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Is manufacturing coming home?

The trend towards shifting manufacturing back to developed countries from cheaper locations is far from straightforward

BRIAN GROOM

Adidas's newly opened, highly automated "speedfactory" at Atlanta in the United States provides a vivid illustration of the possibilities and limitations of reshoring.

Reshoring has happened to some degree over the past ten years as rising wage costs in China and elsewhere in Asia eroded the previous benefits of offshoring. Some companies also had problems with quality, intellectual property theft and long, vulnerable supply chains. Now reshoring has become a hot political issue, particularly since Donald Trump's election as US president.

President Trump pledged to bring manufacturing jobs back to the US; his tariffs on imports from China, Canada and Europe aim in part to achieve that. In the UK, there is debate about whether Brexit could accelerate reshoring or further weaken manufacturing.

Atlanta's production, like that of its sister plant in Germany, is three times faster and also more flexible than at Adidas's Asian plants. It can make short-run products designed for local markets, such as AM4NYC (Adidas made for New York City) trainers, created for New York's urban streets.

These "speedfactories", however, each employ only 160 workers, compared with 1,000 or more in a typical factory in Asia. Adidas plans eventually to take these technologies into factories in China, its fastest-growing market.

"Our production landscape is 90 per cent Asia-based. I do not believe, and it's a complete illusion to believe, that manufacturing can go back to Europe in terms of volume," according to Kasper Rorsted, Adidas's chief executive. "And that goes for the entire industry."

Globally, the question is whether reshoring amounts to a trickle or something more substantial and whether it can restore significant employment, given today's levels of automation.

Reshoring appears so far to have been greater in the US, encouraged by low energy costs as a result of the shale gas boom, than in Europe. Companies such as General Motors, Boeing, Ford and Intel have reshored thousands of jobs over the past decade.

There is conflicting evidence about how strong the trend is. The Reshoring Initiative, a lobby group, reckons 576,000 US factory jobs have been created through foreign investment or reshoring since manufacturing employment's low point in 2010, while three to four million remain offshore. It believes President Trump's corporate tax cuts, reduced regulatory costs and a lower dollar make this a good time to reshore.

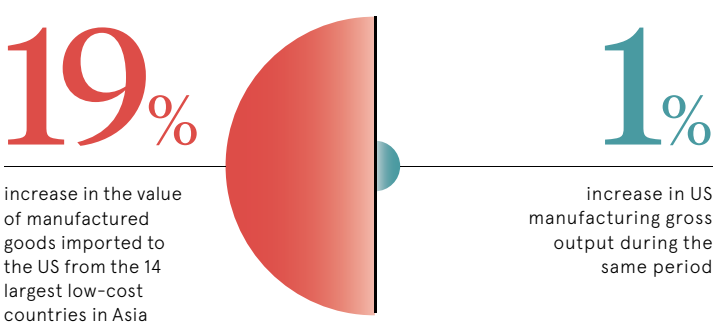
Inside an Adidas Speedfactory, where production is completely automated and three times faster than its traditional plants

However, consultants A.T. Kearney argue that reshoring is "in reverse". They calculate that since 2013 imports of manufactured goods from the 14 largest low-cost countries in Asia have increased in value by 19 per cent, while US manufacturing gross output has grown by only 1 per cent.

Examples of reshoring in the UK include vacuum cleaner maker Gtech, which plans to shift some production from China to Worcestershire, and shoemaker Clarks, which is bringing manufacturing of desert boots home to Somerset from Asia. Elsewhere in Europe, Le Coq Sportif, the sportswear maker, is bringing production back to France from Vietnam.

A survey in 2014 by EEF, the manufacturers' federation, found that one in six UK companies had reshored production in the previous three years. The main reason was quality, followed by certainty and speed of delivery, transport costs and risk of supply chain disruption.

The numbers depend partly on definition. A survey by the University of Warwick's Manufacturing Group, conducted for Reshoring UK, an industry body, found only 13 per cent of companies had directly reshored. But 52 per cent had indirectly reshored, meaning they had decided to increase capacity at home instead of abroad.



A.T. Kearney 2018

Janet Godsell, professor of operations and supply chain strategy at Warwick, says for multinational companies the question is what makes sense in terms of supply chain design. Some have a system that is global for raw materials, regional for manufacturing and local for distribution.

Companies look at total cost, including transport and inventory, rather than simply labour costs, as tended to happen in the 1990s' offshoring wave. The need to reduce lead times and customise products for local consumers are further factors.

"What we should be focusing on is not reshoring but 'rightshoring', making sure we put things in the right place," says Professor Godsell, who adds that the emerging trend is "distributed manufacturing" or having a number of plants around the world, which reduces disruption risk.

Reshoring is not easy or cheap, notably because many countries have lost manufacturing skills as a result of previous offshoring. Mobile phone handset maker Motorola, then owned by Google, closed its Moto X factory in Texas in 2014 after less than two years because costs were high and it could not sell enough in the US market.

Companies find it hard to recruit skilled workers and sometimes have to bring in managers from overseas to design production processes.

Further barriers in the UK include high energy costs and the question of whether banks will lend to small suppliers to invest in equipment, says John Glen, economist at the Chartered Institute of Purchasing and Supply. He adds: "We have reached an equilibrium where, in areas in which the benefits are relatively clear, you will still get offshoring. Where they are not, reshoring will occur."

Will political pressures lead to more reshoring? Brexit could be double-edged. UK manufacturers will try to build up supply chains at home to avoid tariffs and other barriers, but European Union-based companies may use fewer UK suppliers.

President Trump's tariffs might encourage some US companies to reshore from China, but others could move instead to countries such as Mexico or Thailand.

Dr Glen concludes: "If you have significant protectionism, you will have significant reduction in global economic activity. So while there may be benefits from reshoring, total global activity could decrease significantly." ◆

AUGMENTED REALITY

Krisztian Bocsi/Bloomberg via Getty Images

Employee of German car parts manufacturer ZF Friedrichshafen wearing Hololens augmented reality glasses

Vision of the future way of working

No longer the stuff of science fiction, augmented reality is poised to transform manufacturing and even routine engineering

ADRIAN BRIDGWATER

The airlock opened as the engineer's head-mounted display sprang into life. She walked over to the machine bay to examine the day's tasks. The headset displayed the engineer's normal field of vision, but every turn of her head peppered the screen with a flurry of live-streamed text and annotations describing alerts and operational instructions.

"These augmented reality (AR) instructions tell me where to go and how to fix things, but they never tell me how to fix a good baloney and pickle sandwich," grumbled the engineer, before getting on with the maintenance tasks assigned for that shift.

Back in central control, the Motherbrain quantum computer analysed the engineer's progress and switched tasks from core upgrades to longer-view predictive maintenance operations. With so many internet of things sensors now in place around the manufacturing shop floor, it was easy to apply data analytics to the plant and fix the machine that was about to break, rather than the one already out of action.

This is not some dystopian vision of the future or a reinvention of Terry Gillian's 1985 film *Brazil*; this is how AR is set to be applied in modern industrial manufacturing environments. So what will the next manufacturing workforce look like when AR begins to intersect with robotics and drones? How instrumental will AR be in achieving a truly smart factory? Just how close to steam-filled airlocks and bad baloney sandwiches are we?

According to Eric Braddom, AR leader at intelligent product services company Flex, using this technology to collaborate with remote experts to troubleshoot issues or provide work instructions using head-mounted displays on the factory floor still faces challenges.

Mr Braddom claims real-world operational requirements are stringent and must meet high standards for safety regulations, toughness, long battery life and allow a full range of vision. Also, while there have been some large-scale deployments in the last 12 months, widespread adoption will need the low latency and network capacity of 5G to become commonplace.

Jacques Delacour, optics and virtual reality business line director at engineering simulation software company Ansys Inc, concedes that most traditional factory floors still have information displayed on dials, screens or paper. But he says, despite the not-quite-there-yet factor, AR's ability to put instructions directly in the field of view of the operator or technician is a future certainty.

"Working hands free on technical manufacturing tasks will be key. Some mounting operations can only be performed when an engineer's hands are placed in a very specific way. This direction is very complicated to explain on paper, but is very easy to display in 3D," says Mr Delacour.

Ansys has been able to start developing the use of digital twins. These are software-based representations of working manufacturing equipment that can be brought to operational life in 3D video. The company says all information in a device can also be physically simulated, whether it is moving parts, fluids, temperature, ergonomics and so on. Analysis of this virtual twin can be used to make the operations of the technicians and operators safer and more efficient.

Jens Roehrich, director of the HPC Supply Chain Innovation Lab at the University of Bath School of Management, envisages a near future when manufacturing professionals will be able to take photos of parts and assemblies they are inspecting to contrast and compare these to images provided by the company's suppliers via AR. Any discrepancies can then be much more quickly highlighted.

Professor Roehrich points out that, properly applied, AR in the manufacturing space can provide quick access to inventory information, lead times and specifications, which can be summoned in real time without disrupting the flow of production. This will help to cut production downtime and also minimise errors.

Data is significant. "The limiting factor for the adoption of AR in manufacturing isn't just related to factors such as the visualisation technology, it's also restricted by data management systems," says Julian Saunders, chief executive and founder of personal data governance company PORT.im. "Data that is highly accurate and delivered in real time underpins AR. Put simply, any AR system is only as good as the information that fuels it."

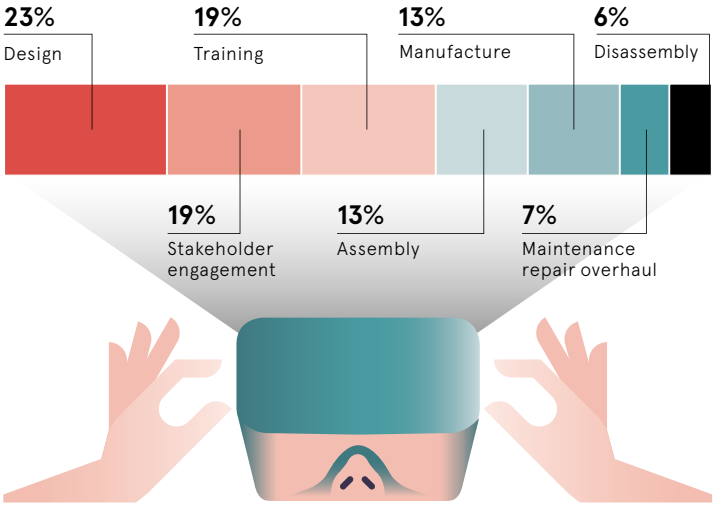
Mr Saunders points out that this is especially true in manufacturing where quickly and accurately ascertaining the location of a component and its provenance, the health of factory equipment or the efficiency of a process requires the collection, management and analysis of scores of data streams. As a result, he says, industrial AR will now evolve hand in hand with the development and adoption of data management systems and the advancement of data science techniques.

