eef **The manufacturers' organisation**

THE 4TH INDUSTRIAL REVOLUTION:
A PRIMER FOR MANUFACTURERS

4IR

Connecting industry

#4IRUK

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UK Manufacturing 2016/17 facts:

2.7 MILLION EMPLOYEES

10% OF GVA

45% OF UK EXPORTS

68% OF BUSINESS R&D

14% OF BUSINESS INVESTMENT

EXECUTIVE SUMMARY

The manufacturing sector is on the cusp of the 4th industrial revolution (4IR), bringing with it new technologies and techniques that will change the products, processes and supply chains involved in every aspect of industry. This technology ushers in even greater connectivity that will allow manufacturers to maintain their competitive edge in a rapidly changing world, and respond flexibly and quickly to customers' requirements.

Not all manufacturers are at the same stage of knowledge about what this will mean for their business. Indeed, we are at the start of this 4IR journey and understandably, many manufacturers are still getting to grips with the subject. This report aims to help manufacturers understand just what the 4th industrial revolution is all about and how it will apply to business.

Through our research we have identified that there will be three main phases to this transformation, each one underpinned by company strategy, ambition and growth – a conception phase, evolution phase and then a revolution phase. Firms have plans to invest and early signs are that the focus amongst companies will be in the evolution stage.

The benefits of 4IR technology adoption for manufacturing will be widespread, with smarter supply chains, smarter production and smarter products. Manufacturers will need to keep pace with the change, they themselves say it will be happening more quickly than ever before and it will fundamentally change their customers' expectations.

This is isn't just a UK phenomenon, it is a global shift, which offers opportunities for UK manufacturers as global supply chains are joined up more effectively. But this global shift also presents a risk if UK manufacturers fail to keep pace. Manufacturers currently feel UK industry isn't geared up for the change, but that their business is – demonstrating a need for greater communication across supply chains and industrial sectors about the benefits.

UK manufacturers can take advantage of this. The 4IR journey starts with optimising existing business processes and many are doing this – we outline some practical use cases in this report. Manufacturers will be prioritising smarter supply chains and embedding smarter production processes within their business.

But beyond technology there are also steps manufacturers must take to prepare their business to ensure any move towards 4IR is a success. These include applying visionary thinking as there will be less certainty on return on investment, changing the internal innovation culture of their business and boosting the role of IT and technology in decision making across all parts of the business.

This report servers as a primer, allowing manufacturers to develop their awareness and start conversations within their business, across their supply chains and with their customers about the range of opportunities 4IR presents.

Companies will already be looking at elements of digital adoption, but the difference with 4IR is the speed of that adoption. As the organisation representing UK manufacturing, EEF stands ready to guide members through this change.

THE 4TH INDUSTRIAL REVOLUTION (4IR) – HYPE OR REALITY?

Manufacturing is, once again, entering an era of considerable change. Over the last few years manufacturers will have increasingly read about the 4th industrial revolution, or Industry 4.0, smart manufacturing, connected factories and factories of the future. But what does it all actually mean and what do manufacturers in the UK make of this transformation?

This has been the focus of EEF's work, in partnership with Oracle – to identify what manufacturers understand of this transformation, how they will be taking advantage of it and what the barriers to adoption may be.

This work, taking place across 2016, has been developed using several surveys, four focus groups across the country and several interviews to paint a detailed picture to share with manufacturers in this report and as part of our ongoing work.

It has been clear from our research that manufacturers understand that this change is happening and the benefits it can bring to business growth and their strategies, but currently there is a mixed picture on knowledge and the application to individual businesses. We have identified three key stages to the 4IR journey, all of which will be tailored to a company's own strategy and growth plan. Firms recognise they need to fully get on top of the change, which will be happening quickly, and understand where and how it will apply to processes, across the supply chain and in products.

