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UK must invest in smart factories

Where does the birthplace of the first industrial revolution stand in the race to be at the forefront of the fourth iteration?

JAMES HURLEY

Industry 4.0, or the fourth industrial revolution, describes a new age of digitally enabled manufacturing whereby computers can control automated production lines. The vision of the potential dividends is compelling.

Artificial intelligence will monitor and improve the physical processes of the factory, even anticipating problems before they occur. New products and processes will be tested virtually so real-world production can begin seamlessly. A network of hub factories around the world will be controlled and upgraded remotely with little need for local human labour.

In short, nations and companies that forge ahead stand to benefit from giant strides in their productivity from Industry 4.0, alternatively known as the smart factory.

While the UK, currently the world's ninth largest industrial nation, has world-class manufacturers in the likes of Airbus, GlaxoSmithKline and Rolls-Royce, there are concerns that reluctance among many companies to invest means the nation risks falling behind.

The UK's share of capital investment in output has been low compared with key competitor economies for many decades.

The last annual survey by EEF, the manufacturing trade body, in October warned that investment in plant and machinery dropped to 6.5 per cent of turnover in 2017 from 7.5 per cent during the previous year.

Despite a slight improvement in recent years, the UK is also still lagging behind Germany and France when it comes to manufacturers investing in intellectual property, for example.

In this context, Hennik Research's last annual manufacturing report painted a relatively optimistic picture of readiness for the smart factory. It found that a quarter of manufacturers are already moving to implement Industry 4.0 in their facilities, while 62 per cent are planning to do so. Two-thirds had made investments in automation in the previous 12 months.

However, Mike Thornton, head of manufacturing at audit, tax and consulting firm RSM, says: "Among our own middle-market clients, we notice there's a lack of understanding and appreciation of what Industry 4.0 can offer, and how this is going to revolutionise the market.


OLI SCARFF/AFP/Getty Images

Airbus has a 15,000-strong workforce across more than 25 sites in the UK and spends more than £5 billion each year with domestic suppliers

This is a key factor that's holding back investment."

Derek Cummings, a director at Protiviti, a global consultancy firm, is concerned that Brexit could temporarily place the UK at a disadvantage in the race for Industry 4.0.

He says: "Unfortunately, until Brexit negotiations are concluded and there is a clearer path forwards in relation to trade deals and potential trade barriers for UK companies, it is difficult for most manufacturers to understand their ability to invest in new plant, equipment, capabilities and technologies."

The government's industrial strategy noted last year that the UK is already a world leader in artificial intelligence and it wants to provide help for industry to apply these innovations.

However, Mr Cummings believes rival nations have a clearer vision. For example, China is focused on investment in robotics and recently overtook Japan as the world's largest industrial robot market.

"Recent estimates suggest that the increased use of industrial robotics is likely to reduce manufacturing labour costs in China, Germany, the US and Japan by 18 to 25 per cent by 2025," he says.

Mr Cummings believes combining the interpretation of industrial data with the UK's considerable strengths in service industries is the way to get ahead in Industry 4.0.

But where is the capital for manufacturers to upgrade going to come from? Since the significant amounts of cash are needed to upgrade facilities for Industry 4.0, equity risk capital will have to play an important role. Manufacturing attracted 17 per cent of all private equity in 2016, according to the BVCA, the industry body, up from 11 per cent in 2014.

However, the inherent complexity of the transformation may mean the UK's shortage of "patient capital" could prove problematic.

David Petrie, head of corporate finance at the Institute of Chartered Accountants in England and Wales, explains: "The issue is not around the number of businesses supported, rather that there is a gap in financing where a product cannot be delivered within five to seven years. Investment with a longer time span than the typical three-to-five-year benchmark used by private equity and venture capital funds is lacking."

Mr Petrie says the proposed state national investment fund should play a role as a cornerstone investor in innovative manufacturing projects, which should in turn help seed private investment further down the line.

"The key to getting more investment in innovation will be from government and private sector partnerships," he says. "For example, there must be an effort to support the provision of financial advice to companies raising expansion or scale-up capital."

Idinvest Partners, a pan-European private equity and venture capital firm with €8 billion under management, says institutional investors themselves may have to innovate to play a greater role. Sylvain Makaya, partner at Idinvest, says this is what the firm has tried to do with its SME Industrial Assets (ISIA) fund.

The unusual, specialist structure aims to finance the modernisation of production equipment for small and medium-sized manufacturers. The €250-million fund was raised because Idinvest believes the kind of manufacturers that could most benefit from improved machinery and processes often struggle to find the right finance.

Instead of purchasing stakes in the manufacturers, the fund buys assets to be leased back to the companies, which are responsible for their management and maintenance. "It allows companies to optimise their cash management, while benefiting from the latest generation of technology and machinery at a reasonable cost," says Mr Makaya.

John Stokoe, strategic development adviser at European computer-aided design company Dassault Systèmes, agrees that interest from venture capital and private equity will be key to readying industry for the smart factory revolution. "Private equity investment will grow when increased government investment is realised, especially when government actively encourages partnerships with academia, industry and the investors," he says. ◆

£455bn potential boost to UK manufacturing from the positive impact of industrial digitalisation technologies (IDTs) over the next decade

175k net gain of jobs as a result of IDTs over the next decade

4.5% reduction in CO_2 emissions from IDTs over the next ten years

Department for Business, Energy & Industrial Strategy 2017

Q&A

dpa picture alliance/Alamy Stock Photo

Festo's pneumatic, lightweight Bionic Cobot at the Hanover Fair last year; collaborative robots or cobots will be a key part of Industry 5.0 as humans work side by side with robots to deliver value-added tasks

Manufacturing gets personal in Industry 5.0

Phill Cartwright, executive chairman of the Centre for Modelling & Simulation, looks forward to the fifth industrial revolution and predicts the role humans will play in automated manufacturing

BEN ROSSI

Most companies are still trying to get to grips with Industry 4.0 and already there is talk of Industry 5.0. What is the difference?

There are reports flying around at the moment saying the UK can get massive benefits from Industry 4.0 and it can, but we're not at the beginning; we're right in the middle of it. Industry 4.0 is the bringing together of robots, interconnected devices and fast networks of data within a factory environment, basically to make the factory more productive and to execute the routine tasks that are best done by robots and not best done by humans. To me, however, it's not just about generating increased productivity, but long-term, high-value careers because the jobs change as you're introducing Industry 4.0 technologies into a factory. As soon as you enter an Industry 4.0 factory, you also get a massive increase in safety, quality and reduced waste. Industry 4.0 starts to move towards Industry 5.0 when you begin to allow customers to customise what they want. Within Industry 4.0, you can already design your own trainers online and the manufacturer, wherever in the world, probably has the best technology with the best price point to deliver those trainers to your door. You can also go on the Mini website and select the kind of car you want with thousands of different variables, not just colours, headlights and interiors, but lots of other apps as well. Industry 5.0 takes that concept of personalisation to the next level.

Can you provide an example of what personalisation will look like in Industry 5.0?

The medical profession is working towards an artificial pancreas and it's not quite there yet. Type-1 diabetes sufferers are issued with a device that draws blood and measures the glucose for sugar levels in your blood. That device talks to another device which then delivers insulin into your blood. It kind of works, but it's a one size fits all and the medical professional does its very best to try and tweak the control system for the individual. Type-1 diabetes is very hard to control because we all have different metabolic rates and we're all different sizes with different skin thicknesses, behaviours, lifestyles and so on. If you move to Industry 5.0, it enables you to give individuals an app that follows their lifestyle and routine, and produces a manufacturing process for diabetes control and ultimately a smaller, more discrete and robust device that's tailor-made for the individual. So for diabetes sufferers, the ability to manufacture an Industry 5.0 process would be completely life-changing for them. The technologies deployed in there are the artificial intelligence (AI) techniques that basically understand and work out how your body is going to react to the device itself, and then take measurements from the field and learn how the body has reacted. They feed that into the manufacturing process to make the best artificial pancreas there is for that particular individual.

> **Industry 4.0 starts to move towards Industry 5.0 when you begin to allow customers to customise what they want**

In Industry 5.0, what will be the new relationship between humans and machines?

As you go from Industry 4.0 to Industry 5.0, you create even higher-value jobs than you did before because you're giving the freedom of design responsibility back to the human. A recent study from Meggitt shows the workspace doesn't become smaller in terms of a manufacturing cell around the human being; it actually becomes bigger. The human being has more responsibility and you end up with a bigger, lighter environment that's safer than the previous environment. The manufacturing operative within the manufacturing cell starts to become more involved in the design process rather than the manufacturing process, which is more or less automated. It allows freedom of design to work with you and enables products that are more bespoke and personal.

As factories become more and more automated, how will humans add value?