> **Humanity has to move on to this next step, both in the workplace and elsewhere**

Evgeny Chereshnev, chief executive and founder of biometric wearable technology company Biolink. Tech, concludes: "Our first use of AR in manufacturing is like the invention of the microscope. The microscope opened up a whole new world for us that already existed, but had remained hidden. With AR, people will start to see the 'data layer of life'; they will be able to see statistics and characteristics of real-world objects in real time. Humanity has to move on to this next step, both in the workplace and elsewhere." ◆

When immersive technologies are used

Where companies use immersive technologies in the product life cycle



HVM Catapult 2018

Smart manufacturing: getting your arms around it

It's time to ignore the smart manufacturing buzzwords and focus on the practical benefits instead

Autodesk Fusion Production enables smart manufacturing through data-driven insights

Mention smart manufacturing to most people and a number of different concepts will come to mind depending on who you're talking to. Take Industry 4.0. The high-tech strategy of the German government promotes the computerisation of traditional industries such as manufacturing. Its goal is the intelligent or smart factory, a unit that benefits from adaptability, resource efficiency and ergonomics, as well as the integration of customers and business partners in business and value processes.

Others will think of China 4IR. The Made in China 2025 strategy aims to turn China into a global manufacturing power able to influence global standards and supply chains, and to drive global innovation.

In the United States, the Smart Manufacturing Leadership Coalition, is a non-profit organisation comprising practitioners, suppliers and technology companies plus universities and government agencies. Here the aim is to enable stakeholders in the manufacturing industry to enable collaborative research and development, standards and shared infrastructure that facilitate the adoption of manufacturing intelligence.

The approaches might be many and varied but, according to Callan Carpenter, vice president of digital manufacturing and named accounts at Autodesk, a leading producer of software for manufacturers, the central idea is simple. "Don't worry about the jargon and buzzwords," he explains. "Smart manufacturing is about exploring more solutions and building better products. At Autodesk we believe that smart manufacturing is simply about doing more, doing it better, with less negative impact on the planet."

Businesses, often overwhelmed by change, can make small, incremental investments focused on key areas, says Mr Carpenter. "Data is the lifeblood, the new oil of the digital business, but the key is to capture the right data so you have enough compute power to analyse and interrogate it to draw essential insights."

The revolution currently taking place in the manufacturing industry is throwing up challenges for many, but those ready to embrace smart manufacturing are already benefiting from the opportunities it offers. Products need to come to market faster than ever and their shelf life is now shorter, offering agile companies the chance to steal a march on the competition.

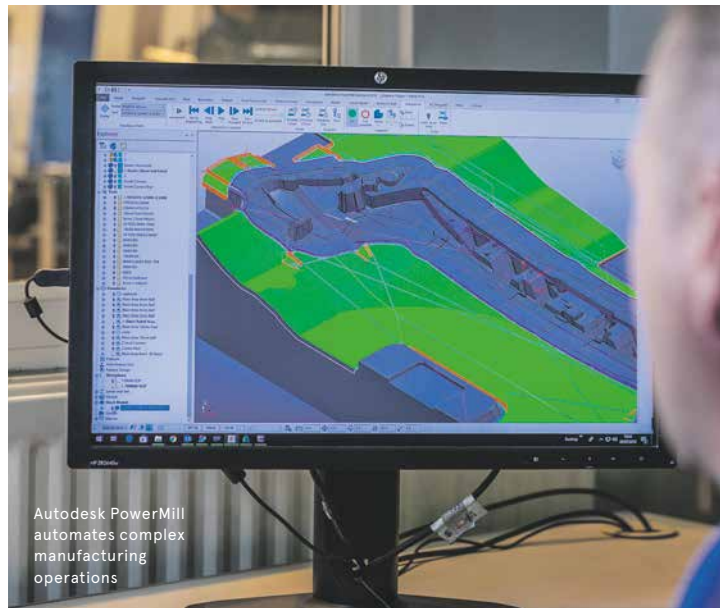
Near-shoring means items are being produced nearer their intended customers rather than a month away by container ship so small runs can be ordered on a just-in-time delivery basis. "Customers expect to get their items more quickly, but they also want what they buy to be customised to them as an individual," says Mr Carpenter. "This might be shoes that are designed to fit your feet exactly or cars which offer you millions of options. A major automotive customer recently mentioned to us that even with a production run of 300,000 there are so many variants that no two are identical."

> **Smart manufacturing is about exploring more solutions and building better products. At Autodesk we believe that smart manufacturing is simply about doing more, doing it better, with less negative impact on the planet**

Meanwhile, customers are also demanding the kind of improved product performance that can only be achieved with advanced materials and processes. Twenty years ago, carbon fibre was only to be found in aerospace. A decade later it had reached the highest performance street cars. Today, thanks to customer expectations of cars that are faster, safer and more fuel efficient, it's increasingly common across the entire industry.

However, smart manufacturing can help businesses meet these challenges and make the most of the opportunities. Increased automation is not only increasing efficiency, but it's taking away manual, repetitive or low-skilled jobs like manual setups, simple tool paths, manual finishing from machine operators, and automating them to boost productivity.

Alongside this change, connected manufacturing is making communications between machine and physical things, creating complex inter-relationships among physical objects. Ubiquitous and inexpensive sensors connected to production hubs mean places, things and media will be connected, intelligent and dynamic.



Autodesk PowerMill automates complex manufacturing operations

Steve Hobbs, vice president of computer-aided and hybrid manufacturing at Autodesk, says: "We're finding that manufacturers are coming to us for help because their manufacturing process is increasingly collaborative and they need technology that connects more and more people to increasingly complex projects. We're going to see global virtual teams and collaboration on a scale unheard of so that's why we introduced Shared Views and Autodesk Drive into our manufacturing technologies such as PowerMill."

Shared Views enables manufacturers to share engineering data with key stakeholders, anywhere, anytime with cloud-connected devices, to request approval or to provide easy access to a field sales team for on-site presentations.

Greater integration of the digital and physical means digital systems are becoming deeply integrated into departments easier. Typical reporting, logging, inventory tracking and times are being cut so skilled workers can utilise their time better to deliver quality products on schedule.

"Products can now gather and stream data about how they're being used to provide valuable insights about the needs of the end-customer for the next iteration of the product," says Mr Hobbs. "As a result, that product can come to market more quickly and it's more likely to be what customers are asking for. We find that when companies experience the practical benefits like this, things they can actually get their arms around, then they really start to embrace the future of making things."

For more information please visit www.autodesk.com/manufacturing

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Polishing up their productivity

Polishing techniques are used in almost every sector of industrial manufacturing from engine components to phone casings. Because of its complexity, polishing is a job that has to be done by hand. Until now, that is. Symplexity is an European Union-funded project that aims to develop new opportunities for collaboration between humans and robots.

A consortium of 15 partners, including Autodesk as well as end-users, universities, integrators and polishing experts, have come together to develop a solution that will free people from repetitive, labour-intensive work and allow them to use their skills to become more productive.

"The collaboration between humans and robot technology being developed through Symplexity is changing the nature of work, reducing the skills gap, and improving productivity and job satisfaction in the smart factory of the future," says Autodesk's Callan Carpenter.

Commercial feature

Factory of the future

The digital factory of the future is not as far away as you may think

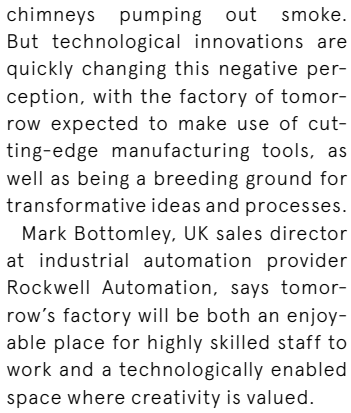
The image much of the general public has of today's factory is one of industrial buildings and unsightly chimneys pumping out smoke. But technological innovations are quickly changing this negative perception, with the factory of tomorrow expected to make use of cutting-edge manufacturing tools, as well as being a breeding ground for transformative ideas and processes.

Mark Bottomley, UK sales director at industrial automation provider Rockwell Automation, says tomorrow's factory will be both an enjoyable place for highly skilled staff to work and a technologically enabled space where creativity is valued.

"The factory of the future will be home to talented graduates who are looking for an exciting career and want to carry out interesting work that drives innovation in the industry," says Mr Bottomley. "Artificial intelligence (AI) and automation are central to this vision with the factory being full of people who are adding the elements that can't yet be automated, so the creative process will happen more and more on the factory floor."

Fully achieving the vision of a digital factory isn't as far away as many people realise, thanks to the advances made in the manufacturing environment over the past decade. "A lot of the technology is already here," says Mr Bottomley. "Digital screens are replacing traditional noticeboards and a lot of factories have a digital infrastructure or digital capabilities ingrained into their manufacturing system; it's just the processes have yet to catch up."

Obtaining funding for projects to modernise factories has traditionally been a difficult goal to achieve, but as awareness has grown around how these investments can be monetised, it has become considerably easier.



Mark Bottomley
UK sales director
Rockwell Automation

To analyse challenges on the shop floor, manufacturing firms need to connect with external partners that are skilled in contextualising factory data

"There are more and more case studies available that prove the efficiency savings you can make by utilising industrial internet of things technologies. Conventional manufacturing areas can be targeted to make the biggest savings, especially around the reduction of downtime and increased flexibility that show digitalisation will give a clear return on investment," adds Mr Bottomley.

Making the factory of the future a reality in the UK requires much more than just individual firms investing more in advanced technologies, with a number of structural obstacles needing to be addressed. Uncertainties around Brexit and the country's relative weakness in productivity when compared to countries like South Korea and Germany will mean the UK must focus on its most competitive areas to take the lead.

From the robust logistics and data warehouse infrastructure to the long-standing culture of innovation and a highly skilled workforce, the UK has a strong industrial foundation to build on. Mr Bottomley believes that to analyse challenges on the shop floor, manufacturing firms need to connect with external partners that are skilled in contextualising factory data.