What is the 4th industrial revolution (4IR)?
The manufacturing sector is on the cusp of the 4th industrial revolution, ushering in new technologies and techniques that will change the products, processes and supply chains involved in every aspect of industry. This technology will enable manufacturers to maintain their competitive edge in a rapidly changing world, and respond flexibly and quickly to customers' requirements.
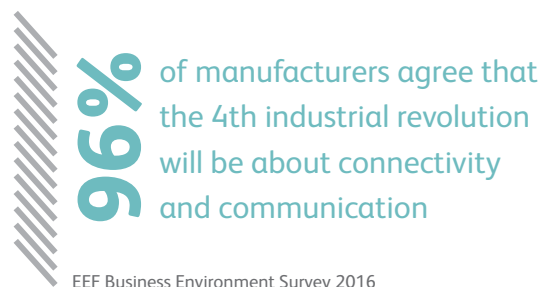
It's about data connectivity
Manufacturers view the core to all of this as being about connectivity. Physical networks link with cyber networks together as one system to allow a real-time flow of information. Data is collected, turned into information and insights, and can be acted upon quickly.

There are three core components to this transformation
1. The Industrial Internet of Things (IIoT) – machines and technologies collecting, sharing and acting on data between themselves
2. Big data – the capture of data on everything and real time analysis of that data by machines and systems
3. Secure and reliable digital infrastructure – a resilient network to link everything up

Data collected can help firms to understand what really is going on, whether that's how a product is being used or how production processes are performing. Data collection can happen in real time and more importantly can be analysed immediately. Issues or problems can be acted upon quickly, maximising equipment efficiencies,

96% of manufacturers agree that the 4th industrial revolution will be about connectivity and communication

EEF Business Environment Survey 2016

minimising downtime and gaining new data-driven insights to help drive growth strategies and respond to customer demands.

These increased insights will also enable and drive possible new business models, giving the opportunity for higher value activity to derive competitive advantage such as mass customisation, service-enhanced business models, service-oriented business models, factory-less goods producers and the circular economy[1].

99%
of manufacturers agree that the 4th industrial revolution will be about getting actionable insights from data

EEF Business Environment Survey 2016

In manufacturers' own words
And this isn't all just theory, during the summer of 2016 EEF carried out focus groups across the country to hear from manufacturers their views on 4IR. The concept is on their radar and they know it is a live debate, they recognise what

it can bring to their business and how it will help achieve growth.

However, undoubtedly not all manufacturers are at the same stage of knowledge. Indeed, we are at the start of this 4IR journey and understandably,

IN THEIR OWN WORDS: HOW MANUFACTURERS DESCRIBE THE 4TH INDUSTRIAL REVOLUTION

Not just about tech but how you join up the tech to work better – more productive, efficient, more insights and information Communication and data analysis Optimisation for efficiency gains – smarter ways of working An enabler of ambition Use data to provide answers more quickly **Quicker innovation Next step in optimisation and efficiency** Will become essential for competitive manufacturing Real time data availability and information **Provide better solutions for customers** Information management from data – data on its own isn't helpful Difference between data and knowledge and information **Information flow and exchange Help to integrate service and product** Better understand product use Help move into mass customisation Connecting up 'buckets' of work areas – information flow **Managing data and systems to improve competitive edge** Product/process/supply chain **– joining up and smarter ways of working between areas** Enhancing service provision Information to help to optimise products **An enabler of ultimate ambition and goals**

Source: EEF 4IR focus groups 2016

[1]Read more in Manufacturing Ambitions: an industrial strategy for economic growth, EEF/Natwest, Oct 2016

many manufacturers are still getting to grips with the subject. Forty-two percent of firms agree that they are familiar with the concept of the 4th industrial revolution (chart 1) whilst others are less certain of what it all entails.

What will it change?

There will be ways that 4IR technologies and techniques can create value across the manufacturing ecosystem. Ultimately ambitions will be rooted in winning new business – increasing sales and growing market share and will be tailored towards the needs of each individual business. New technology as part of 4IR will be the enabler of these ambitions. In very broad terms, there are three areas where 4IR technologies will support in delivering this:

– Smarter supply chains – greater coordination and real time flow of information across supply chains and relationships allows better tracking of assets and inventory and integrated business planning and production. This unlocks new ownership and collaboration models across supply chains.
– Smarter production – the use of data analytics and new production techniques and technologies (such as autonomous robots, multi-purpose production lines and augmented reality) helps to improve yield and speed up production. This allows new business models to be pursued such as mass customisation.
– Smarter products – Rapid innovation and a faster time to market is enabled by data collected from products along with user feedback, whether direct or collected via social sentiment on the internet. This data also allows remote diagnostics and remote/predictive maintenance.