Industry 5.0 will give us the ability to close the loop on design so we can push boundaries of physics on design. If you're trying to make the next-generation aircraft, for example, you're constrained by today's manufacturing capabilities. You're also constrained by the amount of data that you have coming back from the infield service of an aero engine or aircraft and your ability to feed that in-service data back into the design process. With Industry 5.0, you'll be able to automate the manufacturing process better, which means you'll have real-time data coming in from the field. Rolls-Royce's business model in the last ten years has flipped from selling engines to now having 50 per cent of its revenue from providing services to the engine. They can do that because they understand the design of failure of that engine. They know what the quality process is of that engine and they know how they want that engine

Factfile

History of industrial revolution

1.0 **1780 – Mechanisation**
Industrial production based on machines powered by water and steam

2.0 **1870 – Electrification**
Mass-production using assembly lines

3.0 **1970 – Automation**
Automation using electronics and computers

3.5 **1980 – Globalisation**
Offshoring of production to low-cost economies

4.0 **Today – Digitalisation**
Introduction of connected devices, data analytics and artificial intelligence technologies to automate processes further

5.0 **Future – Personalisation**
The fifth industrial revolution, or Industry 5.0, will be focused on the co-operation between man and machine, as human intelligence works in harmony with cognitive computing. By putting humans back into industrial production with collaborative robots, workers will be upskilled to provide value-added tasks in production, leading to mass customisation and personalisation for customers

to perform. Wherever a Rolls-Royce or GE engine is in the world, they know how fast it is, how hot is it, its altitude and where it is in its performance lifecycle compared to where it's supposed to be as per its design capability. If you take that to the next stage and you have true, seamless data between the field, the manufacturing process and the design, you're taking humans out of the manufacturing route, but they'll be more involved in how the product is being used and how it can be designed because they have more information. Flipping the aero and automotive industries from a fossil-fuel world to an electrical world, for example, is going to be a significant design challenge and it will be much easier for humans to solve if the mundane tasks are being dealt with by AI techniques and robots.

To what extent is the UK in a position to lead the fifth industrial revolution?

A recent report by Jürgen Maier found the UK's manufacturing sector could unlock £455 billion over the next decade if it cracks Industry 4.0, with probably 175,000 highly skilled jobs to go along with it, but that requires leadership and intervention from the government. We have the best research in this area in the world, but other countries have clear positions from their governments on intervention to make it happen. I think the good news is the last few governments and this government have realised this is an area worth investing in to unlock that £455 billion and 175,000 jobs. But the needle needs to move a little bit to take the brilliant research out of the universities and into industry. With a small amount of intervention and some leadership, we may not have been leaders in the fourth industrial revolution in this country, but I'm pretty certain we could be absolutely the leading front on the fifth industrial revolution. ◆

> **With Industry 5.0, you'll be able to automate the manufacturing process better, which means you'll have real-time data coming in from the field**

Capitalising on industry's next phase

As Industry 4.0 transcends its buzzword status and emerges as a singular force for business transformation, manufacturers are increasingly looking to embrace the opportunities created by smart manufacturing and the fully connected enterprise

Innovative digital transformation solutions such as big data and predictive analytics can provide major benefits to firms, but a number of issues are hindering manufacturers' progress in these fields. Mark Bottomley, UK sales director at industrial automation provider Rockwell Automation, says a lack of both technical skills and education are key challenges that have to be overcome.

"It's very important to start early by getting more students, especially women and black, Asian and minority ethnic students, interested in science, technology, engineering and maths subjects. Engineers and technicians need to be going into primary schools and taking on the responsibility of engaging pupils in what it means to work in manufacturing today," says Mr Bottomley.

Skilled labour is as important as ever in manufacturing, but for Industry 4.0 to prosper in the UK a comprehensive agenda has to be pushed forward by both industry and government. Mr Bottomley believes that the UK's reputation for being a nation of entrepreneurs and innovators gives the country a cultural advantage.

"Through the Made Smarter campaign and the industrial strategy announced last November, we're starting to recognise the opportunities that are in this area. As long as UK-based staff can keep innovating, they can ensure that UK sites lead the global workforce and keep us at the forefront of the next generation of manufacturing," he says.

Only 29 per cent of manufacturing companies had adopted the internet of things in 2015, according to Statista, indicating that the potential of these innovative technologies has not yet been fully explored. Concerns around cybersecurity, which ranks as one of the top reasons why manufacturers are hesitating to implement industrial internet of things (IIoT) solutions into their operations, are slowing down widespread adoption of IIoT.

Mark Bottomley
UK sales director at industrial automation provider Rockwell Automation

It's vital for manufactures to collaborate with a trusted partner that has established strong partnerships with the wider technology eco-system.

"Within our network we work closely with companies that are well respected in these areas, including strategic global partnerships with Cisco and Microsoft, which allow us to help our customers implement their existing security framework on IIoT solutions without hindering manufacturing operations," explains Mr Bottomley. In practice, this allows verified solutions and remote support staff to gain access to keep the system running on a day-to-day basis, while still employing defence-in-depth best practices to mitigate potential threats.

Businesses that don't fully embrace the opportunities provided by IIoT and Industry 4.0 won't just lose their competitive edge, they'll also start to fall behind competitors in an increasingly global marketplace. Data analytics may not be a new concept, but the next generation of IIoT technologies can be applied to many more functions.

Most high-skilled data scientists are currently spending far too long performing basic data manipulation tasks to reshape data to be able to feed it into a model where they can gain useful insights, reducing the time they spend utilising their core expertise.

Rockwell Automation's analytics platform, called SCIO, utilises cutting-edge data science technologies to automatically interrogate data to retreive specific information that can be used to inform real-time manufacturing decisions. "You can then start to identify and focus in on areas that in the past would have been either very expensive or virtually impossible to understand because you're talking about huge amounts of data," says Mr Bottomley.

Industry 4.0 has already begun to change the conversation around what is possible in UK manufacturing but, according to Mr Bottomley, the best is yet to come. He concludes: "Now that we've been able to collect large amounts of data, the next big challenge is how it can be used to improve productivity. The resulting benefits of IIoT, together with the innovative, entrepreneurial approach British engineers are world renowned for, will help UK industry remain competitive and grow to contribute much more to the UK economy."

For more information please visit www.rockwellautomation.co.uk

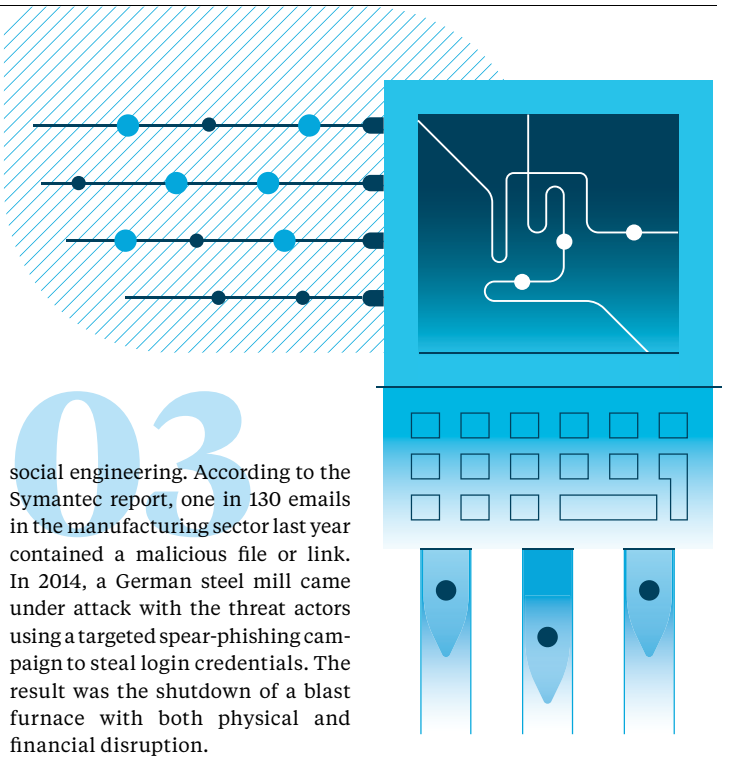
Rockwell Automation

CYBERSECURITY

Five worrying cyberthreats to connected tech

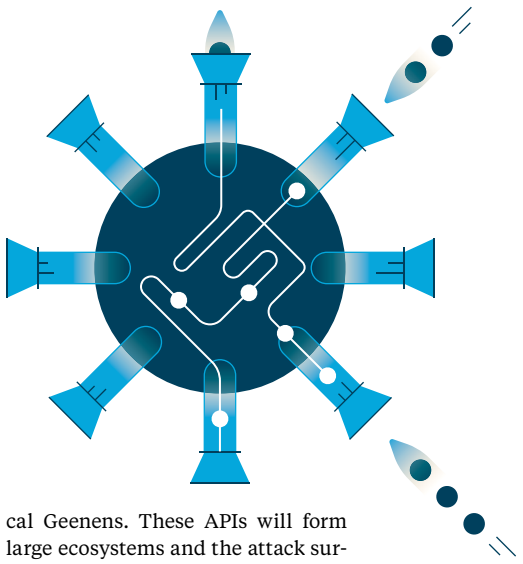
As connected technology develops, potential threats to cybersecurity multiply. Here are five major areas of concern

BEN ROSSI



01 Smart supply chains

Incremental gains in lean manufacturing are in part being driven by client devices able to interface horizontally with other client devices, using application programming interfaces (APIs). But smart supply chains such as this are also increasingly leading to security breaches at plants, according to Bernd Koenig, director of security, Europe, Middle East and Africa, at Akamai. "Poor security procedures somewhere down the supply chain can mean that malware is passed from client to client, infecting them all along the way," he says. Permanent denial of service (PDoS) attacks, such as last year's Brickerbot, have been created to expose the insecurity of internet of things (IoT) devices. "Down the road, APIs exposed on the internet connecting smart and intelligent agents with IoT devices and cloud services will become an even larger threat," warns Radware's European security evangelist Pascal Geenens. These APIs will form large ecosystems and the attack surface will increase with every service that is added. "A PDoS attack on just one of the APIs in an ecosystem will result in a large blast radius," says Mr Geenens. These APIs are effectively the keys which unlock the data hackers need to cause disruption to industrial processes. Unfortunately, the API threat is exacerbated by the lack of security standards in the creation and delivery of IoT.



