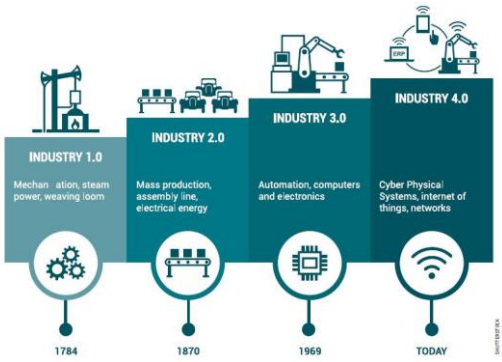
Investment Insight

INDUSTRY 4.0: THE TRANSFORMATION OF THE MODERN FACTORY

"We stand on the brink of a technological revolution that will fundamentally alter the way we live, work and relate to one another... when compared with previous industrial revolutions, this one is evolving at an exponential rather than linear pace.… it is disturbing almost every industry in every country. And the breadth and depth of these changes herald the transformation of entire systems of production, management and governance".

Klaus Schwab, The Fourth Industrial Revolution, 2016

The British economic historian Arnold Toynbee first coined the term industrial revolution to mark a period that began in Britain in the late 18th century with the development of the steam engine and the mechanisation of textile production. Progressively, tasks previously done by hand by hundreds of weavers in cottages dispersed across the land were now carried out instead using power looms under the single roof of a cotton mill. This was the birth of the modern factory and the beginning of the first industrial revolution. The second came in the early 20th century when Henry Ford mastered the modern assembly line and ushered in the age of mass production. Then, in the 1960s, the emergence of information technology and electronics enabled the automation of production giving rise to the third industrial revolution. Yet manufacturing is now entering a new era of transformation which many, like Klaus Schwab, founder of the World Economic Forum, have heralded as the fourth industrial revolution, or Industry 4.0.



At the nexus of Industry 4.0 is the convergence of numerous advances in digital technology. Though none of these are individually new, they have reached a critical tipping point in their lifecycle, driven on the one hand by the declining cost of sensors, data processing and storage, and on the other by exponential advances in areas like big data analytics. These technologies include product lifecycle management software; advanced collaborative robotics; artificial intelligence; the Internet of Things; digital fabrication (including 3D printing); nanotechnology and advanced materials; automated guided vehicles; and new generation RFID solutions. Though each can of course be used separately, when implemented together, integrating the physical and virtual worlds, they have the potential to transform global manufacturing. Indeed the way to think of the factory of the future is as a network of intelligent industrial devices and machines that connect people, machines and processes all the way from the factory floor to the executive suite. This network can collect, share and analyse greater amounts of data at far greater speeds than ever before, delivering not only a step change in the operational efficiency of industrial companies but also in many cases transforming their inherent business model.

The motivation is of course economic. Over the past twenty years, manufacturing production has been driven by the desire to take advantage of low labour and environmental cost locations, with companies often relocating their factories to emerging