Chart 1: Manufacturers still getting to grips with the 4th industrial revolution

% of companies agreeing that they are "familiar with the concept of the 4th industrial revolution"

31% Disagree

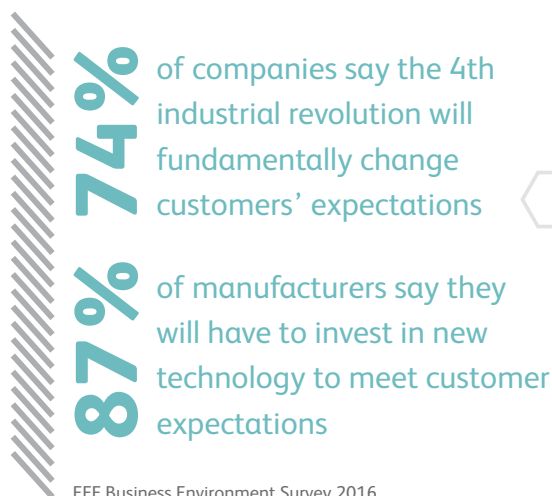**42%** Agree

27% Neither agree nor disagree
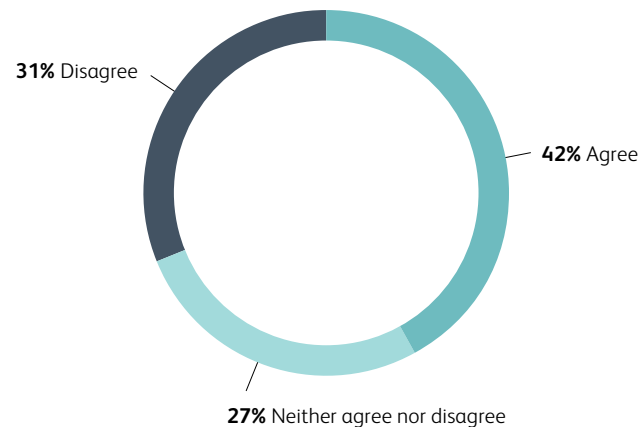
Source: EEF Manufacturing Ambitions Survey 2016

Examples of some of the technologies within each of these areas is explored more fully in section 3.

Expectations and requirements

This transformation is crucial for the sector, 61% of manufacturers agree they could be using digital technologies more to boost their levels of productivity.

But the drive for change will not just be an internal one, the expectations and requirements of customers will require firms to change and adapt to the needs of the marketplace. In order to meet customer expectations, nearly nine in ten companies recognise they will need to invest in new technology.

74% of companies say the 4th industrial revolution will fundamentally change customers' expectations

87% of manufacturers say they will have to invest in new technology to meet customer expectations

EEF Business Environment Survey 2016

The phases to this transformation

Our research to date has identified some clear milestones for manufacturers in the 4IR journey. The journey starts with conceptualising the realm of possibility from their unique business context, to optimising or evolving existing processes before a revolution is ushered in and with it fundamental changes in current business models. All of these steps will be driven by business ambition and strategy, which will not be the same for everyone.

There are many different benefits to this transformation. In the short term, the focus will be on 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.

Is it happening?

From our research there is evidence that firms are already at different stages of the journey. Whilst we have seen that some companies aren't sure what the 4th industrial revolution really means, there are also firms well on the path to revolutionising their businesses.

When we drill down into where manufacturers are already investing, it echoes the three phase implementation already discussed in this chapter.

The majority of investment that is being done, or being planned, is focused on technologies that will help to unlock the evolutionary phase – cloud solutions, capital equipment with networked control systems, embedded data analysis or embedded sensors, and multi-purpose production lines. These are also the technologies that companies feel are most helpful for delivering their business plan.