02 Data manipulation

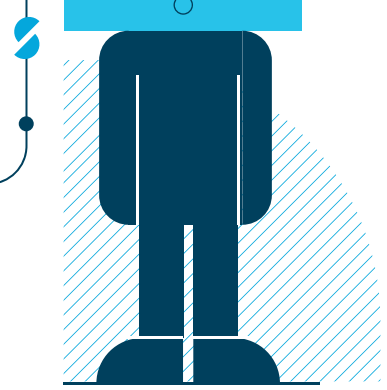
Manufacturers must understand they are no longer just at risk from data theft, but also data manipulation. "This is where hackers can get into a system and alter the data to showcase false information, which could be in the form of anything from sales figures to temperature gauges," explains Jason Hart, chief technology officer for data protection at Gemalto. Just last year there were reports of GPS spoofing which manipulates positional data. "The impact of incorrect position information is pretty evident for tracking deliveries on land and sea," warns Tom Holloway, principal business resilience consultant with Sungard Availability Services. "Given the minute scope for error in lean manufacturing processes, minor variations in supply chain flows have the potential to cause significant disruption." Or how about the millions of lines of code within 3D printable files that are the data supply chain of the future? Dr Adrian Davis, director of advocacy at (ISC)², reveals there is currently "no universal cybersecurity quality assurance built into 3D printing software or printers to alert manufacturers if design specifications are changed".

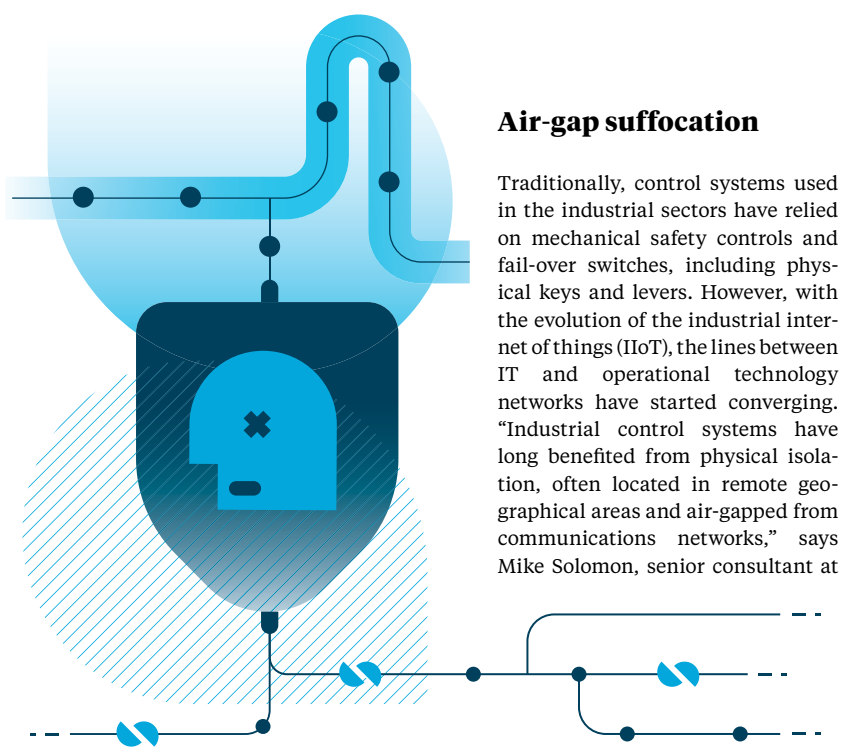
03 Social engineering

The manufacturing industry is a highly lucrative target for hackers, with Symantec's *2017 Internet Security Threats Report* ranking it as the third most breached industry globally. Industry 4.0 is the creation of intelligent networks, connecting machines, users and systems to autonomously exchange information and trigger actions. "Complex production processes that were once isolated are now vulnerable to cyberattack," says Darren Thomson, chief technology officer and vice president of technology, Europe, Middle East and Africa, at Symantec. "One exploited system can cause a ripple effect that takes down multiple facilities." Yet despite the complexity of Industry 4.0, the most commonly successful attack vectors remain the simplest ones, such as social engineering. According to the Symantec report, one in 130 emails in the manufacturing sector last year contained a malicious file or link. In 2014, a German steel mill came under attack with the threat actors using a targeted spear-phishing campaign to steal login credentials. The result was the shutdown of a blast furnace with both physical and financial disruption.

04 IP-enabled operational technology systems

"The increased use of IP-enabled operational technology (OT) systems is becoming one of the biggest targets for cyberthreats," according to Alex Hinchliffe, threat intelligence analyst at Unit 42, Palo Alto Networks. Not all that surprising when you consider the value of breaching and controlling such systems to tap into the connectivity on offer. In December 2017, Unit 42, the Palo Alto Networks threat intelligence team, discovered a new malware family named Satori which exploits known vulnerabilities on internet of things devices. "What is worrying about Satori is how it had evolved into a new variant that can carry out zero-day attacks," Mr Hinchcliffe explains, in other words the ability to exploit completely unknown vulnerabilities. "The challenge is that OT systems are hard to adapt and therefore struggle to keep pace with evolving threats like Satori." Indeed, manufacturers of OT systems can be very prescriptive about what users can do with their technology, forcing organisations to use legacy software and hardware. Simon Leech, enterprise security specialist at HPE Pointnext's Worldwide Security Center of Excellence, concludes: "Patch management remains a concern in a connected environment. The operational teams aren't used to having to reboot systems to install patches as the systems are relied upon 24/7."





05 Air-gap suffocation

Traditionally, control systems used in the industrial sectors have relied on mechanical safety controls and fail-over switches, including physical keys and levers. However, with the evolution of the industrial internet of things (IIoT), the lines between IT and operational technology networks have started converging. "Industrial control systems have long benefited from physical isolation, often located in remote geographical areas and air-gapped from communications networks," says Mike Solomon, senior consultant at BSI Cybersecurity and Information Resilience. This removes the need to apply stringent access controls. However, secure and effective access controls have yet to catch up with the advent of internet-connected devices. "Maersk, one of the world's largest shipping companies, suffered massively from 2017's NotPetya malware outbreak," Mr Solomon adds. This forced staff to revert to manual systems while global IT departments had to reinstall 45,000 new PCs and 4,000 new servers. Maersk estimated the cost to the business at $250 million to $300 million. "The fact that threats will find a way into critical systems can no longer be ignored," Mr Solomon warns, concluding: "Critical assets exposed by the IIoT must be protected." ◆

Commercial feature

ActiveCockpit provides shop-floor data capture and analysis

Not so much revolution as industrial evolution

The next big thing in manufacturing starts not with a bang, but a whir...

Industry 4.0. We've seen that term so many times that you'd be forgiven for wondering when 5.0 is going to arrive. But among the hype and hysteria, not to mention the existential confusion about where it starts and ends, it's easy to lose sight of the fact that Industry 4.0 is very much already here and it's not so much a revolution as an evolution – it just depends how you go about implementing it.

Wheels of industry keep revolving

Industry 4.0 may elicit reactions ranging from mild scepticism to muted panic. Is it too much too soon? How do we scale up our legacy systems? Will our people cope? But it's vital to bear one thing in mind: continuous improvement.

Customers don't explicitly want a straight switch to Industry 4.0 and factories constantly connected to the internet of things (IoT). However, they do want to get the best out of manufacturing processes. They're always pressing for better and more; incremental improvements in quality, efficiency and effectiveness. This drive for continuous improvement holds the key to making a success of Industry 4.0 and minimises the risk that inevitably accompanies such a step-change.

It's certainly something that the team at Bosch Rexroth UK lives by and not just in the context of Industry 4.0. "We're always thinking about how we can get better," says managing director Alastair Johnstone. "It doesn't just mean new tools and techniques, but also challenging the way we think and plan for the future."

As a main supplier of the drives, controls and connected components that are helping other businesses prepare and adapt to the next manufacturing paradigm, the company puts this continuous improvement at the core of what it does, and what it recommends for others integrating Industry 4.0, through a simple, three-step process.

Practical implementation in the real world

▶ 01 Implement sensors and controls

It's the sensors, fitted on to specific machinery and equipment that make connected manufacturing possible. Before fitting anything, however, it's vital to analyse requirements and objectives. Once you're clear on those, you can start with a technology such as Bosch's XDK or CISS smart sensors, offering multiple measurement capabilities in a single unit.