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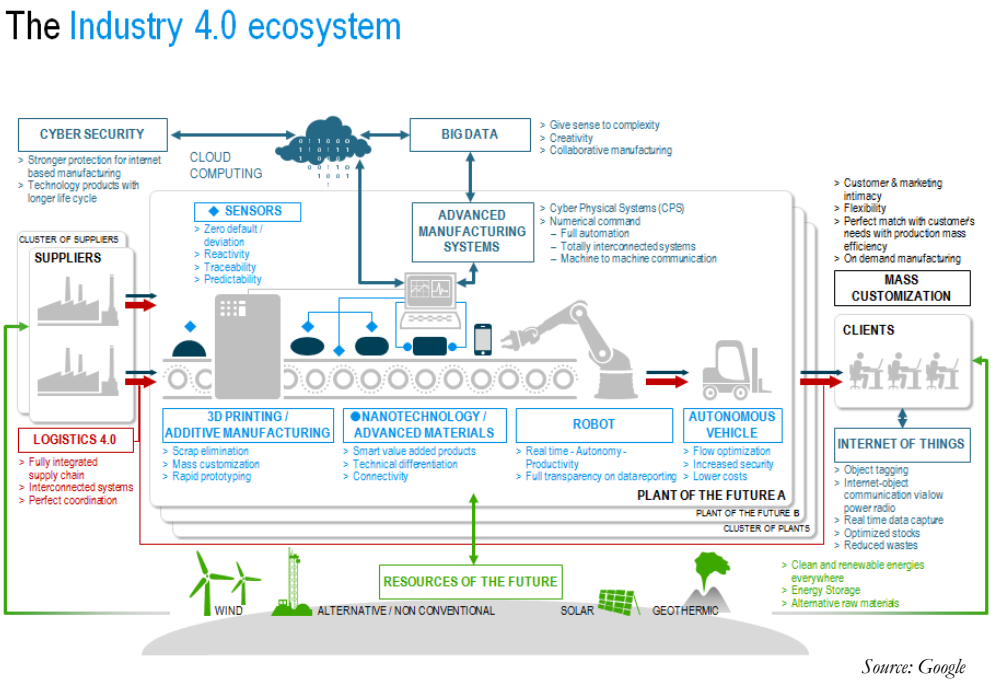
markets to take advantage of these arbitrage opportunities. At the same time the emerging economies infrastructure boom was in full swing, fuelling demand. These dynamics have now changed. The emerging markets boom is largely behind us. A growing middle class in these markets is increasingly demanding higher wages while the skilled manufacturing talent pool globally is shrinking. New global competitors have emerged. Tighter regulatory requirements on safety and security need to be met. At the customer level, goods are expected to be delivered at an ever faster speed to the market and mass product customisation is increasingly the norm. These all pose an unprecedented challenge for manufacturers and demand novel solutions. This is what Industry 4.0 is aiming to address.

A unique ecosystem of interlinked products and solutions

The Industry 4.0 ecosystem touches on all aspects of production: the design and development of products and processes; the actual physical process of manufacturing; the management of the production supply chain; in-factory logistics; as well as after sales customer support and ultimately the sales process itself.



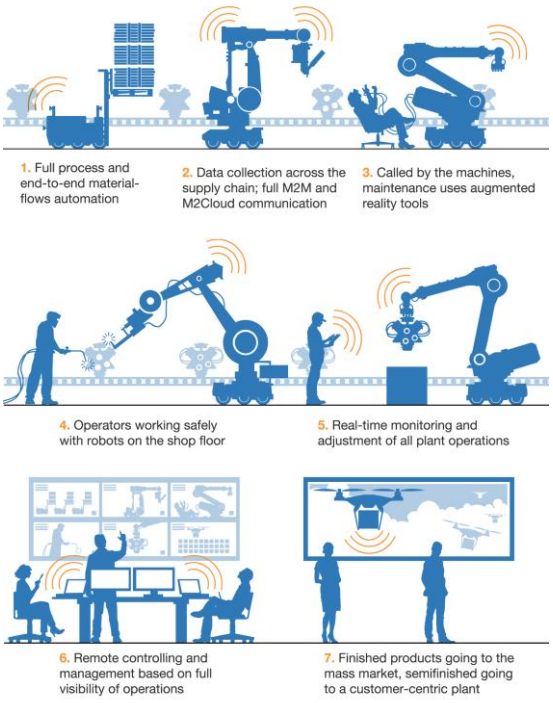
Source: Google

Product and process design is the most immediate aspect affected. As products and the way these are made become increasingly complex, the need to optimise their design becomes imperative. Under *Product Lifecycle Management software* solutions products and manufacturing processes are drafted in simulation laboratories using virtual design models. The products themselves take tangible shape only after most of the design and engineering problems have been worked out, simulating the entire life cycle from design and development to production, servicing and disposal. Manufacturing processes are simulated, optimising factory efficiency, avoiding costly errors and reducing implementation times. The opportunity is enormous with the addressable market estimated at $30-35bn by 2020. Players like Siemens and Dassault Systemes offer the broadest suite of solutions and increasingly dominate this space along with other more specialised players like Autodesk, Ansys and PTC.