"A certain amount of this will be done by companies such as Rockwell Automation, and we will see more and more of these processes fulfilled by software, with it being of the upmost importance to employ the best people to keep yourself ahead of the competition," he says.

Advances in manufacturing technology also have the potential to provide small and medium-sized enterprises with a competitive advantage over larger firms, as new innovations in this field are available to all companies, no matter their size, enabling smaller businesses to offer a more flexible service.

Efficiency savings are a core benefit that the factory of the future brings to manufacturers, but a technologically enabled plant can truly transform operations factory-wide. "AI can recognise problems before they arise by analysing the huge amounts of data manufacturers produce. Importantly, having the ability to build a digital twin means you can virtually walk down the production line as the factory is designed, eliminating errors that would require costly redesigns, bringing huge competitive advantages as the time to market will be reduced," Mr Bottomley concludes.

Rockwell Automation

TRADE WAR

Unintentional consequences of trade war

From car factories in Mexico to soybean exporters in Brazil, alternative markets could become unexpected beneficiaries of US President Donald Trump's attack on overseas manufacturing

Soy animal feed from Brazil unloaded at a port in Nantong, China

BENJAMIN CHIOU

The trade war has officially begun. Author of *The Art of the Deal* Donald Trump has finally showed his hand in putting "America first" with a whole arsenal of import tariffs. And yet, manufacturers from all sides are feeling the heat as China and others retaliate with countermeasures in what is set to be a drawn-out, tit-for-tat battle on global trade.

It is the American exporters who would be bearing the brunt over the illogical and politically misguided actions of President Trump

No one wins in a trade war, the old adage goes. But while there will inevitably be more losers than winners, product-sourcing from alternative regions could increase as cost pressures weaken the demand for domestic manufacturers in affected countries.

President Trump kicked things off in January with punitive duties on solar panels and washing machines produced outside of the United States, aimed at lessening international competition for US manufacturers to mitigate an alleged threat to "national security".

The number of levied products has since risen exponentially and the list of affected countries has expanded, with tens of billions of dollars-worth of taxes imposed on a host of products from China, the European Union, Canada and Mexico. With President Trump threatening further action, he has given these nations little choice but to hit back with retaliatory tariffs.

Suresh Lodha, Indian business magnate with interests in iron and steel, and chairman of UK engineering firm Western Thermal, says Trump's tariffs are "strategically misplaced and self-defeating" as they stand to weaken the US economy: "It is the American exporters who would be bearing the brunt over the illogical and politically misguided actions of President Trump."

Applications for tariff exemptions may mitigate slightly the overall impact of the trade war on smaller manufacturers. Nevertheless, producers from every side will undoubtedly begin to feel the pinch and the International Monetary Fund's latest *World Economic Outlook* estimates, if current "trade policy threats" are realised, global GDP could be 0.5 per cent below projections by 2020, equal to $430 billion in lost output.

"If a country imposes tariffs on another, one can't complain if they retaliate. This is a key art of the deal Mr Trump seems to have missed," Mr Lodha says.


VCG/Getty Images

01 Brazilian farmers

The global soybean business is not one to scoff at as it may play a central role in trade wars going forward.

America is the largest producer of soybeans worldwide and over half of its exports were shipped to China in 2017. UN Comtrade data shows that China bought $12.4 billion-worth of US soy in 2017, representing its second-largest source behind Brazil.

Chinese imports of soybeans, which are largely used for animal feed, have jumped over the past decade on the back of a surging population, rising incomes and a growing demand for meat.

China has now slapped a 25 per cent tariff on American soy in a bid to encourage its pastoral farmers to source beans from alternative markets. The Ministry of Commerce has said that any tax revenues raised from its retaliatory tariffs on American goods will go towards alleviating the trade friction impact on domestic businesses. This, it explains, includes encouraging increased commodity imports, notably soybean and soymeal, from non-US producers.

As the trade spat continues, it could strengthen an already solid Brazilian soybean industry, which exported more than $20 billion of beans to China last year.

Severe droughts in Argentina, Brazil's other key soybean export rival, could be a further boon to Brazilian soy demand, along with higher Brazilian soy prices which have risen sharply following the Chinese tariff announcement.

American farmers have already come under intense pressure, so much so that President Trump has announced a $12-billion emergency aid package for the agriculture sector, essentially compensating for losses created by his own trade war.

Ismail Erturk, senior lecturer in banking at Alliance Manchester Business School, says US exporters could find creative ways of accessing the Chinese market, through nearby autonomous territories such as Hong Kong, Taiwan or Macau.

Meanwhile, any boost in demand for South American beans may be short lived due to a lack of supply and higher prices, according to Stefan Vogel, head of agri-commodities at Rabobank.

"Looking at current pricing levels, imports from Brazil are $60 per tonne more expensive than those from the US," Mr Vogel says. "This means that despite the 25 per cent tariff on US soybeans, the overall cost for imports of US soybeans into China is almost similar to buying Brazilian soybeans. Once soybean supplies in South America are running seasonally lower, which we would expect from the fourth quarter in 2018, the high US supply levels will allow the US to price South American countries out of the market."

02 Mexican auto plants

The US automotive sector has been a vocal opponent of Trump's proposed 25 per cent tariff on imported vehicles and car parts. They argue the duties, combined with levies on steel and aluminium imports already in place, would in fact reverse the very manufacturing expansion the president craves, inflating prices for consumers and leading to the loss of hundreds of thousands of jobs.

With statistics from the Center for Automotive Research (CAR) showing that imported vehicles accounted for 48 per cent of all new light vehicle sales in the US last year, carmakers are right to be worried.

CAR estimates that the price of all new imported vehicles sold in the US would rise as much as $6,875 if the tariffs are fully introduced, while the extra cost of imported parts for US-assembled vehicles would be $2,270.

It is important to note that these estimates only take into account parts that cross the American border once; in reality parts can cross the border many times before a car is built. The North American Free Trade Agreement (NAFTA), which President Trump wants to renegotiate, has hitherto minimised taxes to enable a free flow of trade across borders.


Volkswagen car plant in Puebla, Mexico

PEDRO PARDO/AFP/Getty Images

Higher costs could force international firms assembling cars in the US to relocate manufacturing production to low-cost markets such as Vietnam, Malaysia or nearby Mexico. Foreign carmakers with assembly plants in America accounted for 23 per cent of all new light vehicle sales in the US last year, so whole supply chains would need to be rejigged.

For Mexico, much will depend on the ongoing renegotiation of NAFTA. Cheaper wages in Mexico have largely been blamed for a recent drop in US manufacturing employment and are one of the key reasons why President Trump has demanded to rewrite the agreement. As a cornerstone of Trump's 2016 election campaign, it is hard to imagine the president taking a softer stance that could benefit factories across the border at the expense of his own.

Regardless, Mexico's auto industry has benefited from a slew of manufacturing investments in recent years, becoming a crucial hub for global automakers thanks to a raft of other free trade agreements. With NAFTA still up in the air, the country may seek to reduce further its reliance on the US, the destination for 80 per cent of its exports.


aapsky/Shutterstock

03 Airbus

Few companies are more at the centre of political posturing than Boeing.

On the one hand, China and Europe are pivotal markets for the Chicago-based aerospace giant to capitalise on in the next decade; on the other, investment overseas at the expense of American factories will likely be accompanied by a tirade of abuse, and taxes, from President Trump.

Boeing, the world's largest jet manufacturer, said in its latest global industry report that it expects China to overtake the US as the largest domestic air travel market within ten to fifteen years. With China accounting for one fifth of the company's order book, it isn't a market that Boeing can ignore. And this is a dilemma Beijing is very aware of.

As part of its countermeasures against the US, China is slapping on a 25 per cent tax on aircraft weighing between 33,000 and 99,000 pounds, essentially targeting Boeing's flagship product, the 737 passenger airliner, which is built at the company's 102,000-square-metre factory in Washington.

China also recently confirmed it was willing to continue discussions with France over a $18-billion deal for 180 A380s, manufactured by Boeing's key rival Airbus, leading analysts to speculate about how ongoing political wrangling will impact competition between the two.

"If Boeing's order book comes under pressure from tariffs, existing Airbus production and assembly facilities in the UK, Germany, Spain and France could benefit," says Jens Roehrich from the University of Bath's supply chain management department.

However, Professor Roehrich highlights that Airbus's huge current backlog of orders would take years to clear. "Hence Airbus cannot just easily absorb all of China's demand for new aircraft," he says.