Some of the more revolutionary areas are not on the radar for firms – unsurprising given we are at the start of the 4IR journey. Just a small proportion are already invested in technologies such as fully autonomous robots, universally integrated data networks or augmented reality.
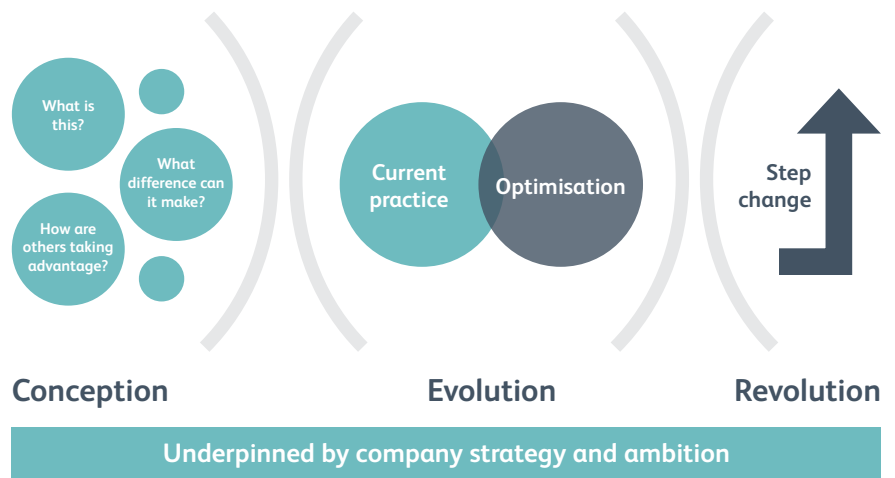
Some of this technology will allow manufacturers to completely change their current business models, and further carve out competitive advantage. Indeed a lot of these

80%
of manufacturers say it will be a business reality by 2025
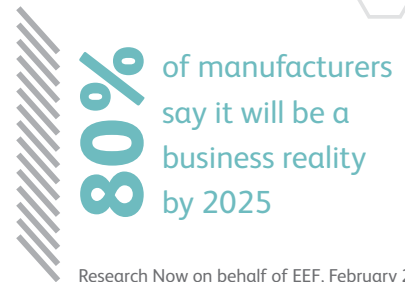
Research Now on behalf of EEF, February 2015

The 4IR Journey

– The first phase – Conception – where companies figure out what 4IR is all about, what it can offer and how it could apply to their business.
– The second phase – Evolution – a period where there can be some advancement on current practice; concepts and some off the shelf solutions can be implemented and tested, further optimising current processes and putting in place new solutions.
– The third phase – Revolution – this will be the huge step change in terms of how value is derived and how interaction with customers and suppliers happens.

What is this?
What difference can it make?
How are others taking advantage?

Current practice   **Optimisation**

Step change

Conception   **Evolution**   **Revolution**

Underpinned by company strategy and ambition

technologies have not yet entered the minds of manufacturers from an investment point of view – with large proportions not yet considering a wide range of technologies (chart 2).

Manufacturers say it will be happening… and quickly
What is different about the 4th industrial revolution compared with the revolutions that have gone before, is the speed at which change will happen. This view was echoed by participants in our focus groups and in our survey, with 68 % of respondents saying 4IR will be happening faster than previous changes in manufacturing.

Despite this speed the majority of companies feel they will be able to keep up – 61 % of companies said they wouldn't find it difficult to keep up with the speed of change that the 4th industrial revolution will bring.