Industrial Internet of Things platforms have made remote asset monitoring and administration, predictive maintenance and dynamic manufacturing a reality. Industrial operating systems leveraging cloud based storage and big data analytics transform factories to networks of machinery responding not just to human commands but to their own perceptions and self-direction. As a result, manufacturing becomes increasingly flexible maximising asset utilisation, reducing downtime and optimising supply chain management. Numerous industrial automation players participate in the industry including one of our core holdings, Rockwell Automation, as well as GE, Siemens and Schneider Electric. It is indeed one of the largest potential opportunities within Industry 4.0, with an addressable market size that is estimated at $200-250bn by 2020.

Robotics is also developing away from the bulky caged beasts we all have in mind when thinking of a car assembly line. *Advanced collaborative robots* are increasingly able to work alongside humans displacing low skilled, repetitive labour tasks, a trend that will only increase as their cost decreases and higher end capabilities like *machine-learning* and independent decision making improve. Kuka (now owned by Midea Group), ABB, Fanuc and Universal Robots (now owned by Teradyne) have been at the forefront of robotic development driving penetration in broader industrial applications, including areas like logistics, assembly and testing.

Smart automated plant illustration



Source: "Industry 4.0: How to navigate digitization of the manufacturing sector," McKinsey Digital, 2015
McKinsey&Company

At the same time, the traditional approach to manufacturing, in which various individual parts are welded or forged into a single product is changing. *3D printing,* whereby a physical object is produced in one complete unit from a digital blueprint, has already transformed prototype development of new models. Progress in material science allows for a broader range of materials to be utilised and as higher speed and lower energy consumption thresholds are surpassed, wider adoption will follow. The technical advantage the technology offers is indeed transformative. 3D printing can lead to lower raw material consumption, it can help overcome structural vulnerabilities that forged or welded products often suffer from, and more importantly it allows mass customisation to become a tangible reality. Two companies, 3D Systems and Stratasys have been at the forefront of this $25-30bn potential market, though printing giant HP has been making significant inroads, infringing on their first mover advantage.

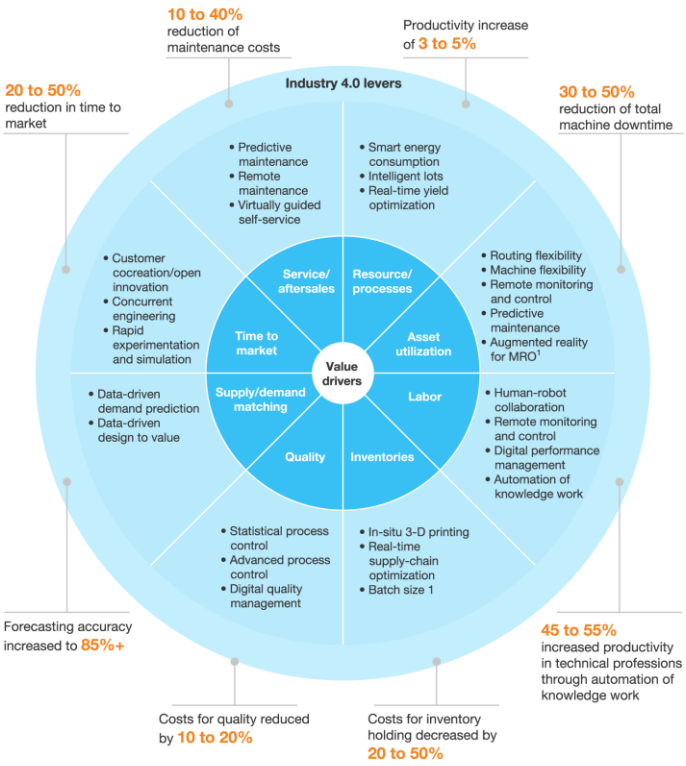
Logistics processes are also being transformed through *automated guided vehicles* and *warehouse management systems*. Increasingly connected and automated logistics systems that seamlessly transport objects through factories and distribution centres lower labour and inventory costs and allow for more flexible production models that do not rely on a fixed assembly line. Key participants include Kion, Jungheinrich, Siasun and Kuka. At the same time, *next*