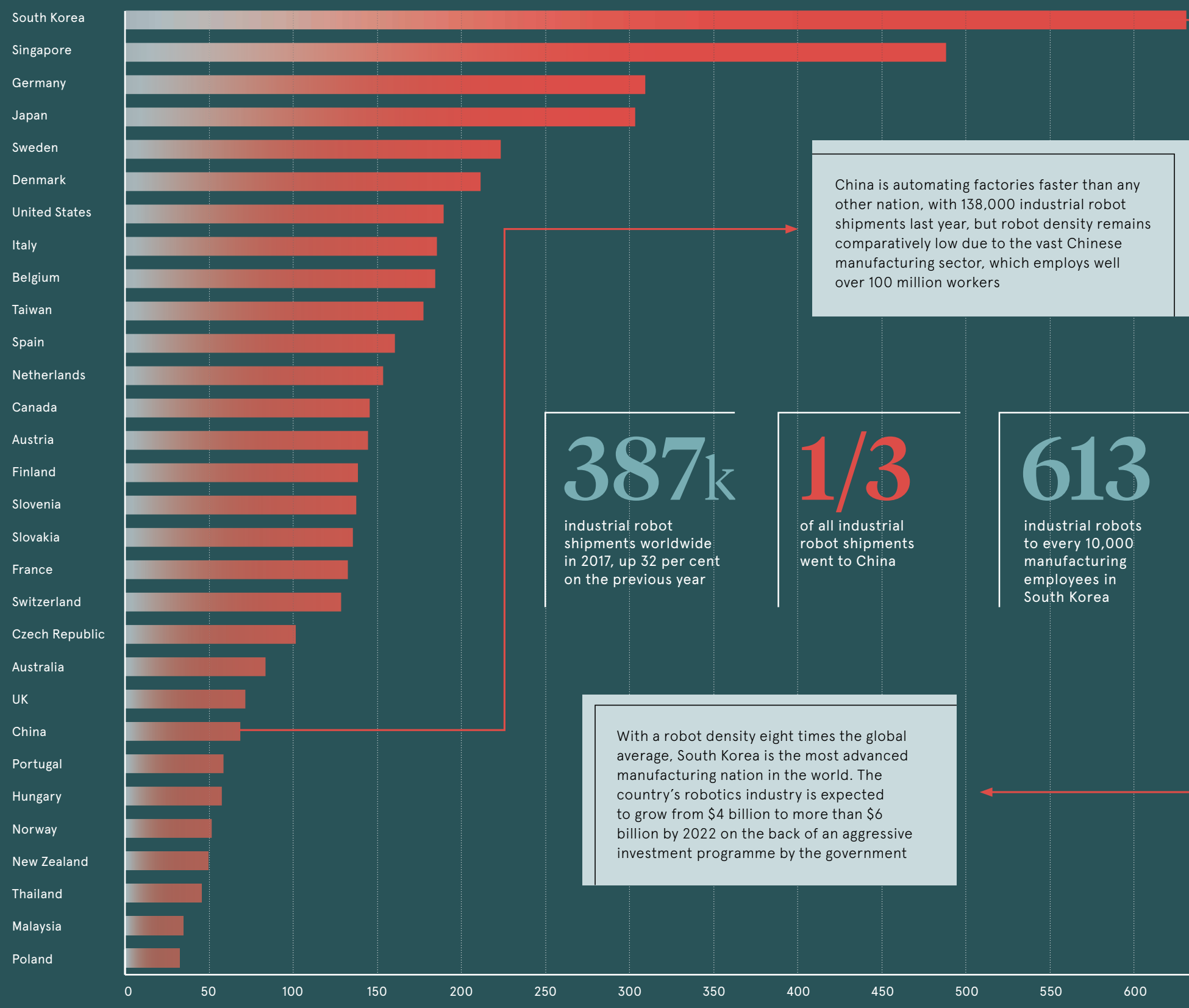
Nevertheless, trade frictions between the US and EU could also shore up demand for Airbus, according to Mr Erturk from Alliance Manchester Business School. "The Trump administration seems to use the rhetoric of trade wars to negotiate new trade deals... this opens up the opportunity for the EU to change trade rules to the benefit of European plane manufacturers," he concludes. ◆

ROBOTIC REVOLUTION

Sales of manufacturing robots have more than doubled over the past five years as businesses ramp up their investments in automation and smart factories. South Korea continues to lead the way in terms of robot density in manufacturing, with six robots to every hundred employees, while the automotive and electronics sectors comprise the lion's share of annual sales

Robot density

Number of installed industrial robots per 10,000 manufacturing employees in 2017



China is automating factories faster than any other nation, with 138,000 industrial robot shipments last year, but robot density remains comparatively low due to the vast Chinese manufacturing sector, which employs well over 100 million workers

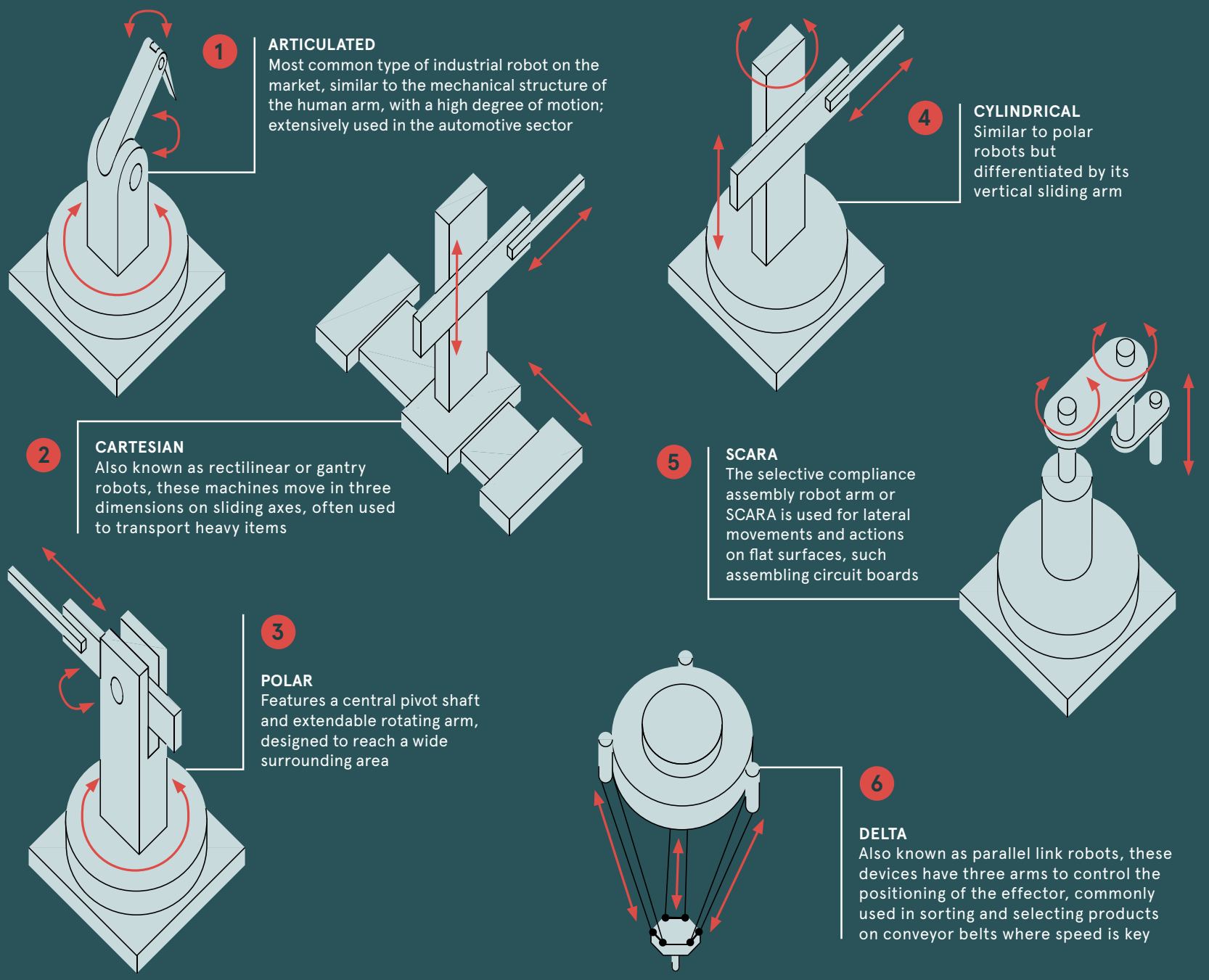
387k
industrial robot shipments worldwide in 2017, up 32 per cent on the previous year

1/3
of all industrial robot shipments went to China

613
industrial robots to every 10,000 manufacturing employees in South Korea

With a robot density eight times the global average, South Korea is the most advanced manufacturing nation in the world. The country's robotics industry is expected to grow from $4 billion to more than $6 billion by 2022 on the back of an aggressive investment programme by the government

Main types of industrial robots



1 ARTICULATED
Most common type of industrial robot on the market, similar to the mechanical structure of the human arm, with a high degree of motion; extensively used in the automotive sector

2 CARTESIAN
Also known as rectilinear or gantry robots, these machines move in three dimensions on sliding axes, often used to transport heavy items

3 POLAR
Features a central pivot shaft and extendable rotating arm, designed to reach a wide surrounding area

4 CYLINDRICAL
Similar to polar robots but differentiated by its vertical sliding arm

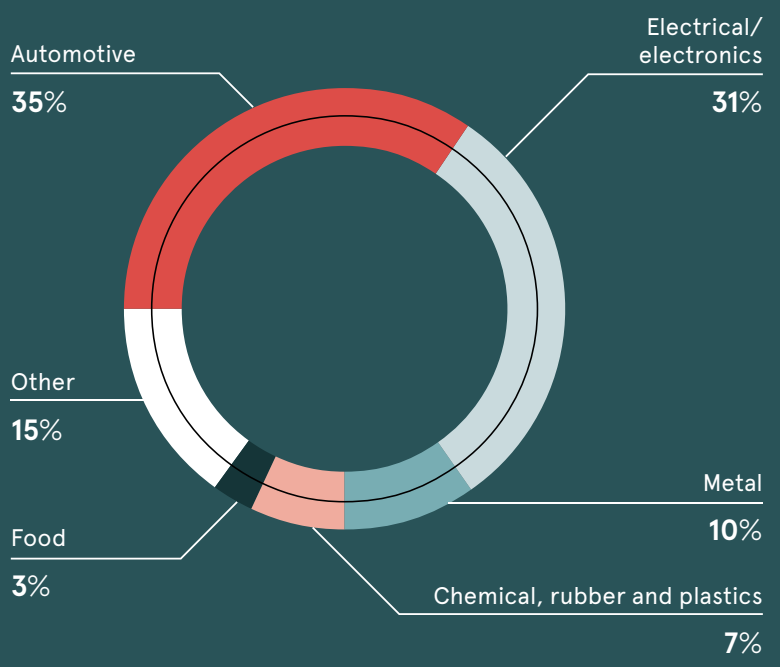
5 SCARA
The selective compliance assembly robot arm or SCARA is used for lateral movements and actions on flat surfaces, such assembling circuit boards

6 DELTA
Also known as parallel link robots, these devices have three arms to control the positioning of the effector, commonly used in sorting and selecting products on conveyor belts where speed is key

650

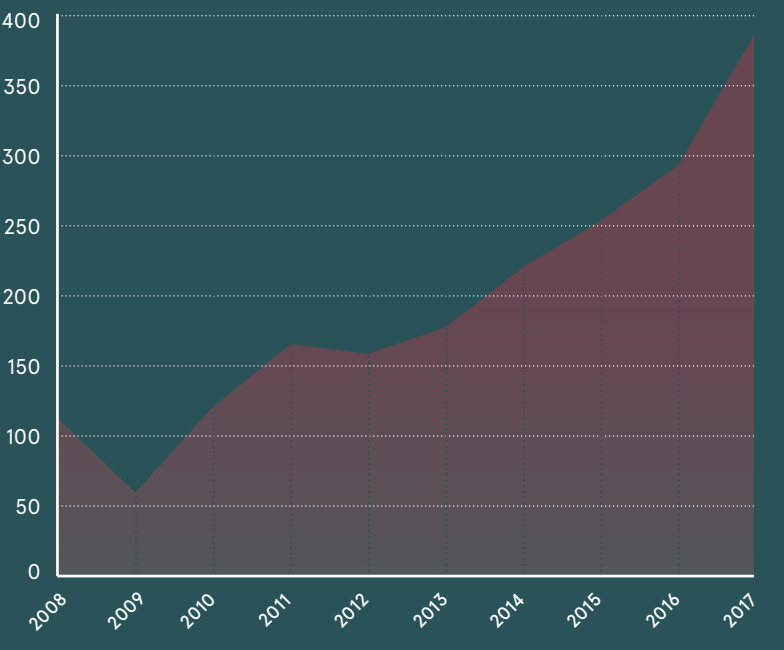
Robot supply by industry

Industry share by annual supply of industrial robots



Robot shipments have doubled within five years

Estimated global annual shipments of industry robots (thousands of units)



International Federation of Robotics 2017–18

BLUE COLLAR JOBS

Rob Lambert/Unsplash

‘New collar’ is a better fit for industry

Politicians are getting fired up about manufacturing as economic nationalism is on the rise, but how well do they understand blue collar jobs?