> **The full force of the fourth industrial revolution won't be signalled by a big bang, but by the reassuring whir of our machines tirelessly moving into the future**

▶ 02 Enhance these sensors

Steadily, gradually test, assess, enhance. These are how sensors, once configured, can be honed to fit the demands of your business and customers. Products such as the IoT Gateway Starter Kit provide a handy way to do all this, gathering and converting sensor data into easily accessible, and actionable, insights in the form of apps and dashboards. This step is all about evolutionary improvement, step by step.

▶ 03 Roll it out at plant level

You've opened the gateway, you've optimised your process; now it's time to take these steps out to your wider plant. Using the principles of your connected machines, widen the net within the bounds of your infrastructure and capabilities to create a fully digitalised factory. For this, Bosch Rexroth's Software Development Kit is a crucial aid in developing and deploying the necessary software architecture, libraries and services to enable that ultimate goal: the smart factory. The Software Development Kit enables you to handle and interpret large amounts of data to give accurate, real-time actionable information.

It's clear from these steps and the principles of continuous improvement that adopting Industry 4.0 is not so much a revolution as an evolution. Even in the natural world, evolution is effectively a test of various adaptations with one eventually becoming the norm. That's something else that Bosch Rexroth has taken to heart: that if you're going to recommend a way of adopting Industry 4.0, do it yourself first.

Pioneer's rulebook, chapter one: experiment on yourself

Self-experimentation can be the best proof of concept. It's also the other arm of Bosch Rexroth's dual strategy for Industry 4.0: as well as pioneering these products and platforms, its team also tests them out on its own facilities, equipment and machinery.

Caution is the keyword for the company here, with the gradual implementation of Industry 4.0 principles and projects taking precedence over any kind of big-bang approach. Its Glenrothes facility, a critical part of the hydraulic supply chain for major names in construction and earthmoving equipment, needs to be connected and competitive on a global level. It's a test bed for smart-monitoring and connectivity products, but it also needs to keep producing at a pace to meet customer demand with minimal disruption to day-to-day business.

For example, ActiveCockpit, a shop-floor data-capture and analysis tool, is being rolled out in critical areas of the machining cell and in assembly. This was, initially at least, intended to improve existing processes and make life simpler for operators, with real-time information to drive further improvements.

It also helps Glenrothes staff gradually acclimatise to changing processes, practices and tools, and converts extensive amounts of data into easily understood actionable information that can streamline and simplify future implementation, laying the foundations for further integration of connected machines.

This is the fundamental truth of Industry 4.0 in practice. It's not about replacing machinery outright or overhauling processes en masse. It's about adapting existing assets and making little changes, learning from it, applying that learning then more tweaks and adoptions, and then more, until you look back and realise the revolution was not televised – it was all a gradual evolution.

"Clearly, Industry 4.0 can be as wide or as deep as you want it to be," Mr Johnstone concludes. "The key point is you can't do it all in one go. This is a journey that we are just at the start of, but one we need to embrace and quickly, as the momentum generated by Industry 4.0 will only accelerate."

As the wheels of industry keep on revolving and connected components come online, node by node, the full force of the fourth industrial revolution won't be signalled by a big bang, but by the reassuring whir of our machines tirelessly moving into the future.

This article has been adapted from Bosch Rexroth's latest white paper, *A practical roadmap for the implementation of Industry 4.0.*

For more information please visit www.boschrexroth.com

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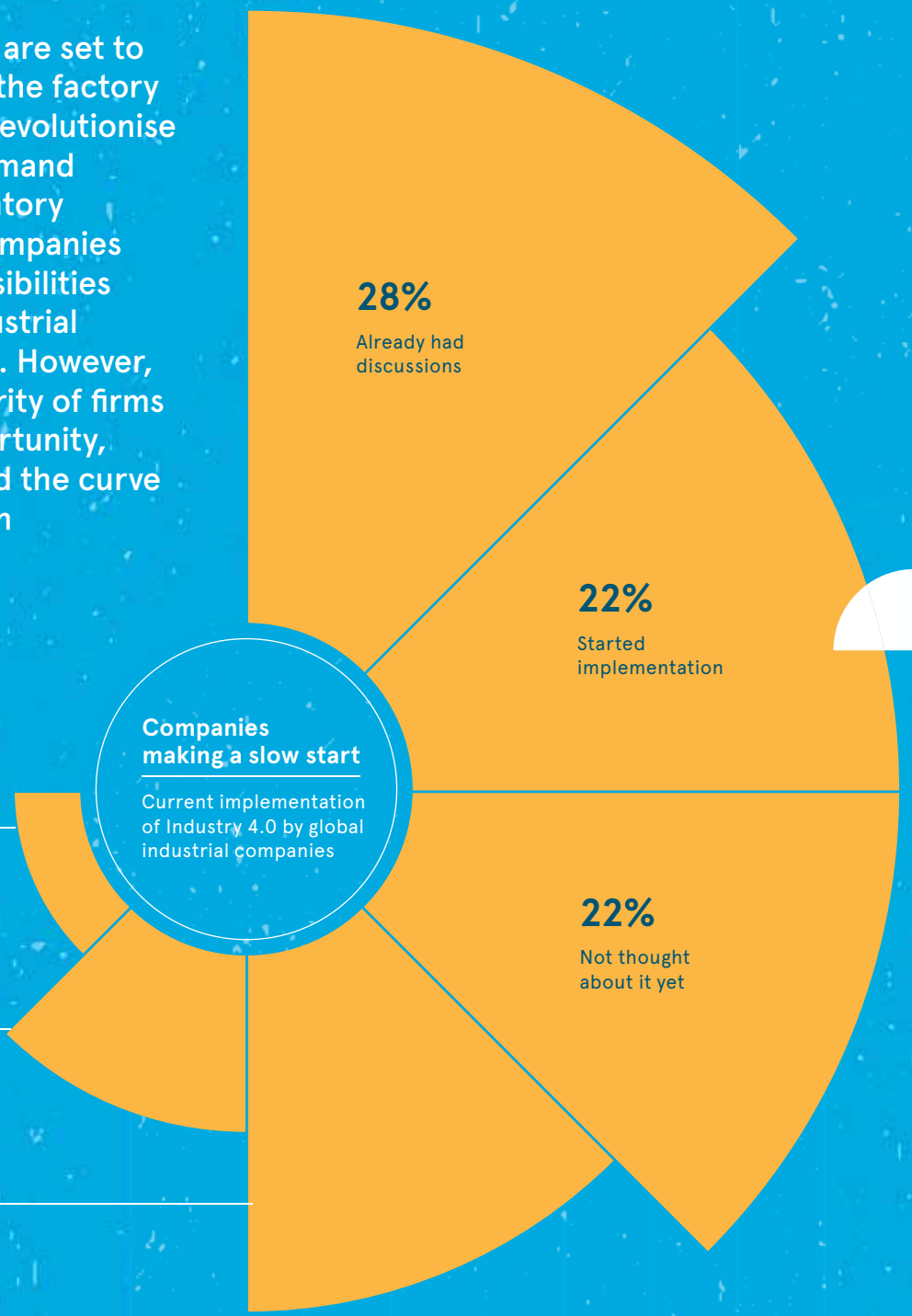
IoT Gateway gathers and converts sensor data into usable insights

INDUSTRY 4.0

Connected devices are set to not only transform the factory as we know it, but revolutionise everything from demand forecasting to inventory management, as companies wake up to the possibilities that the fourth industrial revolution presents. However, while the vast majority of firms recognise the opportunity, many remain behind the curve in terms of adoption



*Percentages do not equal 100 due to rounding

Stanton Chase 2017

88%

of global industrial companies agreed that the industrial internet of things (IIoT) is critical to their future success

66%

said IIoT will result in new revenue streams and business models for their company

49%

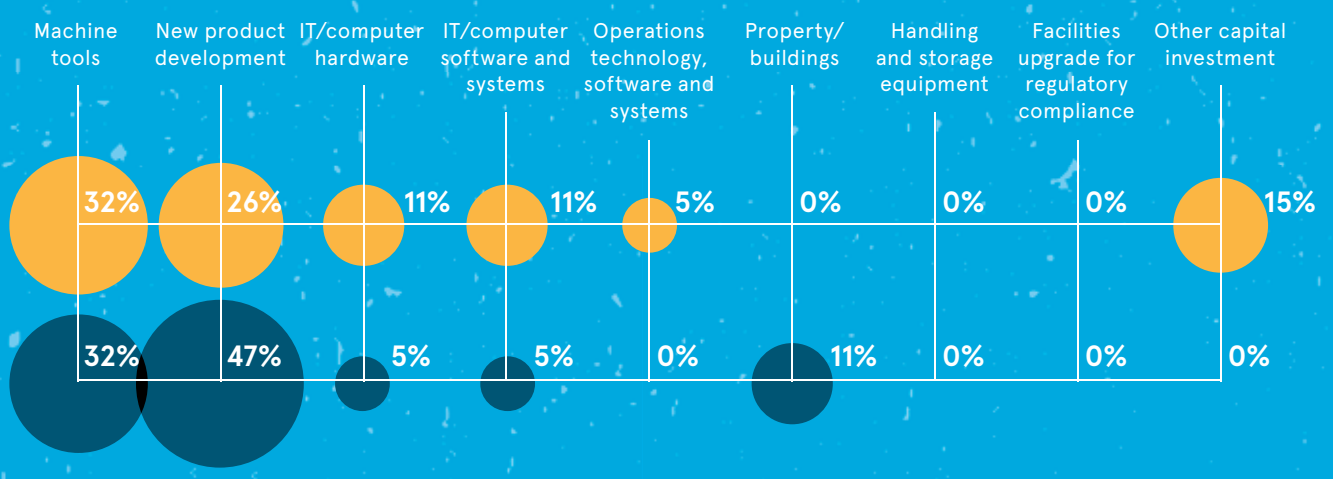
believe IIoT will enhance the customer experience