generation radio-frequency identification (RFID) technologies allow the identification and tracking of objects across manufacturing networks transforming the supply chain management process. Though the technology is not new, next generation solutions increasingly come at more competitive pricing points. As "costs per tag" fall below the current $0.50 level, application will broaden beyond high value items, allowing for better inventory administration and production line throughput, reducing working capital.

Outlining the benefits

These technologies offer tangible benefits. At its core, Industry 4.0 addresses two of the manufacturing industry's key challenges. Firstly, it shortens time to market enabling the development of ever more complex products with increasingly shorter innovation cycles. Secondly, it optimises industrial processes and individual assets, reducing inefficiencies and resource consumption, increasing production output and quality, and enhancing workforce safety. But importantly, Industry 4.0 has also the potential to generate revenue gains for manufacturers. These stem from incorporating enriched digital features in product offerings and from introducing enhanced analytics or other services to customers. At the same time, it enables companies to deliver more personalized products and customized solutions with the higher margins that these would normally bring. Indeed mass customisation is now becoming a reality.

The McKinsey Digital Compass maps Industry 4.0 levers to the 8 main value drivers.



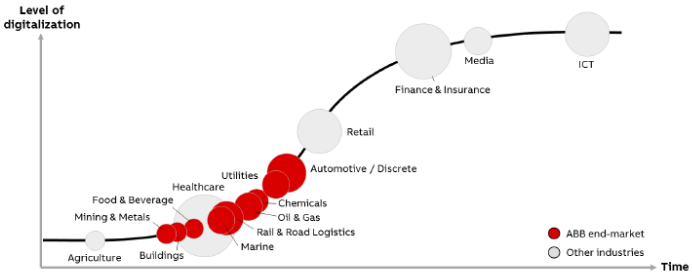
[1]Maintenance, repair, and operations.

Source: "Industry 4.0: How to navigate digitization of the manufacturing sector," McKinsey Digital, 2015
McKinsey&Company

Manufacturers are already recognising these benefits and transforming their factory floors. In 2016, in a survey called *Industry 4.0: Building the Digital Enterprise*, PwC surveyed more than 2,000 companies from 26 countries across the industrial spectrum, including aerospace and defence; automotive; chemicals; electronics; engineering and construction; paper and packaging; industrial manufacturing; metals; and transportation and logistics. One-third of the respondents said their company had already achieved advanced levels of integration and digitization, and more than two thirds expected to reach that point by 2020. This momentum reflects expectations of significant payoffs with the respondents noting that on the basis of their experience to date, they expected to see both cost reductions and revenue gains from their digitization efforts. Indeed over 40% of the companies surveyed expected to secure cumulative efficiency gains and cost savings of more than 20% by 2020 and many anticipated that these will be accompanied by incremental revenues of a similar magnitude. All told, survey respondents expected to see $421bn in annual cost reductions and $493bn in increased revenues by 2020. Investment levels are significant, with companies expecting to spend over $907bn annually to develop

these capabilities. In a similar study called *Industry 4.0: How to Navigate the Digitalization of the Manufacturing Sector* published in 2015, McKinsey identified similar productivity gains across the manufacturing value chain, with the analysis pointing to the potential for a 30-50% reduction in machine downtime, a 10-40% reduction in maintenance costs and a 20-50% reduction in time to market.