SHARON THIRUCHELVAM

Political leaders tend to fixate on the most tangible and visible aspects of the manufacturing process – the factory floor. But focus on the assembly line misses a much larger part of the value chain.

Design, supply chain management, aftercare and servicing are likely to add much more value than the assembling of parts in cars or washing machines. Even for complex and expensive machines, such as passenger jets, assembly is a low-value proposition compared with making the parts that go into them.

Politicians also tend to draw a sharp line between goods and services. For manufacturing companies themselves this line is increasingly blurred. Even the auto industry, the archetypal provider of blue collar jobs, sees its future in the provision of “mobility services” rather than just cars.

Running fleets of leased cars, shared rides and autonomous vehicles are integral to their future business strategies. Similarly, in raw materials, suppliers of cement and steel, such as Arcelor Mittal and LafargeHolcim, position themselves as service providers, offering design and consulting services to manufacturing and construction companies.

There is no denying that employment in manufacturing is falling. In the United States, it employs less than 10 per cent of the workforce, compared with 25 per cent in 1970. In the UK, 10 per cent of the workforce are employed in the sector compared with 33 per cent in the 1960s. Even in Germany, according to the World Bank, just 27 per cent of jobs are in manu-facturing, down from 41 per cent in 1997.

But politicians who bewail the sector’s drop in share of GDP as a symptom of its overall decline are misled. Current GDP metrics fail to account for the practice of outsourcing and longer supply chains.

> **Advanced manufacturing will provide good jobs for skilled workers with diplomas or degrees**

Manufacturing companies increasingly contract other firms to manage marketing, catering, logistics, transport, IT services and accounting. Statistically, the replacement of a payrolled building manager with a contractor is indistinguishable from the disappearance of an assembly line job.

The fact remains that no industrial strategy will bring back good union-protected blue collar jobs. Low-skilled manufacturing jobs are mostly dead ends, with 62 per cent leading to no advancement in the US, according to research by JFF and Burning Glass Technologies, and new workers paid less than longer-term employees.

In the short term, advanced manufacturing will provide good jobs for skilled workers with diplomas or degrees. Such “new collar” workers are in high demand. On the factory floor, one worker with a masters degree will typically delegate to two with bachelor degrees and seven skilled workers.

“The US does a good job at churning out the first two [graduates]; what we have not done is a great job at the last [skilled workers],” says Stephen Catt, deputy director for workforce de-velopment at the Advanced Robotics for Manufacturing Institute.

The scale of these new collar jobs will be modest, offering nothing like the mass employment of years gone by. Even these will be supplanted within a generation, according to Adair Turner, chair of the Institute for New Economic Thinking and former head of the Financial Conduct Authority.

Governments that suppose otherwise are fighting a losing battle. “It is almost inevitable that by 2100 all the factories in the world will employ no more than a minute share of all workers, maybe less than 1 per cent, making any attempt to ensure a large share of ‘real manufacturing jobs’ an impossible objective,” says Mr Turner.

Extreme inequality, occasioned by widespread automation, should be a major concern for politicians the world over, far more pressing than job losses in manufacturing alone.

Bill Fotsch and John Case, proponents of open-book management, suggest employee profit-sharing schemes paired with complete transparency of company accounts as one way to boost engagement, productivity and wages. Staff at every level would be encouraged to take initiatives and responsibility for the company’s overall success and their personal dividends.

This sounds more promising than the default policy prescription offered across the political spectrum, which is “to equip people with the skills to flourish in a world of continuous change”, says Mr Turner. We also cannot presume that individual successful companies will create jobs in other parts of the economy or through their domination of a given sector, or several sectors; Amazon being a case in point.

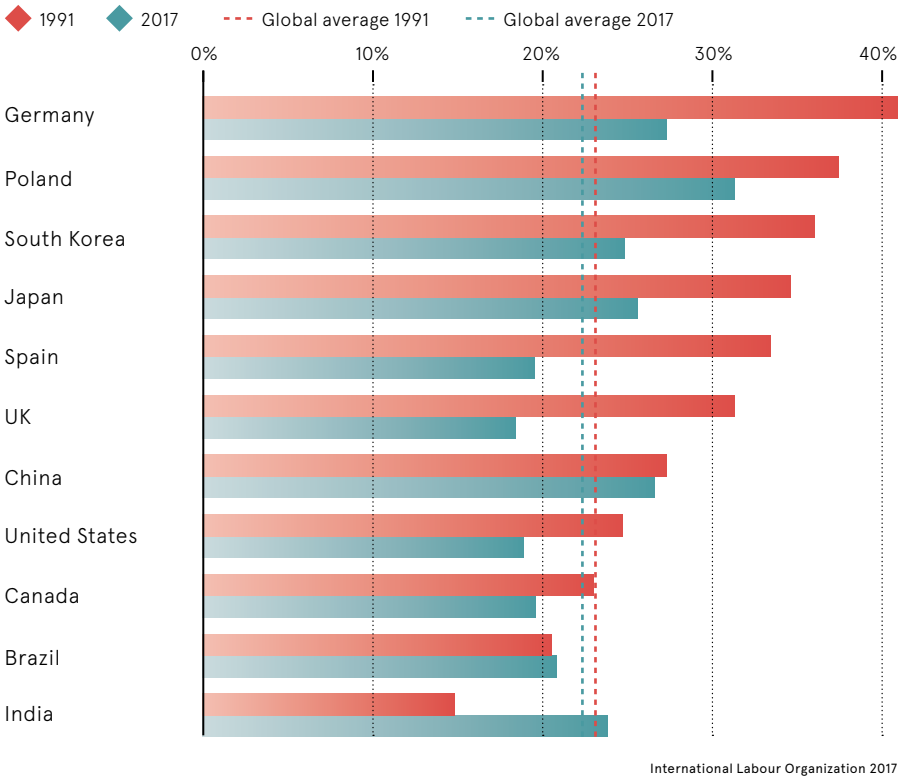
Similarly, the idea that teaching every person to code will help them flourish in an IT-intensive world is also flawed. Thirty years after the computer age began, the total number of workers employed in the development and production of computer hardware, software and applications remains at only 4 per cent. The US Bureau of Labor Statistics predicts just 135,000 new jobs will be created in software development between 2014 and 2024, far fewer than for personal care aides (458,000), registered nurses (439,000) and home health workers (348,000).

Jobs in the caring profession are a far cry from metal bashing and forklift truck operating, and are hardly guaranteed to appeal to the majority of lesser skilled men and women, not least because such jobs are undervalued both in terms of pay and status.

Governments mulling over their future industrial strategy would do well to also focus on how to create decent and dependable employment for the less skilled in other socially and economically productive sectors, such as trades, social care and craft. ◆

Industry workforce as a percentage of global employment

Industry employment includes those in mining and quarrying, manufacturing, construction and public utilities sectors



International Labour Organization 2017

Safety is the new driver of profitability

Rethinking process safety management can do more than avoid the risk of action by regulators – it can improve the bottom line

Running a manufacturing or heavy industrial plant these days is an increasingly risky proposition. Stricter regulations enforced by more aggressive regulators and the increased risk of reputational damage that can knock a company's share price mean business leaders have to pay more attention than ever to safety.

In the UK, the stakes have been raised further with action taken by regulators against individuals within the company. Fines have increased enormously over recent years. Under Sentencing Council guidelines, a company's turnover is considered, along with the degree of injury caused, according to whether the company's culpability is low, medium, high or very high. Substandard safety practices can cost a company 10 per cent or more of its turnover in fines.

To make the point, the Sentencing Council has decreed that fines should be "sufficiently substantial to have a real economic impact which will bring home to both management and shareholders the need to comply with health and safety legislation". Meanwhile, according to a Freedom of Information Request, the largest fine of 2016 was two-and-a-half times the size of the most substantial fine of 2015 and almost ten times that of 2014.

"This more threatening landscape in which industry is operating means that business leaders must rethink the way in which they handle safety," says Steve Elliott, senior marketing director of Schneider Electric, which is leading the digital transformation of energy management and automation. "As part of this change of mindset, they should stop thinking about the cost of safety and consider, instead, the value of safety."

Safety, argues Mr Elliott, is not just about compliance any more. "Rather than simply focusing on the stick of higher fines and other increasingly severe sanctions, some business leaders are now realising that constantly improving safety also offers a carrot in the form of increased profitability. But too often safety is still regarded as being about issues such as trips and slips, working at heights and handling hazardous chemicals. Yes, these things are important, but in order to increase efficiency and profitability safety means so much more."

He points out that companies that look at their manufacturing and industrial processes from a safety perspective and identify how better safety can keep those processes working, reduce their down time and therefore drive their productivity and profitability. Three quarters of the capital spent on an industrial building such as a large manufacturing plant goes on production assets. "If the process is driven to the point where it damages an asset, the problem goes beyond just downtime and people. From the board's perspective, a good amount of invested capital is in play."

For years process safety systems have operated as separate, unconnected entities. Now technology such as the industrial internet of things enables safety experts working in industry to analyse safety issues from the past, present and future perspectives. This data can then be used in a predictive and preventative way so safety managers and their colleagues in the rest of the business are not simply reacting to problems as they occur.

"When we talk to customers, they tell us that it's often been difficult in the past to get funding for environmental, health and safety (EHS) issues within their organisations because the return on investment (RoI) is difficult to demonstrate," says Mr Elliott. "But the RoI payback for this more systematic, strategic approach to operational and safety management and control can be very significant – and it makes getting approval for investments much easier."