Chart 2: Some technologies not yet on the minds of manufacturers

% of companies already investing in or considering investment in each technology
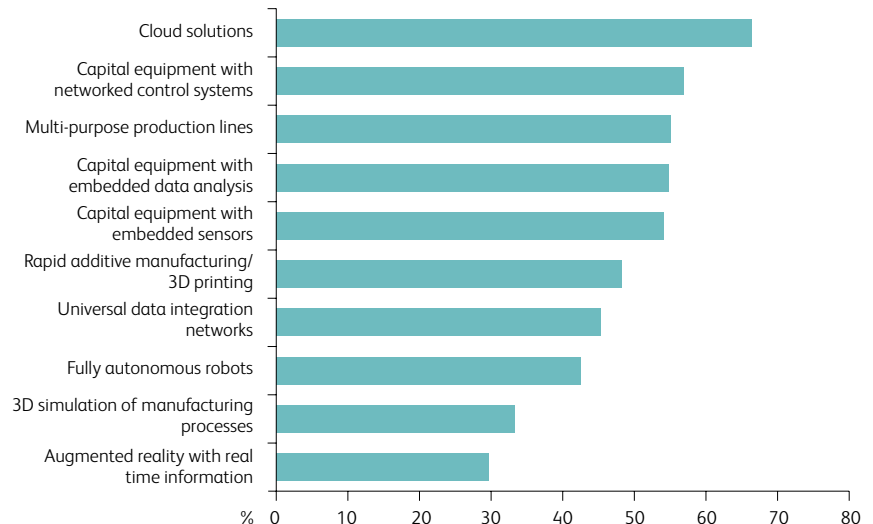
Source: EEF Manufacturing Ambitions Survey 2016

> **" The speed of current breakthroughs has no historical precedent "**
>
> Klaus Schwab - Founder and Executive Chairman, World Economic Forum writing on the 4th industrial revolution

IN SUMMARY:

Manufacturers don't feel that the 4th industrial revolution is hype – but there is uncertainty from some about how it will apply to their business.

It will be happening in different phases: a research and conception phase, an evolution of business processes followed by a revolution in business models and ways of creating value.

For some the concepts will not be new – different companies will be at different stages of awareness and adoption and will be approaching this from different angles. All of this will be overseen with the ambitions and strategy of a successful and growing business in mind.

In the following sections we discuss whether the UK manufacturing sector is ready for 4IR and what business environment factors may influence the change, what some of the practical examples of where 4IR technologies have benefited company strategy, and some other non-technology aspects to consider to foster the right culture for technology investment to deliver expected benefits.

IS THE UK MANUFACTURING SECTOR GEARED UP FOR THIS?

Understanding what the 4th industrial revolution can offer is a far cry from being able to take advantage of it. A major determining factor will be the UK business environment and the ability of policymakers to take the necessary steps to underpin this transformation of industry.

The 4th industrial revolution is happening globally and concurrently. In Europe, Germany (Industrie 4.0), France (Industrie du Futur), Sweden (Produktion 2030) and Italy (Fabbrica Intelligente) are all actively taking an interest. The US and Chinese manufacturing sectors are also readying themselves for this change, driven by different strategic objectives.

The European Union 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 – as part of the ambition to create a Digital Single Market.

Within that context it is important that UK manufacturers are geared up for this change. While manufacturers can invest in the right technologies or approaches in isolation, the benefits will only be realised where change is driven right across supply chains.

In most sectors of manufacturing – supply chains are dense global networks that have developed over time, 4IR could therefore be both a risk and
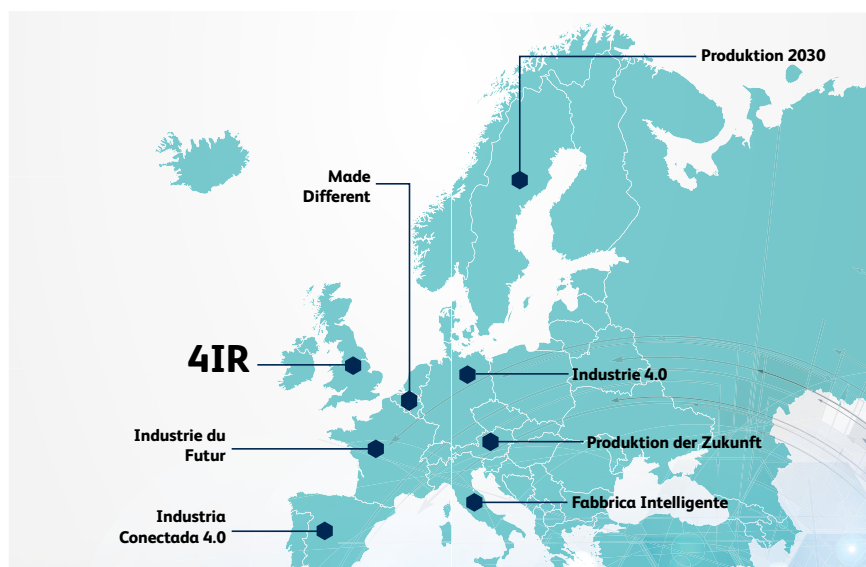
Only **11%** of manufacturers think the UK manufacturing sector is geared up to take advantage of 4IR

EEF Manufacturing Ambitions Survey 2016

4IR IS HAPPENING ACROSS EUROPE

Known by other terms in Europe and around the world. This is a global revolution.