Implementation in different industries will of course be dictated by specific factors, including each individual industry's current level of automation, its asset and labour intensity levels, the age of its asset base, the market dynamics it is facing and the nature of the products manufactured. The automotive and electronics industries have of course been at the forefront of the drive to automate production and key adopters of technologies like robotics, with the automotive industry alone accounting for over 40% of global robotics sales. But companies across the industrial spectrum from chemicals to food and beverages are deepening their levels of digitalisation and moving towards Industry 4.0.



Source: ABB

Picking the winners

For the solution providers themselves all this implies not only a tangible revenue opportunity but also has the potential to transform their own business model. Industrial automation companies have the potential to evolve from sellers of machines into service providers. Connectivity and data analytics enable companies to collect detailed information on products and processes and provide customers remote diagnostics and maintenance, or even remote operations management, with product as a service as a new business model. It means an opportunity to differentiate product offerings, extract more value from installed bases, tap into new and more recurring revenue streams and build deeper and stickier customer relationships. Interestingly software companies have typically traded at a 40% premium to capital goods companies. With 40-60% of revenues for major automation players embedding some software and connectivity features, the way these companies are valued from the investment community is likely to be revisited in the future.

It is important to remember of course that implementation of Industry 4.0 will not be without its challenges. Industrial infrastructure has high specification requirements in terms of security, reliability and performance. Infrastructure and manufacturing assets require seamless reliability and the ability to perform on a continuous real-time basis. The cost of system failure and production downtime is tremendous. At the same time, security of data is paramount. Industrial customers will want to maintain close control of information on their intellectual properties, assets and processes, and governments will place severe restrictions on data of critical national assets such as transport and energy.

This is why we believe specific industrial automation providers are uniquely placed to deliver on this transition, leveraging on important strategic advances. We look for companies that are trusted suppliers to their customers with relationships covering the age of their installed base, which can be over 20 years in the case of many large infrastructure assets. We look for players with asset management and operations management capabilities that have been developed over decades, connecting assets, predicting outcomes and with

the critical domain know-how to provide context to data analytics. Indeed an in-depth understanding of verticals like healthcare, transport and power is key to ensure that the data extracted can be contextualised correctly.

Rockwell Automation, a long-term holding, for example, is a leading global provider of industrial automation control and information solutions and a pioneer in integrating manufacturing IT with ERP. The company is one of the few pure plays in the industrial automation market with a leading technological offering. Its flagship Industry 4.0 offering marketed under the banner "Connected Enterprise," builds on the company's long heritage in sensors, control systems and network solutions and aims to transform the manufacturing floor and process by integrating all discrete systems across the organisation into a single, unified network infrastructure. Importantly, Rockwell's domain expertise, large installed base, open Ethernet solutions and scalable architecture position it strongly to benefit from this structural opportunity.

Where capabilities cannot be developed internally acquisitions come into play and takeovers of assets will only pick up pace. Chinese firms have been notable in deepening their presence in the space with the acquisitions for example of KraussMaffei by ChemChina and of Kuka by Midea Group as well as the strategic partnership of Kion with Weichai Power. Among traditional automation players, Schneider Electric bought Invensys for £3.4bn back in 2013 in a bid to enhance its process automation and control systems business, further expanding its portfolio in September this year by taking a controlling stake in engineering software developer Aveva. Siemens has spent over $10bn in the last decade building its software presence, acquiring companies including UGS, LMS International, CD-adapto and most notably Mentor Graphics for $4.5bn in November 2016. Indeed Emerson Electric's boosted $29bn bid for Rockwell Automation at a valuation of 19.5x 2018 EBITDA just last week underscores the inherent value of these assets.

Back to the weaver's cottage

It is ironic that the fourth industrial revolution may be moving the output of production back to its origins. The first three industrial revolutions made mass production possible with thousands of identical products at the end of the assembly line. Henry Ford had famously said that buyers could have any colour of the Model T car they wanted so long as it was black. But the fourth revolution is now taking production back to its origins, enabling mass customisation and transforming factories into highly sophisticated weavers' cottages where the batch size becomes once again one.

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