Industry of Things World 2017

Machine tools and product development take the lion's share of budget

Where manufacturers are allocating capital investment in technology

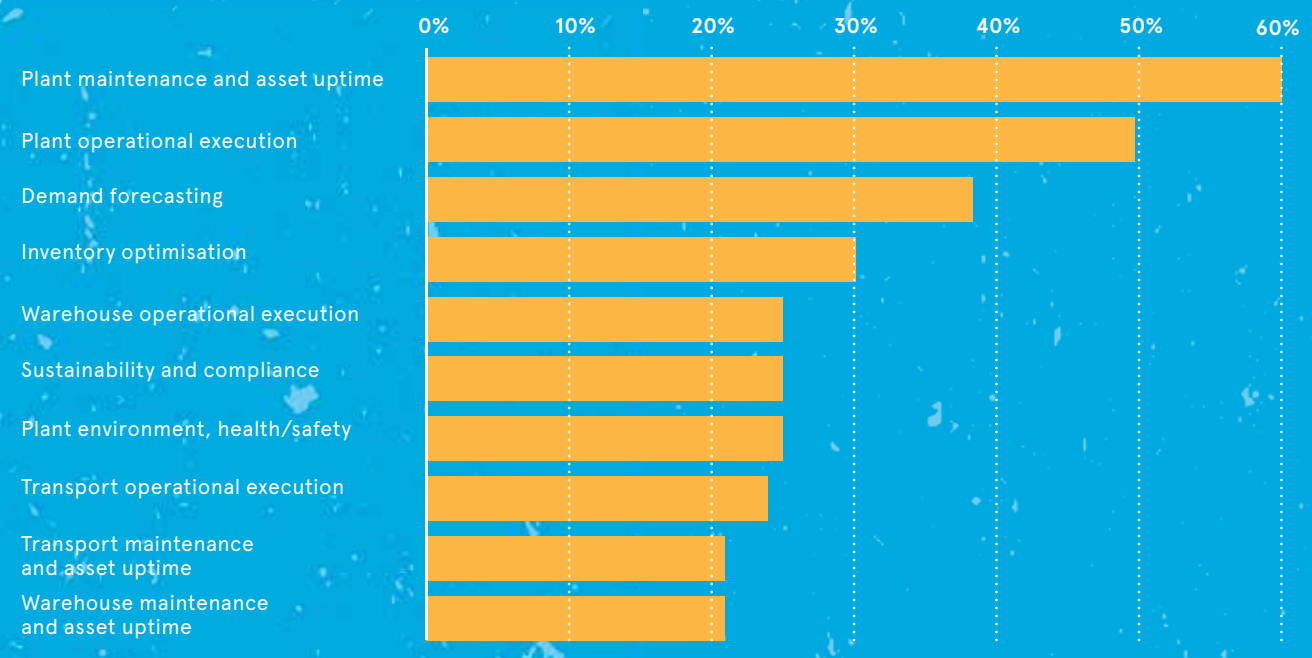
The Manufacturer/Hennik Research 2017



Maintenance and output expected to improve

Percentage of industrial firms that selected the following areas expected to improve through IIoT...

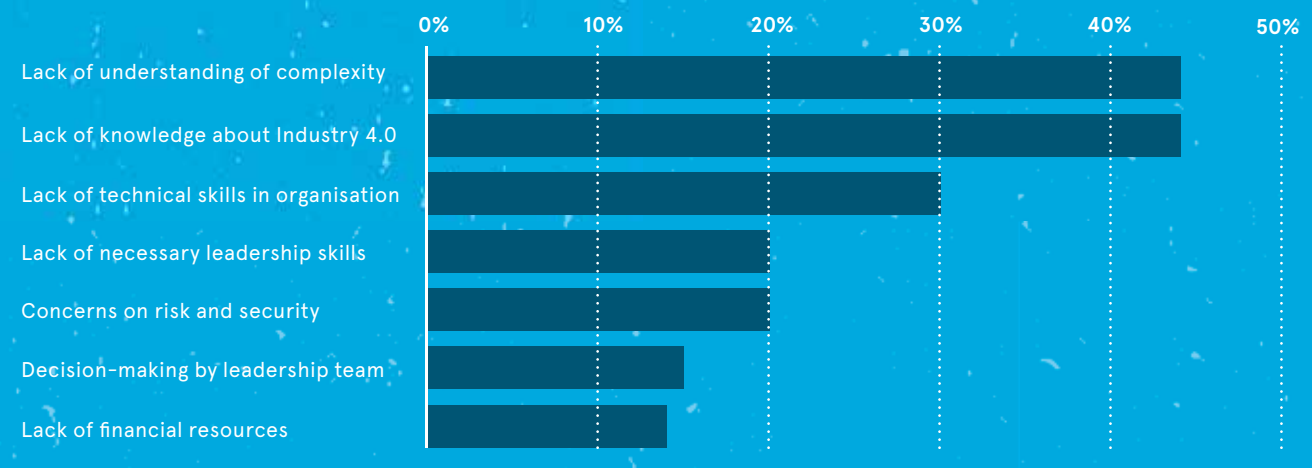
Industry of Things World 2017



Knowledge gap holding back implementation

Percentage of global industrial executives who selected the following challenges to implementation of Industry 4.0...

Stanton Chase 2017



SERVITISATION


Matthew Lloyd/Bloomberg via Getty Images

Industrial machinery manufacturer Caterpillar is lauded for its after-market logistics service

Waiting for pay day from servitisation

With a significant chunk of manufacturers yet to derive any value from servitisation, what is holding them back from realising its potential?

BEN ROSSI

Technology-driven disruption in the manufacturing sector has signalled an explosion in the servitisation business model as companies seek new revenue streams closer to the success and operations of their customers.

However, despite seven in ten manufacturers telling a recent IFS study that servitisation is well established or in progress in their business, one in three said they are yet to derive any value from it. Crucially, 58 per cent revealed they are only beginning to utilise data-driven insight, a core component of servitisation.

Servitisation, which sees manufacturers innovate to compete through services rather than products alone, is endemic within manufacturing. While the 1990s saw steady growth in recognition that services can form the basis of competitive advantages, the emergence of Industry 4.0 in recent years has accelerated demand for the model.

Of particular interest are so-called advanced services, which focus on the delivery of outcomes rather than simply the provision of a product and the maintenance of its condition.

While more and more manufacturers are exploring and creating advanced services, led by success stories such as Xerox that moved from printing to document management and construction machinery giant Caterpillar, now lauded for its aftermarket logistics provision, a lack of openness to change has inhibited growth.

"These are the same cultural challenges that are inhibiting productivity improvements and are pervasive within society and traditional manufacturing industry," says Professor Tim Baines, executive director of the Advanced Services Group, Aston University's dedicated centre for servitisation research. "Bizarrely, the UK was a world leader in servitisation, but this has slowed.

"Developing this portfolio of services is challenging and takes time. There has been a masking effect in publicity about servitisation caused by hype around initiatives, such as Industry 4.0, but servitisation is here, it is embedded and is growing,"

The manufacturers that have struggled to derive value from servitisation have typically failed to understand that customers buy solutions because they view it as a way to move risk. Some companies also underestimate how well they know how their equipment is being used by customers and don't build this into the revenue model, so they lose money.

"Because solutions are services and services are intangible, it is often difficult to communicate the value that is being created through their use, and customers can view them as a drain on finances," says Mark Johnson, associate professor of operations management at Warwick Business School. "Also services make money over time and require different skills to deliver. Manufacturers that do well through this understand they often require different organisational units to deliver them well."

"The internet of things and artificial intelligence are enabling servitisation to progress faster

7/10

manufacturers say servitisation is well established or in progress in their business

1/3

are yet to derive any value from it

6/10

are only beginning to use data-driven insight

IFS

Those that have made it a success share an understanding solutions need longevity. Both Xerox and Caterpillar, for example, have extensive remanufacturing operations to reduce costs, and they work well with partners to gain a deep understanding of their customers and how they can make them more productive. "At the heart of each of the solutions is a robust product supported by excellent services and an understanding of how to make money from it," says Professor Johnson.

The maturation of cloud-based technologies within Industry 4.0, including the internet of things and artificial intelligence, is now enabling servitisation to progress faster. Putting sensors on products creates digital data across a number of parameters, which manufacturers can use to understand more about how the product is used.