For example, Schneider Electric's patented real-time accounting and Dynamic Performance Measures help managers to identify potential safety constraints more quickly and easily. Just as electricity prices now change approximately every 15 minutes, rather than every few months, this system reacts extremely quickly to variations in process conditions through real- time process data.

By accurately measuring the safety risk of a piece of equipment, process unit, plant area or plant in a real-time, continuous manner, plant operators can identify the nature of a safety constraint and work out how to overcome it more quickly. Thanks to this kind of ongoing real-time measures of safety risk, those operators can determine how hard they can safely drive the plant at any one time.

In addition to technology, companies that are benefiting from this new approach have undergone a change of culture. Instead of viewing safety as an adjunct, outside the mainstream and as a challenge to profitability, this new control theory means everyone from the board downwards now regards safe operations of industrial plants as a driver of profitability.

"Because of this, EHS can be turned into a mainstream business process within industrial companies enabling them to achieve new levels of both safety and profitability," says Mr Elliott. "But, more fundamentally, it means that rather than simply leaving safety to whoever has the safety portfolio, it becomes an issue for the C-suite. A member of the board is charged with focusing on safety from a profitability standpoint. This, along with state-of-the-art digital technology, means that far from being a brake on growth, safety can drive the company forward."

For five tips to drive profitable safety please visit schneider-electric.com/safety

Life Is On Schneider Electric

Safety first: three questions every board needs to ask itself

01 If an operator shuts down your plant causing serious financial loss, what will your first reaction be?

02 Do you know what impact your decisions will have on the level of risk at your sites, not just now, but in the future?

03 Are you doing everything that you can to prevent a major accident?

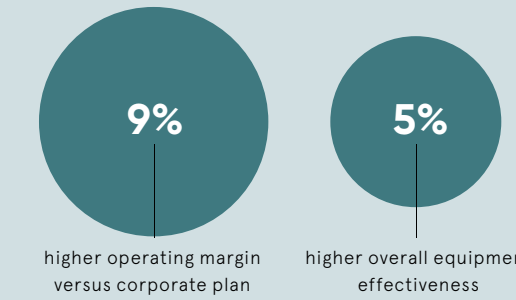
Positive side of safety management

3X

Companies in the top 20 per cent of risk maturity generate three times the level of EBITDA as those on the bottom 20 per cent

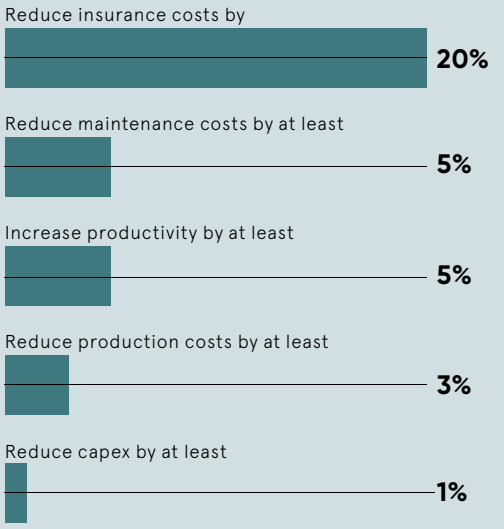
EY 2012

Companies using safety management systems and analytics



Aberdeen Group

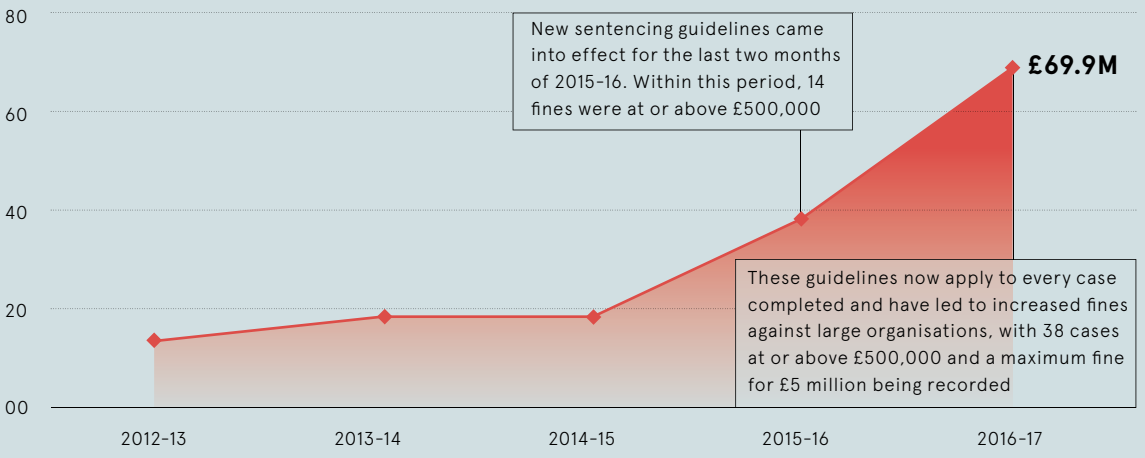
Process safety management: safety is good business



CCPS

Negative side of safety management

Total fines for health and safety offences prosecuted by HSE and in Scotland by the Crown Office and Procurator Fiscal Service



Health and Safety Executive (HSE)

> **Far from being a brake on growth, safety can drive the company forward**

3D PRINTING

Adding business value at a different scale

Big corporations and small startups can benefit from incorporating 3D printing into their manufacturing process, regardless of scale

SOORAJ SHAH

3D printing, or additive manufacturing, was thought to be a game-changer when machines were first launched several decades ago. In the years since, the technology has made its mark and changed the way manufacturing is carried out in various sectors.

It has already delivered success in the aerospace and automotive industries, where companies such as Boeing and Mercedes have succeeded in printing parts out of metal, plastic and composites that are lighter and more resilient.

Modern cars and planes already use many parts made from 3D printing, although strict quality control and high-performance materials mean that it will be a few more years before the potential in the aerospace industry is really seen.

Within the automotive sector, Formula 1 is often the first place for technological and manufacturing innovation to take place and in 2015 the Williams F1 team used 3D-printing technology from EOS to construct the exterior parts of the front wing assembly for their 2016 racing car. The reason, like many organisations that use 3D printing, was to make the process simpler, faster and less expensive.

"With traditional manufacturing, it took the team months to produce parts it now takes a matter of hours or less. Williams now ships over 2,000 parts per month and this translates into cost reductions," says Dr Adrian Keppler, chief executive of EOS.

However, to achieve this the Williams team was clear that it had to integrate additive manufacturing into the development process of its prototypes. In other words, 3D printing should not be seen as a bolt-on to existing methods, but should be part of an overall process.

But while large corporations with billions of dollars-worth of resources in research and development can adopt the technology, integrate it and use it on a regular basis, can the same be asked of small and medium enterprises (SMEs)? And is the frequency of 3D printing relevant when it comes to succeeding?

For SMEs, the barrier of entry has been significantly lowered thanks to the emergence of new tools and lower prices. In addition, there are also many 3D-printing bureaus, such as Manchester's Print City, that offer mass-scale manufacturing to smaller companies, which may not necessarily have all the hardware or equipment they need.

This is often the way SMEs and startups get to exploit new technologies, through a technology partner or specialised provider. However, Asif Moghal, senior industry manager of manufacturing at software provider Autodesk, suggests that even for these smaller companies, 3D printing should be seen as part of the overall design to manufacture an ecosystem, rather than a siloed process.

"Manufacturers should outline the business problem they have and look at how additive manufacturing can be used in collaboration with other technologies to solve it," Mr Moghal says. He adds that Autodesk has seen this approach taken by both small and global manufacturing companies.

"For example, sportswear brand Under Armour looked to generative design and additive manufacturing to improve the shape and performance of the soles of its trainers, while SME manufacturer FIT AG used both technologies, along with subtractive manufacturing, to create innovative geometries for a lighter and more efficient automotive engine block," Mr Moghal explains.

> **The largest machines can now be used as a single business machine by small specialist manufacturers and also by larger businesses for the manufacture of complex components**

Another SME, wooden toy producer Father's Factory, has worked with XYZprinting to reduce the time from design to moulding from between six and eighteen months to one month by 3D printing prototypes of the latches, knobs and brackets for trialling.

"While a large company can achieve something similar, it's particularly useful for companies similar to Father's Factory that are producing small batch runs of products, as reducing the production timeline and decreasing labour costs makes a bigger difference to their margins," says Fernando Hernandez, Europe, Middle East and Africa managing director at XYZprinting, who adds that the successful use of 3D printing is not dependent on scale.

Instead, as Peter Brooke, director of UK manufacturing operations at consultancy Deloitte emphasises, companies need to be fast, flexible and capable of understanding the implications 3D printing will have on the nature of their business, whether this is in terms of cost, labour changes or competition to the normal business model and ability to compete.

"The largest machines can now be used as a single business machine by small specialist manufacturers and also by larger businesses for the manufacture of complex components," Mr Brooke says.

Some smaller companies have brought the 3D-printing process in house. Mental health organisation Chanua Health had initially worked with partners to 3D print a brain to help teach students studying the organ.

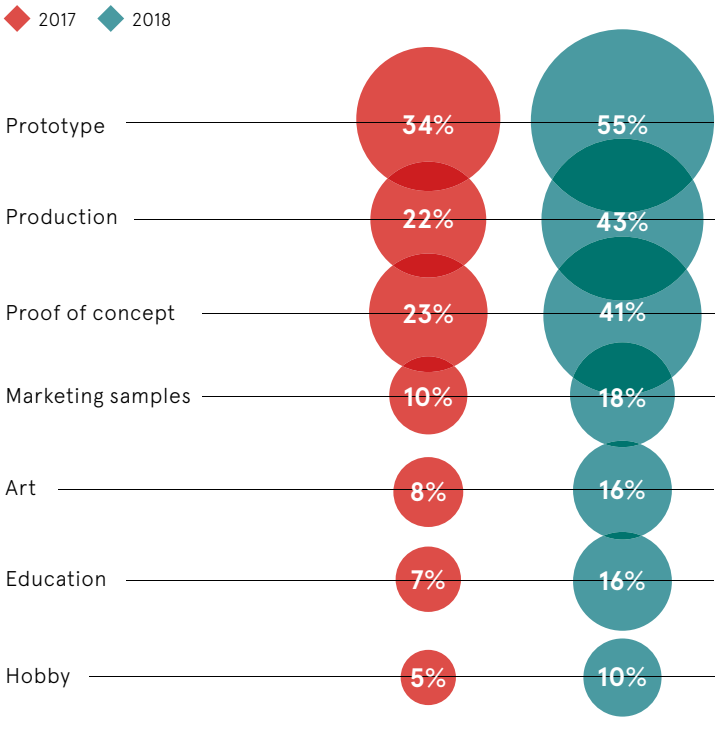
"We were so impressed at having an idea for a product, designing it and printing it on the same day that we invested in our own 3D printer, and we are currently designing other complementary educational aids and games using 3D-printed models," says Naomi Mwasambili, chief executive at Chanua.