Produktion 2030

Made Different

4IR

Industrie du Futur

Industria Conectada 4.0

Industrie 4.0

Produktion der Zukunft

Fabbrica Intelligente

61% of manufacturers disagree that they will find it difficult to keep pace with the change brought about by 4IR

EEF Business Environment Survey 2016

opportunity for UK manufacturers, depending on their position in that global supply chain.

There are advantages to moving first
There are therefore downsides of not taking advantage of the opportunity presented. First movers may spend more upfront, but will realise the benefits faster, particularly in the evolution phase, freeing up resources for faster and further reinvestment. First movers may also be able to capitalise on their advantage by displacing supply chain competitors at the global level.

An additional benefit of moving first is the ability to determine the platforms that will underpin the processing and exchange of data, locking this in across your supply chain and reaping the benefits before your suppliers' other customers dictate these platforms.

Late movers may see lower upfront costs, as some solutions may be closer to being 'ready-made', but keeping pace with the change will be difficult. This is especially true if the business culture is overly conservative in its approach to change or if this is applied 'off the shelf' without a meaningful business strategy to underpin it.

Early indicators are UK manufacturers are positive about their ability to take advantage of the changes associated

with 4IR. Our survey showed that 61% of manufacturers disagree that they will find it difficult to keep pace with the change brought about by 4IR, 68% are also not worried about the competition that will be brought about by this change.

Despite this only 11% of manufacturers think the UK manufacturing sector is geared up to take advantage of 4IR, 57% either don't know or are neutral and 33% say the sector isn't geared up for this change.

This highlights an early warning - not enough of the UK manufacturing sector is confident enough to start discussions about this with their peers in industry. Without industry and supply chain leadership, the risk is that the UK will be left behind.

There is also a risk of complacency of understanding. Change will be

happening quickly and while the outcomes from technology may be clear now, new insights may change the manufacturing process in unforeseen ways within some sectors. Keeping abreast of change will be a significant requirement for industry leaders.

Will the UK business environment hold back the sectors ambitions?
While a lot of the focus for implementing 4IR will be down to manufacturers, our focus groups highlighted a number of unknowns which could hold back investment which needs an industry level discussion and solution. There are also business environment factors which still need to be addressed by policymakers. Some of the factors set out below have been well document but are worth repeating. Fixing these will be the basic minimum needed to ensure the UK has the best business environment to attract 4IR investment.

Only **35%** of manufacturers agree that their current internet connection is adequate for their expected needs over the next five years

EEF Digital Connectivity Survey 2015

Digital connectivity

4IR is about trusted data transfer and connectivity. EEF's previous surveys have shown manufacturers are investing significantly in leased lines to ensure they have the internet reliability to support their business. Despite this, some manufacturers are being left behind by existing digital infrastructure in the UK, most notably SMEs in rural areas, where the choice of providers is limited and so the cost is prohibitive.

For manufacturers who do have a choice of standard business internet packages, that choice is undermined by the technology that underpins the UK's core network (copper). A more reliable and resilient network is needed, such as fibre – however Britain is at the bottom of the league table on fibre rollout with only 2 % of the UK's digital infrastructure network provided as dedicated fibre to the premise.

Data security

The free flow of data, which is a core part of 4IR, could be easily undermined by a major cyber breach, particularly one that affects the entire supply chain. Companies may adopt a cautious approach, limiting access to data to avoid such an event. This is because the risk of data breaches and data manipulation could cause serious financial, safety and reputational damage.