Armed with more advanced and integrated insights into their products, they can optimise performance and distribution, and create a range of services that utilise the data as well as improve the after-market experience.

These technological developments, along with changing views on ownership and resource use, enable manufacturers to see how customers are using their products and then add innovative services to help optimise that use, according to Duncan Johnston, UK manufacturing industry leader at Deloitte. "More companies will adopt it," he says. "Processes that are currently bespoke will become standardised and many organisations will move to different business models."

To achieve that move to a servitisation model, however, manufacturers need to reassess their culture and organisational structure. Evolving from a culture that prizes engineering excellence to one that places customer service at the heart of revenue generation requires a major shift in mindset. But knowing what is valuable to the customer will be the golden differentiator between manufacturers in Industry 4.0. ◆

OPINION COLUMN

‘If we get this right, there is a massive prize in creating a key lever and cure for the UK economy’

The manufacturing sector is on the cusp of the fourth industrial revolution, ushering in new technologies and techniques that will change the products, processes and relationships involved in every aspect of industry.

While the sector has hit a period of uncertainty following the outcome of the European Union referendum, faced with this pace of change happening globally, it cannot afford to stand still if it is going to deliver greater value to customers, improve productivity and remain competitive on the world stage.

In Europe, Germany (*Industrie 4.0*), France (*Industrie du Futur*), Sweden (*Produktion 2030*) and Italy (*Fabbrica Intelligente*) are all actively taking an interest. The EU is also spearheading a series of work streams with the aim of incentivising bottom-up activities under the guise of its Digitising European Industry programme.

But what do manufacturers in the UK make of this transformation?

Transformation is crucial for the sector. More than four fifths say they will have to invest in new technology to meet customer expectations, while three quarters say it will fundamentally change the expectations their customers will have from them. Both of these will have a major impact on the skills we will need from our current and future workforce.

Manufacturers view the core to all this as being about connectivity, using real-time information flow to discover new insights from data and acting upon those insights quickly to create value through new products and processes.

In the real world this is impacting on everything from the ability to analyse data on the performance of individual jet engine blades to improve performance, automotive manufacturing cells in car plants talking directly to their suppliers to order components, to the ability of domestic boilers to call automatically for service in the event of a malfunction.

According to manufacturers, the pace of change to produce these outcomes will be a three-step process, through conceptualising the realm of possibility from a unique business context, to optimising or evolving existing processes before a revolution is ushered in with business models changing fundamentally.

There are many different benefits to this transformation. In the short term, the focus will be improved operational efficiency through better use of capital, workers and resources. Over the medium term, the transformation will unlock new products, services and business models that will allow value to be added and captured in different ways.

Debates rage about what the benefits in the future may be, but they will include a move towards an autonomous, pull economy with end-to-end autonomous decision-making by machines, continuous demand-sensing and more optimised use of resources. This does not mean, however, that robots and autonomous machines will replace people as some fear.

But as always there is a global race to get ahead. Government has a role to enable this transformation to take place and the recent *Made Smarter Review*, which works as a partnership with industry, was a major step forward. It identifies policy interventions and support mechanisms that will encourage advanced manufacturing and broader industry in the UK to invest more in digital technologies, and drive faster innovation and automation of industrial processes.

At the same time there is a wider economic and societal imperative for doing this. It isn’t just about numbers, processes and investment strategies. If we get this right, there is a massive prize in creating a key lever and cure for the UK economy, with opportunities for many new, highly skilled and well-paid jobs, giving more people in our economy the chance to feel less like they are being left behind.

Stephen Phipson
Chief executive
EEF The manufacturers’ organisation

Commercial feature

Avoiding costly machine failure

Prognostics powered by machine-learning cuts factory downtime in half without the need for data scientists

As manufacturers continue to automate their factories and connect them with intelligent sensors, the data collected is providing critical information on the health and remaining life of their machinery, enabling scalable predictive maintenance.

The idea of understanding the health of machinery, otherwise known as condition-monitoring, is nothing new. As a principle, it’s been around for generations, but online technology saw widespread adoption in the 1990s in the aerospace industry.

Unfortunately, performing it at industrial scale has remained a pipe-dream for everyone other than the privileged few who have been able to afford the sky-high costs of scaling it up, and employing an army of expensive monitoring and data experts to extract the critical insights.

Prognostics goes beyond condition-monitoring by showing the remaining useful life of machinery. As manufacturers delve further into Industry 4.0, they are increasingly seeking these techniques to reduce costly downtime. Fortunately, the democratisation of enabling technologies, such as cloud computing and the internet of things (IoT), is now set to accelerate these from their limited-scalability phases.

“Prognostics software takes in data from Industry 4.0 machinery and automatically builds a picture of machine health as well as the remaining useful life,” says Alex Hill, chief commercial officer at Senseye, a young UK company whose machine-learning-based software for predictive maintenance already helps several Fortune 100 companies prevent downtime from machine failure on their production lines.

“By automating condition-monitoring and prognostics analysis, you can do predictive maintenance at scale, so you know which machines are currently healthy and which aren’t, and you know which ones will be healthy or not in a given timeframe.”

Senseye helps manufacturers avoid downtime and save money by automatically forecasting machine failure. Its unique machine-learning algorithms allow it to be used on any machine from any manufacturer, taking information from existing industrial IoT sensors and platforms to diagnose failures automatically and provide the remaining useful life of machinery.

If unplanned downtime happens, for example in the automotive industry, every minute costs £50,000, Mr Hill says. “It’s an incredible amount of money that our customers want to avoid losing; if they have a downtime event they can never make that back. By using our technology, industrial companies have reduced downtime by 50 per cent in three months. It’s incredibly quick to see results.”

Central to Senseye’s approach is cloud-based technology that doesn’t require experts in condition-monitoring or data science to operate. It’s designed to be used by the maintenance team, not IT staff.

> **Senseye helps manufacturers avoid downtime and save money by automatically forecasting machine failure**

Previously, predictive maintenance was so difficult and expensive to do at scale because of the need for these skills. By not relying on human expertise to analyse the data, manufacturers can now enjoy predictive maintenance at scale, going from a few machines to a few thousand without requiring more resources.

“We do all the difficult analysis work for them and they just get information about what machines are causing problems and how long they’re likely to live,” says Mr Hill. “We connect with whatever data source is already being used so installation can take anything from half an hour to two weeks, depending on what’s in place, making the whole set-up process as painless as possible.”

In the coming years, predictive maintenance is not only poised to reduce factory downtime drastically, but it will also enable servitisation in industrial sectors. The concept has already transformed the aerospace industry by changing the business model of many aircraft manufacturers, for example, from physically offloading assets to selling and delivering flight hours.

The evolution of servitisation will mean industrial manufacturers will begin to sell machine capability rather than machines themselves. For example, instead of the manufacturer selling a welding robot, it will sell a number of welds per hour, moving from a model of selling hardware to offering products as a service.

“Delivering a product as a service requires a high degree of automated data analysis when you’re looking at the industrial scale of hundreds or tens of thousands of machines,” says Mr Hill. “Predictive maintenance, without large deployment or ongoing costs and with a return on investment of months, now really is achievable.”

For more information please visit senseye.io

senseye

Breaking barriers in additive manufacturing

Collaboration with an additive manufacturing specialist in a long-term business relationship can overcome potential pitfalls and ensure success

The transformative impact of additive manufacturing is well-known by global manufacturing executives. Faster prototyping, less waste and more product flexibility are hard to resist for any business, but 53 per cent of respondents to the GE Global Innovation Barometer do not believe additive manufacturing has yet reached its full potential.

'Fear of the unknown' is certainly an issue when it comes to the widespread adoption of additive manufacturing across virtually all sectors, especially as finding staff with the appropriate design and production skills to make the implementation of additive manufacturing successful is a major barrier facing companies looking to take advantage of the next revolution in manufacturing. Understanding the massive variety of materials available, their distinct properties and what printing machines are most appropriate can at first seem like a difficult process to initiate.

Behrang Poorganji, materials development manager at GE Additive, works with a team of engineers to ensure customers have the most suitable materials for their products, even going as far as creating new materials based exactly on user requirements. These custom-made material recipes offer at least the same or better performance than conventional substances and improve profitability due to their bespoke nature.

"The materials we have today are all built on the conventional manufacturing paradigms that actually impose unnecessary constraints on designing a material. But now we have a technology that can open the boundaries of design and manufacturing like never before," says Mr Poorganji. "By asking our customers what their performance needs are we can create whatever works best for their applications, whether it be a material with a lightweight structure or one that is able to withstand high temperatures or pressure."

While choosing the correct material is a vital part of the process, machine selection can be equally important. Depending on the industry, there are a range of machines in terms of size and material compatibility to consider. For example, the GE's Concept Laser Mlab machines are more suitable to smaller applications and for using with precious metals, whereas larger parts can be fabricated in a Concept Laser Xline.

Additive manufacturing excels at building complex parts out of expensive materials, as the process only uses the exact amount of material needed, and in the process cuts waste and saves on material costs over traditional manufacturing methods. Industries that tend to use higher grade and more expensive materials, like aerospace manufacturers and the medical device industry, can see considerable raw material savings when making the transition to additive.