John Bolto, specialist adviser at consultancy Advisian, suggests that the oil and gas sector can benefit from taking control of the supply chain by incorporating 3D printing into processes, and the same applies to SMEs.

"Instead of relying on manufacturers, companies can print parts on site. This gives them more ownership of the supply chain and vastly reduces the variables, like shipping or procurement, that can cause delays, while also negating the need for vast physical inventories," Mr Bolto concludes. ◆

3D-printing applications worldwide

Percentage of global manufacturers using 3D printing that use it for the following



Sculpteo 2018

OPINION COLUMN

‘UK manufacturing will adapt to a new way of maximising value through the fourth industrial revolution’

The future is getting increasingly uncertain, with UK growth clouded by Brexit and political uncertainty across the globe. But one thing we can be sure about is that with the fourth industrial revolution (4IR), the future of manufacturing is digital.

Technologists describe this as one system which links physical networks with cyber networks, allowing real-time information flow. This will enable intelligence and product insight to be discovered and acted upon quickly, so there will be new ways of creating value.

Manufacturers talk about this revolution as using new technologies such as sensors, robotics and data analytics to gain insights into product use, improve productivity and competitiveness. This will bring new techniques that will change product design, production processes and customer relationships.

Better customer experiences, higher levels of efficiency and more highly skilled jobs will result. The opportunity is clear, but with this will come disruption to traditional business models, new types of supply chain engagement, and the need to take employees and suppliers on the journey too. The UK cannot opt out.

Manufacturers are starting the 4IR journey with their growth ambitions underpinned by the development of new business models including new services. There will also be greater focus on innovation in both new products and processes, along with closer collaboration within supply chains and investment in new technologies.

That’s not to say all companies are quickly moving ahead in these areas. The application of 4IR technologies is an area where companies are still trying to understand how best to apply to their own businesses in three distinct phases.

The first phase is conception when companies figure out what 4IR is all about, what it can offer and how it could apply to their business. The second phase, evolution, is a period when there is some advancement on current practice. Concepts and off-the-shelf solutions can be implemented and tested, further optimising current processes and putting in place new solutions. The third and final phase is revolution when the step-change occurs in terms of how value is derived, and how interaction with customers and suppliers happens.

For those at the conception phase, optimising processes and supply chains is where some early wins will be found. The evolution of manufacturing processes and the revolution of the product and service offerings to customers will follow, but this will happen in fits and starts.

Sharing of best practice through technology diffusion and peer learning from companies at the frontier is where a lot of improvement will take place. We are helping manufacturers navigate the complexities and challenges presented by 4IR and to seize upon the many opportunities it will afford.

In addition to manufacturers adapting their own processes to meet this evolving challenge, there is a role for government policy here too. Industrial strategy must play a role in enabling companies to learn, adapt and adopt more quickly, not just to keep pace with competitors, but to propel them to the head of the league table.

Sector deals, such as Made Smarter led by Professor Juergen Maier on industrial digitalisation, should help inform this. Government must also play a role in the skills required to implement 4IR, from encouraging young people to pursue a career in engineering to upskilling the current workforce with the necessary digital skills.

Despite the political turbulence and potential uncertainty, this is a very exciting time for industry in the UK and the economic gains will be significant. UK manufacturing will always adapt, as it will to a new world post Brexit and a new way of maximising value through the fourth industrial revolution.

Stephen Phipson
Chief executive
EEF, The manufacturers’ organisation

Commercial feature

What’s missing? Extracting value from data analytics

Manufacturing firms have turned to data analytics and artificial intelligence (AI), but many are missing the mark. A sharper business focus is needed to achieve expected returns

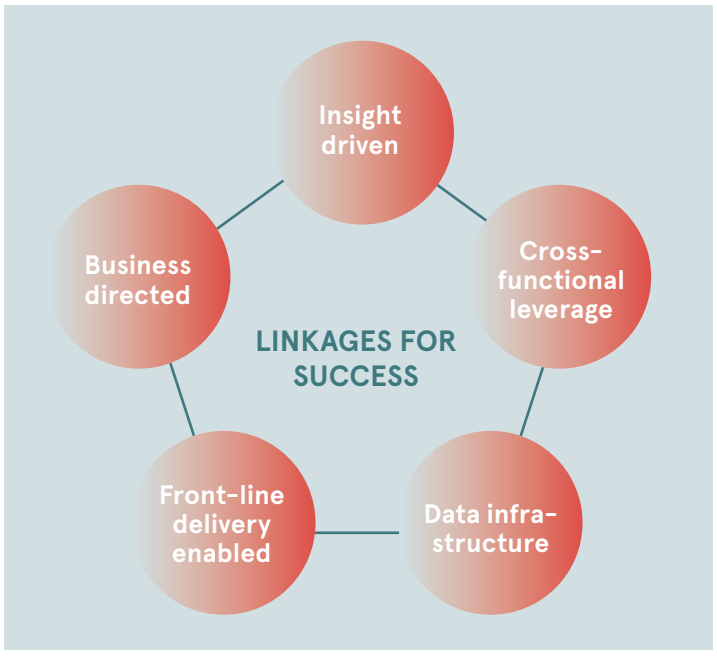
Aside from the high-tech and leading corporates, adoption of digital technologies in the manufacturing sector remains subdued, a consequence perhaps of not seeing widespread evidence of the tangible benefits. Achieving expected returns on investment from advanced analytics and AI is less a question of technology and more a business challenge.

Success stories among early adopters are well publicised and demonstrate the advantages to be gained when the power of data from multiple sources is harnessed through expert hands and into business execution.

More precision in research and development reduces costs and increases success, product lead times can be compressed, sales and service are optimised for overall value, goods can become services, supply chain efficiencies are maximised, defects are reduced and production assets can operate at their potential.

For many though, there are “missing links” that are preventing the expected value being realised from the potential a wealth of data, analytical skills and technology are offering.

Clarity of business priorities is the starting point and that requires executive level direction. Technology has provided the toolkit, but how it should be used to best effect cannot be delegated to the IT function. The increasing presence of chief digital officers on executive teams is one trend bridging the gap between the business agenda and the role of technology.



50%
of initiatives don’t deliver their cost of capital

35%
of cases lacked alignment between IT and the business

67%
of companies reported human and technical capabilities as a bottleneck

“Generating business insight is a critical business capability that unlocks new value yet sometimes seems to be forgotten among the increasing volume of information and analysis,” explains John Mason, a partner at the transformation consultancy Curzon & Company.

Advanced analytics enable businesses to combine multiple datasets to highlight new information. The same cross-functional thinking is required in the application of this information.

For example, optimising asset performance will require co-ordinated action across production, engineering, maintenance and third-party equipment suppliers to achieve the potential performance uplift that connectivity and predictive analytics can offer. Most importantly, the business and IT functions need to work much more closely, and find a common language.

Risks associated with data security are often cited as a brake on adoption. Having a robust governance framework that defines who owns what information and how it should be used is essential.

Arguably the least considered aspect of a technology-led investment in data and analytics is the practicality of turning insights into measurable results. Success requires organisations to have the capabilities to act on and implement changes. The ability to test, learn, adapt and adopt is needed at all levels, and information needs to be made available to those who are going to use it in a way that is practical. Implementing minimum viable products and adopting “fast-fail” approaches that can quickly demonstrate impact are not widely established practices in many organisations.

Operating models and processes need to be capable of accommodating evolving knowledge, and the perceived threat that time-served, experienced staff may feel need to be overcome. “The expectation that the whole organisation will automatically see the benefits is likely to be unfulfilled. Involvement and ownership are key, as they are for any sustainable business change to work,” says Mr Mason.

When the links are forged for businesses to generate genuine commercial insight and swiftly translate it into action, the potential advantage of analytics will be fully realised.

To find out how to make the connections and achieve measurable business results please visit curzoncompany.com

CURZON & COMPANY
STRATEGY AND TRANSFORMATION

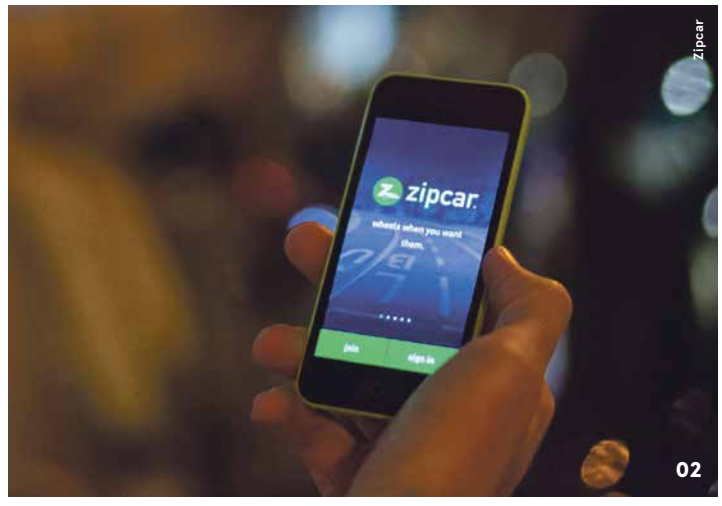
AUTO

On the road to services and sharing

Servitisation and the sharing economy are shaping the future of the car industry as easy access looks more attractive than ownership

MOIA

01



Zipcar

02

01
Volkswagen's on-demand, ride-sharing service Moia is now available in Hannover after one year in testing phase

02
Rapid urbanisation means there isn't the space for everyone to own a car, so vehicle-borrowing firms such as Zipcar have seen a surge in popularity

OLIVIA GAGAN

Cars aren't likely to disappear any time soon. It is estimated that worldwide just over one billion are on the roads. The way we use them, however, is changing and the automotive industry is racing to keep up.

The rise of car-sharing and ride-hailing companies such as Uber and Lyft suggests occasional, low-cost access to shared cars is becoming more desirable than having an expensive, shiny new vehicle depreciating on your driveway.

