacturing. Instead, in the future we will see more and more collaborative robots, designed to work side by side with their human colleagues. They will be the protagonists of 'smart factories'.

The challenge is to allow new generation robots and workers to live together in a friendly and safe way for the latter, a challenge that calls for machines designed in a totally different way. The key point is how to make human workers and robots interact safely. In the past, there were no interactions at all; robots and workers were placed in different workplaces with no contact either possible or desired. Then workplaces became shared in a limited way called 'exclusive motion' where either the robot or the worker was moving. Contact was possible but only with a stationary robot as in the case of industrial robots acting as handling assistants.

Ascending the level of scale of Human Robot Cooperation (HRC), we find solutions in which there are no more physical safety fences but only virtual ones, such as laser barriers where contact with the robot is still not desired and very unlikely. The generation of so called 'cooperative robots' assumes that in the shared workspace contact is possible yet not desired or, at the highest level of cooperation, is fully desired with simultaneous motion of the worker and the robot as is the case with manual guidance. A totally new paradigm in the automation of the fabrication process for which we can introduce a yet unused acronym, RAM or Robot Assisted Manufacturing.

Shoe factories will then become attractive for workers, healthy and safe environments where humans perform rewarding jobs while repetitive ones are left to machines and robots. Yet the widespread diffusion of robots does not come without a price. Many recent studies analyse the short

and long-term impact that robots, artificial intelligence and automation in general will have on the future of labour. Almost all analysts agree that in the long term the impact will be positive in terms of job creation and quality of work. Some, however, believe that in the short term, we will see a more negative and destructive phase in which jobs will disappear or be transformed, a scenario worth careful consideration by planners and policy makers in the near future.

AUGMENTED REALITY

The dictionary defines augmented reality or AR as being a technology that superimposes a computer-generated image on to a user's view of the real world, thus providing a composite view. Commercial models of AR devices, ranging from simple glasses to elaborate goggles and helmets, are already available and one can think of applications of the technology in fields such as remote machine maintenance, process control and field operations. Wearable devices such as the HoloLens from Microsoft could replace displays and other equipment, presenting the operator with the necessary information with a context sensitive approach and allowing them to stay focused on the assigned task. It is quite likely that we will see them in the shoe factories of the future. An application of AR and wearable technologies aimed at replacing projection systems normally used in the current generation of cutting machines is now under study at ATOMLab, the Research and Innovation laboratory of Atom Group.

3D PRINTING

Additive manufacturing is another pillar of the digital transformation that we have already dealt with on previous occasions in *World Footwear*. What we want to restate here is that this technology has an inherent potential to disrupt the mere notion of products, the way they are fabricated and the relationship between consumers and the products they buy. It is vital that companies understand this potential before they are swept away by the digital tide. Hybrid shoes with more and more 3D printed parts are making their appearance in the market, with major brands such as Nike,

adidas, Reebok and others introducing their own interpretation of the concept. This will shift the balance of shoe making from high touch to high tech.

The original shoemakers worked directly with their customers solely through the high touch of their skill and manual ability. Since the coming of industrialisation, shoe manufacture has become increasingly less touch and more tech. Additive manufacturing is ushering a new high tech revolution based on the combination of an all 3D printing manufacturing approach and customisation. This is going to change dramatically the entire footwear value chain, especially if we think that the true potential of additive

manufacturing is in making possible what is totally impossible with other technologies.

The digital transformation of manufacturing and, indeed, our very lives is already happening and is there to be seen in every single one of our daily activities. In this respect Industry 4.0 may be considered a 'meta revolution' meaning that it factorises and multiplies all the most relevant aspects of work organisation, mechanisation, automation and IT, raising them to an unprecedented level of effectiveness through the power of digital data. In the future, we should therefore expect to see more and more smart shoes, in smart factories produced by smart workers. 🌀

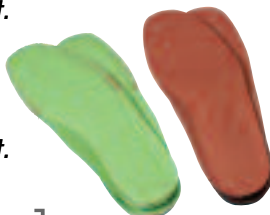
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