Potential additive manufacturing customers usually want to hear about successful projects and case studies as part of their decision making plans, but the best way to clearly see if additive manufacturing is right for a company is to engage directly with those additive experts who can advise based on extensive market knowledge.

The vast majority of companies would benefit from partnering with an external additive manufacturing expert to ensure both a cost effective implementation process and a quicker product cycle. "If you decide to go it alone with additive manufacturing, you're talking about significant investment in a lot of cases. That is just something that not a lot of companies can quite frankly afford," says Josh Mook, engineering manager at GE Additive.

"We focus on supporting the customer through their journey to product and try to understand exactly how they differentiate themselves from competitors. Through an extensive discovery workshop we find ways additive can impact our customers and then begin to generate the business cases to support its introduction," adds Mr Mook.

When a clear connection is established between additive manufacturing and bottomline business benefits, especially around the impact it can have on improving competitiveness in the market place; customers quickly start to come around to the idea of utilising additive as a key instrument in their manufacturing toolbox.

> **The success rate of implementation is going to be much higher using a process where you have an expert with you every step of the way**

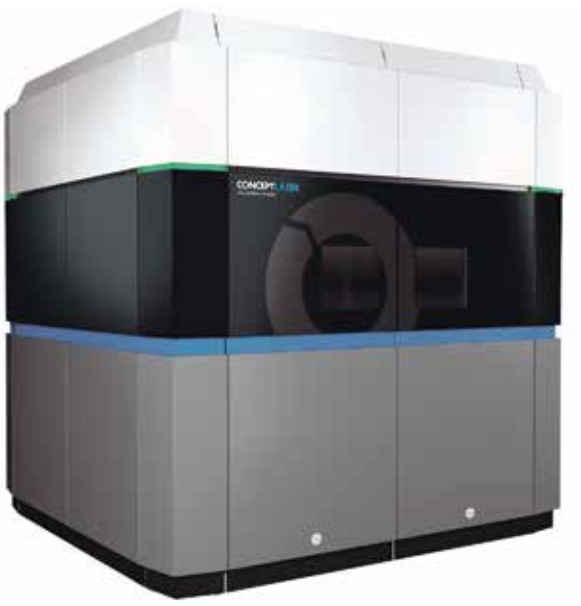
Collaborating with an additive manufacturing specialist shouldn't be a one-off project, but rather a long-term business relationship. Additive manufacturers should play a central role in everything from identifying use cases to achieving product certifications and beginning low-rate production, all the way up to implementing additive manufactured components into a product.

"We believe the success rate of implementation is going to be much higher using a process like this where you have an expert with you every step of the way, opposed to just giving you a pat on the back saying good luck and goodbye," says Mr Mook. Working with a design team that has a proven track record of success with dozens of other projects around additive manufacturing helps ensure that whatever issues are encountered during the implementation process, will have all been seen before and the team will know how to overcome them.

GE is unique in the additive manufacturing environment as it's the only original equipment manufacturer who is designing for additive and introducing their own products into the field using the technology, allowing the company to showcase the full possibilities of additive. The Advanced Turboprop Engine from GE Aviation saw around 12 to 18 months eliminated from its product design cycle, thanks to the use of additive manufacturing.

The changes additive manufacturing will bring to the supply chain are expected to be significant, as a single printing machine will, in some circumstances, be able to replace an entire factory building and the complex infrastructure support will no longer be required. The aerospace and biomedical industries have led the way in the adoption of additive manufacturing, but the next few years will undoubtedly see an increasing number of sectors such as, power generation, renewable energy, automotive and industrial equipment fully embracing additive manufacturing, with those companies who hesitate set to fall behind.

"We have a saying at GE Additive: additive manufacturing is here. You're either going to be the leader in additive or a victim of it. The companies that don't see the value and choose to sit on the sidelines are either going to be overtaken by competitors or potentially even lose to new market entrants, as additive effectively lowers the barrier to entry in a lot of industries," said Mr Mook.



With high levels of precision, even on intricate shapes, additive manufacturing opens up new design possibilities

GE Additive

SUSTAINABILITY

It's time for sustainability to get radical

Kevin Frayer/Getty Images

If sustainability now demands radical solutions, we must fully embrace technology and use it to sustain the planet

JIM McCLELLAND

In sustainability circles, we are often told small is beautiful, and slow and steady wins the race; resilience is a marathon, not a sprint, after all. The clichés of incrementalism have a reassuring ring of common sense to them, but what if they are wrong?

Faced with the sheer scale of world issues, such as urbanisation and climate change, and charged with the aspiration and grand ambition of the United Nations' sustainable development goals (SDGs), what if little by little is simply not enough? Is it time to go big and get radical?

The short answer, on both counts, is maybe. For a start, the scale of the impact does not always match the size of input. In business and industry, seemingly minor process tweaks truly can deliver really substantial sustainability gains.

By way of illustration, Frank Piller, professor of technology and innovation management at RWTH Aachen University, cites a project story shared by Tim Eschert, the founder of New York-based artificial intelligence (AI) startup Fero Labs. The tale tells of a case when, helping a large European steel mill reduce waste in production, Fero Labs was able to generate a saving of 3 per cent that amounted to 180,000 tons of steel available to be used again. The solution was to prevent "mill scale", which is a standard quality problem, but a major source of waste and energy consumption.

Interestingly, only one fix was needed. Professor Piller explains: "The trick was to use existing data, existing sensors, existing machinery, existing people, but a new prediction algorithm."

Small opportunities to innovate are everywhere, says Manfred Kube, head of M2M Segment at digital security firm Gemalto. "Connected internet of things (IoT) technologies have huge potential to help industrial enterprises fulfil their sustainability goals," he says. "The possibilities are practically limitless. We've even worked with agricultural firms to use IoT to develop smart beehives which monitor temperature to protect against mites that pose a threat to rapidly declining bee populations."

More common potential applications of IoT in the service of sustainability might include use of connected sensors to gauge emissions, detect water leakage or reduce waste. Remote monitoring could also eliminate manual maintenance checks on machinery and field equipment, as well as enable fleet operations to track vehicle performance or even optimise routing based on real-time traffic-flow data from smart streetlights.

It is the cumulative effect that counts, says Mr Kube. "Individually, these activities can have a small, but significant impact. But combined together, they can form a co-ordinated IoT strategy which could revolutionise an industrial organisation's approach to its sustainability responsibilities," he says.

20%

of total greenhouse gas emissions come from industry

PwC 2017

It is not just industrial or manufacturing sectors seizing the initiative. High street food and clothing stores at the head of the retail supply chain are also alive to the opportunity, says Mike Barry, director of sustainable business (Plan A) at Marks & Spencer. "We have seen this collective wave of technology and innovation leaving the lab and entering the marketplace – blockchain, AI, robots, 3D printing, drones – and all of those have tremendous power to make us more sustainable, says Mr Barry."

It is the anticipated impact of market shocks and shifts that is really driving demand for radical solutions. "We can't just keep getting iteratively better," he says. "There are going to be some great big steps and disruptions ahead, and I should like to think M&S has created the capacity, the skills and the partnerships it needs to use that technology revolution to become a demonstrably more sustainable business."

One prime example of tech-led innovation, currently prompting a fundamental rethink of the dynamics of more sustainable consumption, is mass customisation, says Professor Piller. "Producing on demand exactly what customers want, when they want it, can become a strong driver of sustainability: no overproduction, no unwanted products," he says. "Another enabler is the emergence of adaptable products, smart products that can be changed and modified via software in the usage stage."

The key is thinking not just different, but big. He adds: "I urge managers not to stop with operational efficiency when drafting their Industry 4.0 strategy, but to consider the effect on new business models. Sustainability demands radical solutions."

When it comes to Industry 4.0, what is in danger of slowing the rate of sustainable application is not perhaps the speed of technological advance, but the relatively conservative and risk-averse culture of responsible business applying the brakes.

New models call for new mindsets, argues international non-executive director and author Marga Hoek. "Traditionally, sustainability professionals are just not very innovative," she says. "This needs to change, completely. We must embrace technology and use it to sustainability's advantage."

Small changes in the way connected devices are used have the potential to create massive savings in waste and energy consumption

In her latest book, *The Trillion Dollar Shift*, launched at the recent World Economic Forum's Davos summit, Ms Hoek discusses how business can successfully engage with the UN's SDGs. In it she analyses prospects for a range of budding game-changers in the tech space, from medicine delivery by drone in Africa, to 3D-printed food and a robotic pig that tackles sewer sludge.

> **Traditionally, sustainability professionals are just not very innovative**

For Ms Hoek, embracing the dynamic and disruptive business opportunities heralded by the dawning of the fourth industrial revolution is not just desirable, but essential. Industry 4.0 is effectively a sustainable business imperative. She concludes: "We can only reach the SDGs if we are willing and able to make good use of radical innovation, and the accelerating power of ICT and technology. It makes the global goals more achievable."