So does this pose an existential threat to car manufacturers, businesses which spent more than a century profiting from car ownership as one of the ultimate symbols of freedom and success?

Jonathan Hampson, UK general manager of Zipcar, a company which allows users to borrow vehicles parked in their neighbourhood, says the auto industry's perception of firms such as his shifted dramatically as profits and influence grew.

"Twelve years ago, car manufacturers would look at us like we were an environmental fringe group. Now they're falling over themselves to get involved in the sharing economy," he says. "The penny has firmly dropped that they need to do something a bit different."

But for some manufacturers this means a wholesale shakeup of the very nature of their operations. They still deal in steel and glass, dashboards and tyres; the making and selling of solid, physical products.

However, to compete with firms like Uber and Zipcar, they are also entering the far less tangible world of "mobility services", which encompasses everything from electric scooter hire to car-sharing apps.

Change is happening quickly. Volkswagen bought its first stake in Israeli ride-hailing app Gett in 2016. It has since created Moia, a mobility services company. The manufacturer wants a substantial share of its total sales to come from Moia by 2025.

> **Car manufacturers are falling over themselves to get involved in the sharing economy**

Meanwhile, BMW and Daimler have merged their existing car-sharing, electric vehicle charging, parking and ride-hailing businesses into a new joint venture. The idea is to create a one-stop mobility shop where consumers can park their electric car, charge it and then order a ride home in a car share after a night out.

Japanese car giant Toyota jumped on the trend in July by launching a car hire service in Honolulu, Hawaii. Its vehicles are now available for hire by the hour or the day across the city, ordered via a smartphone app. A digital key allows users to lock and unlock the car. Toyota do not call it a car rental service; it's dubbed "a mobility solution".

Tony Hughes, managing director of economic research at analysts Moody's, says these changes, rebrands and new businesses are an attempt to generate another kind of brand loyalty. "At present, carmakers seek to produce niche products to attract loyal, repeat customers. If vehicles are used by customers in half-hour chunks, there is no room for loyalty," says Dr Hughes.

When you order an Uber to get home from a restaurant, it's unlikely you'll have a strong opinion on exactly what make, model and age the car is. You will care if it arrives on time, however. And so rather than gaining market share by creating a car everyone recognises and wants, manufacturers' future sales could be driven by helping their customers move more seamlessly than with a rival.

The growth of companies like Uber, Lyft, and Zipcar bear this idea out. City dwelling means there simply isn't the space for everyone to own a car. Fuelled by smartphones, universal internet access, and dwindling time and space reserves, we are now able to order products and services instantly, from food to films to laundry services. Sharing

and on-demand services are now an everyday, accepted way of living, what Mr Hampson calls "the model of access over ownership".

Despite these shifts in what consumers want, the auto manufacturing industry is, for now, hardly one that is in terminal decline. Research portal Statista shows automobile sales are rising and are set to hit 81.5 million by the end of 2018. Volkswagen's operating profit reached an all-time high last year at €13.8 billion. Sweden's Volvo had a record-breaking year for sales.

Even if vehicle-sharing becomes the dominant model of car usage, Dr Hughes points out: "Having fewer cars on the road does not necessarily imply that there will be fewer car sales."

This is in part because vehicle-sharing and ride-hailing companies tend to favour modern vehicles which fit in with the modern, low-emission image they want to portray. Zipcar's Mr Hampson says the average life of a vehicle in their fleet is about a year to 18 months; after that it is sold on. To keep their operations as low carbon as possible, the business is aiming for an-all electric fleet by 2025.

This represents another area of opportunity for car manufacturers. They may be rebranding themselves as smartphone-driven service providers, but there's a more traditional role they can fill as providers of the next generation of electric cars to both individuals and the service industry.

As electric vehicles become cheaper and more models come to market, their appeal is growing. A July report by the AA suggests 50 per cent of young people in the UK would like to own an electric car, in contrast to just a quarter of their parents. State policy is starting to back electric vehicle manufacturing, too. This summer the UK government said it wants at least 50 per cent of new car sales to be electric by 2030.

In a keynote speech at Volkswagen's 2018 annual general meeting in Berlin, chief executive Dr Herbert Diess called e-mobility "the engine of the future".

Nothing is guaranteed in this new landscape for car manufacturers. Electric vehicles are certainly picking up traction, but that does not negate the appetite for petrol and diesel vehicles which is growing in countries such as China. Car-sharing may become the dominant mode of urban car use, but it's yet to become a compelling business proposition in rural areas.

Car-sharing and ride-hailing is still a relatively new industry, and startups often fail. Mr Hampson says: "We've been through the early-adopter phase, the car-sharing evangelists. We're not quite in the mass market yet, but it's now a commonly understood solution."

> **Car-sharing may become the dominant mode of urban car use, but it's yet to become a compelling business proposition in rural areas**

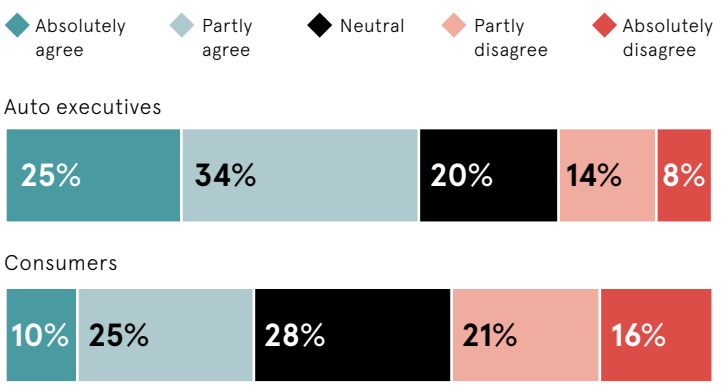
Market consolidation could happen, given the amount of companies crowding into the car-sharing space. Dr Hughes' bold prediction is that "if ride-sharing companies become truly huge, they will seek to buy vehicle manufacturers, and shift research and development efforts firmly in the direction of cost reduction and reliability".

Demand for cars seems unlikely to disappear in the near to mid-term. But as the sharing economy grows, being in the business of making them has become more complicated; manufacturers now operate in an increasingly fragmented, competitive market.

Carmakers are deploying a variety of new methods to hold on to their increasingly capricious customers, whether that's through convincing them they need a new electric car of their own or by becoming their car-sharing provider of choice. As Matthias Muller, then-Volkswagen chief executive concluded at the launch of Moia: "Even though not everyone will own a car in the future, Moia can help make everyone a customer of our company, in some way or another."

Future of car ownership

Auto industry and consumer opinion on whether car owners will want to own their own vehicle by 2025



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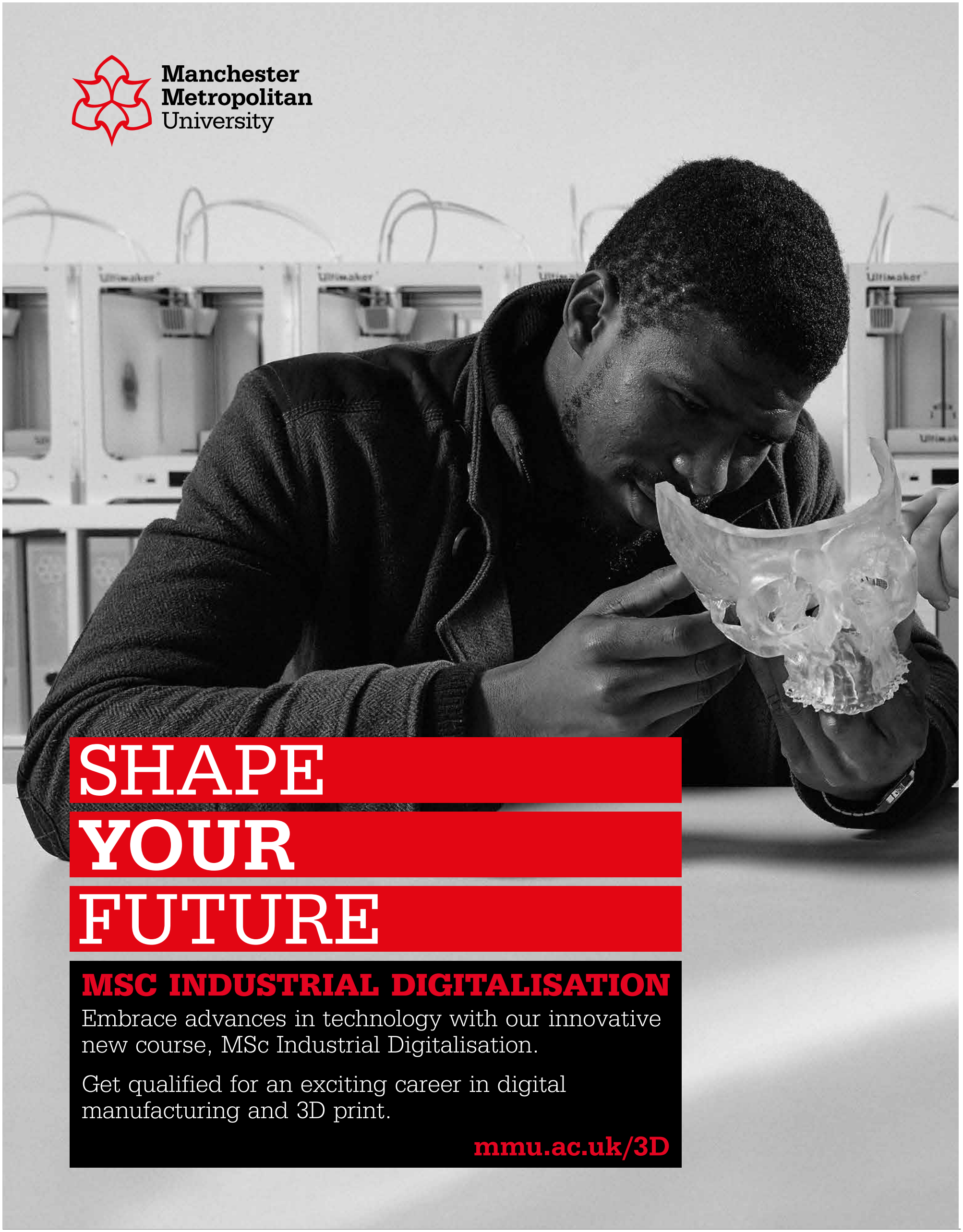

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