Ultimately, the call is for radical alignment in pursuit of these shared goals. It's time for tech to get sustainability – and for sustainability to get tech. ◆

OPINION COLUMN

‘This revolution has huge potential, but we need to get serious about education and skills’

Britain has a once-in-a-generation opportunity to increase productivity in the manufacturing sector and across the wider economy. This means encouraging businesses to unlock the potential of their data and become early adopters of transformative digital technologies. To do that, Britain needs to focus on skills.

Digital technology has made it possible for firms to develop innovative business models that harness real-time data to lower costs and improve efficiency. Customers can have access to higher-quality products and services, and companies can boost growth and create jobs. This means a healthy economy and rising living standards.

The recent *Made Smarter Review* argued that Britain can and should become a world leader in industrial digital technologies, converging breakthroughs in artificial intelligence, robotics, the internet of things and big data. This is one of the primary objectives of the All-Party Parliamentary Group on the Fourth Industrial Revolution (4IR).

The review suggested that embracing the 4IR could boost growth in UK manufacturing by £455 billion over the next decade, creating a net gain of at least 175,000 jobs and a reduction in CO_2 emissions by 4.5 per cent. This should focus minds in Whitehall and in businesses around the country.

Key to achieving the ambitions of the industry leaders, who led the *Made Smarter Review*, will be ensuring Britain has a workforce that is fit for the future, equipped with the right skills to harness the opportunities of industrial digitisation.

Britain has a widely recognised shortage of workers educated in science, technology, engineering and maths (STEM), the skills needed to build this new era of British industrial success. In our efforts to close this gap, Britain starts from a position of strength, with world-class universities, a strong base of scientific research and an additional 1.8 million children in good or outstanding schools since 2010.

Solving this challenge will be vital if Britain is to make the most of the 4IR and the government clearly recognises this. By delivering a comprehensive overhaul of the UK’s technical education system, the prime minister has promised to deliver a skills revolution for post-Brexit Britain.

Acknowledging that nearly half of all businesses report a shortage of STEM skills as a serious concern, the government is investing £500 million a year into a new system of T levels, developed in collaboration with industry experts, to give young people a clear and straightforward path into STEM careers.

Moving forward, we must continue to roll out reforms to our education system at all stages of life so children develop the right skills for the future, so the working-age population is encouraged to continuously upskill throughout their working lives and so adults affected by automation are given opportunities to retrain and go back to work.

That said, growing the STEM workforce must not be done at the expense of creativity, social skills and collaborative problem-solving, the kind of abilities that are highly automation resistant and will be valued by British firms for decades to come. Scientists and engineers may be needed to build this new economy, but we must avoid creating skills gaps in other areas.

This is not just about coding for kids. It’s about preparing everyone, whatever their age, for a more digital, more automated world. It’s about combining the capabilities of people and machines, automating repetitive administrative tasks and freeing human workers to add value in other ways.

This revolution has huge potential to boost economic growth and raise living standards, but if we are to make a success of it, and if the British people are to view it as an opportunity and not a threat, we need to get serious about education and skills.

Alan Mak

Chair of the All-Party Parliamentary Group for the Fourth Industrial Revolution

EDUCATION

Workers must be trained for a new future

A fourth industrial revolution, featuring automation and data exchange, is set to transform industry, but requires new skills and training for the UK workforce

VIRGINIA MATTHEWS

Apathy, fear and dislike of hype have all played a part in ensuring the UK ranks just 11th in the world in terms of its digital readiness, according to the latest government figures. Yet for a growing number of businesses, it’s lack of access to relevant skills and education which is causing consternation.

Around one million workers will need to be reskilled or upskilled within the next five years to keep up with next-generation 3D printing, artificial intelligence, virtual reality, augmented reality and the internet of things, among many other innovations.

But while beefing up engineering talent on the shop floor is vital, skills gaps further up the food chain are also hitting home.

Overall, 30 per cent of respondents to the latest *Stanton Chase Global Industrial Executive Survey* say their biggest challenge in implementing industrial innovation is lack of technical skills, while 20 per cent say the same of leadership skills such as change management.

“It seems that there are frequent bottlenecks due to a lack of common understanding and, in some companies, the speed of execution is hampered further by layers of hierarchy,” according to Gert Herold, the executive search firm’s managing partner and vice president for Europe, the Middle East and Africa.

“It is a great challenge for the C-suite and talent management to prepare an entire organisation for workplace 4.0, to keep all seniority levels and age groups involved and motivated, and to safeguard permanent learning.”

For business leaders without a technical background, the problem is compounded, says the British Automation and Robot Association, whose president Mike Wilson notes that while there are already 170 robots per 10,000 employees in Germany, the UK figure is just 33.

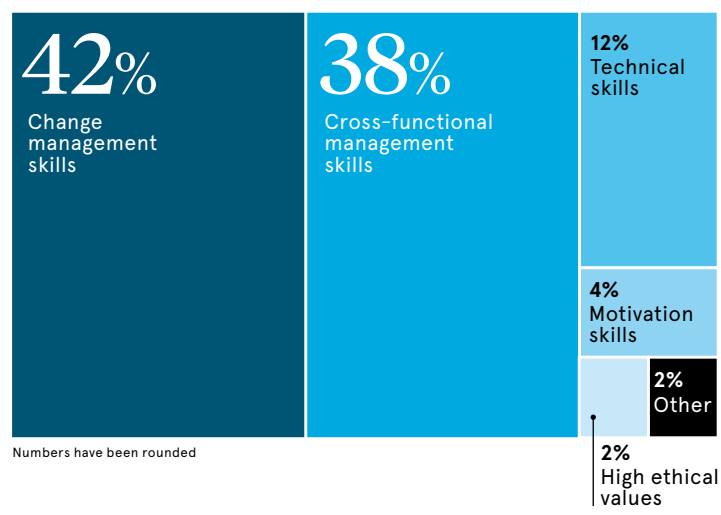
“It’s worth remembering that leadership skills will become more important than technical ones and once we start to demystify the Industry 4.0 jargon, this will become clearer,” he says.

“In the meantime, if you’re a chief executive without a clear grasp of the various bits of kit

Germany is leading the way in technical education, but it’s not an easy model to follow

Skills most needed for Industry 4.0 project leaders

Global survey of industrial executives and professionals



Numbers have been rounded

Stanton Chase 2017

Skills most needed for Industry 4.0 project leaders

people are talking about, make sure you talk to your own engineers before you fork out money just to make yourself and your company look good."

So if the UK is in danger of being stuck at the back of the class when it comes to technological education, despite the trumpeting of new T-level technical qualifications, which of our direct competitors are grabbing all the A stars?

"Germany inevitably stands out in terms of its world-class apprenticeship system and I would argue that Italy is leading the way in terms of how its government encourages manufacturers to take the plunge via financial incentives," says Laura Pickering, education development manager at the Manufacturing Technologies Association.

"But I'm particularly impressed by Spain, whose national strategy for industrial digitalisation – *Industria Conectada 4.0* – has put lifelong learning and training at the centre of its digital skills strategy, while also addressing the issue of youth unemployment."

She notes that while the rapid pace of change means that many of today's engineering undergraduates will be out of step by the time they graduate, apprenticeships are less vulnerable.

Ben Rowland, co-founder of Arch Apprentices, concurs. "Germany is leading the way in technical education, but it's not an easy model to follow," he says. "While the work-study approach is deeply entrenched in the German culture, in the UK we're still battling to get schools, employers and young people to see apprenticeships as a viable alternative to university."

Ms Pickering stresses that while there is already an acute skills shortage in UK science, technology, engineering and maths, or STEM, we're still missing a trick when it comes to gender balance.

"France, Germany and Spain have worked hard to attract more women to engineering, while we still have the lowest proportion of female engineers in Europe at just 9 per cent. This needs to change," she says.

In the view of everywoman co-founder Karen Gill, Industry 4.0 could actually mark a turning point.

"Although men have largely dominated the discussion on Industry 4.0, it is a great opportunity for women too," she says. "At a time when raw technical skills will need to be overlaid with emotional intelligence, better communication and more collaboration, women will come to the fore."

Although business, science and academia are already working closely together via innovations such as Catapult centres, which echo the long-established *Fraunhofer* network in Germany, Mr Wilson fears an overload of blue-sky thinking.

"Having spoken to many small and medium-sized enterprises, I am convinced that what we need now is the sort of down-to-earth, practical training which will allow existing engineers to, say, put robots on packing lines via adaptations to a firm's current technology, rather than buying in new," he says.

"What firms require is a clear automation strategy looking no further than five or ten years ahead, rather than thousands of MBA theses on what artificial intelligence will look like 20 or so years from now."

Neil Lewin is learning and development consultant at Festo, which uniquely for the UK combines electrical automation manufacturing with industrial training. Its educational offer includes both introductory workshops on Industry 4.0 as well as site visits to a fully automated factory in Scharnhausen, Germany.

> **What firms require is a clear automation strategy looking no further than five or ten years ahead**

"Britain is at the starting point of its Industry 4.0 skills journey and, in many ways, so too is the rest of the world," he says.

"My advice is to break down your educational needs into small chunks, and then mix and match the various training opportunities out there, be they executive coaching, factory floor training, whole-company workshops or indeed lifelong learning strategies." ◆

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