However, while this reaction may be rational this will limit the benefits of adopting 4IR. Manufacturers need to put in place a more rigorous approach to managing cyber threats across their business, including making it a board level discussion. EEF's surveys show less than six in ten (56 %) of manufacturers say cybersecurity is given serious attention by their board.

New approaches to managing and storing data will also offer solutions. This includes cloud based approach which can improve resilience and security and minimise downtime. Manufacturers will need to understand the range of options to secure their data and adopt a mixed approach based on their requirements.
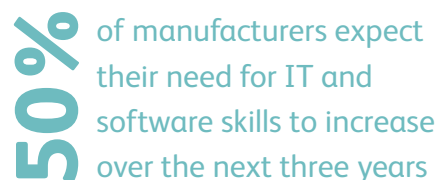
Staff skills

No discussion on manufacturing is complete without discussing skills. Despite the high capital intensity of the sector and the increased use of technology that will come about as a result of 4IR, the availability of talent will continue to determine the success of a business.

Across all our focus groups retraining and upskilling were identified as important to fully realise the benefits of 4IR. This is a major issue as projections indicate that current new entrants into the manufacturing sector will not be enough to cover those leaving, and so companies know they must look to the existing stock of skills they have in their workforces and to up-skill and re-skill these employees in order to make 4IR implementation a success and achieve their growth ambitions.

These requirements sit alongside the ongoing skills challenge within manufacturing. EEF's surveys show that manufacturers increasingly recognise the importance of digital skills to prepare themselves for this transformation.

The change will also create new highly technical skills requirements through new and changing job roles in production and design. Alongside this the move towards greater use of technologies such as wearable augmented reality (explored in the next section) may increase the number of generalist roles within manufacturing. Leadership and management skills will be just as important – this is explored further in section 4.

Just **36%** of manufacturers have a cyber-breach incident response plan in place

EEF Digital Connectivity Survey 2015

50% of manufacturers expect their need for IT and software skills to increase over the next three years

Source: EEF Skills Survey 2015

Interoperability of technologies
The lack of interoperability of technologies across different systems and platforms will be a barrier for manufacturers, particularly those further down the supply chain. Across our focus groups manufacturers all discussed their experiences of having to adopt different software solutions to meet customer expectations – this was a particular worry for smaller manufacturers.

Solutions in this space will require industry and supply chain leadership and potentially new supply chain collaboration approaches - in one of our focus groups the Sharing in Growth programme within the UK aerospace industry was identified as a potential model that could be used across other sectoral supply chains as part of 4IR.

22% of manufacturers say poor data compatibility between different systems and machines was likely to be a barrier to them adopting new digital technologies and techniques

EEF Business Environment Survey 2016

IN SUMMARY:

Both government and industry will need to act
Some of the challenges set out above will require government intervention and EEF will continue our early advocacy in this area to champion manufacturers and manufacturing in the UK.

Remaining close to EU Digitising Industry programme, which forms part of the Digital Single Market strategy, will also be important - both during and when Britain's membership of the EU comes to an end.

Across 2017 EEF will be stepping up our work with members to provide the intelligence, support and networking to ensure the UK manufacturing sector is on the front foot and able to take advantage of this change within their business.

4IR - FROM THEORY TO APPLICATION

The discussion on 4IR to date has largely been a theoretical one and manufacturers taking part in our focus groups highlighted the need for more detailed information to be provided to allow them to start to engage with this topic. This report is an attempt to redress the balance.

4IR is not something that will be done to manufacturers but is something that manufacturers will have to consider and apply to meet their business strategy – what follows is not a crib sheet, but an attempt to connect the theories to practical examples and what these have achieved.

Ultimately 4IR is about enabling manufacturers to respond to modern industrial competitiveness pressures, while allowing them to serve the modern customers who will increasingly expect a more nimble approach to manufacturing.

This section will focus on some of the practical use cases for 4IR technologies and techniques to enable manufacturers to conceive how some of this can be applied to their business. It deliberately focuses on examples that are easier to grasp. Some of these use cases may seem obvious to some, but for others this may not be the case - this was a point that divided our focus groups, with some saying "we're already doing that" while others felt that this was only the case in some sectors where 4IR is being driven by OEMs.
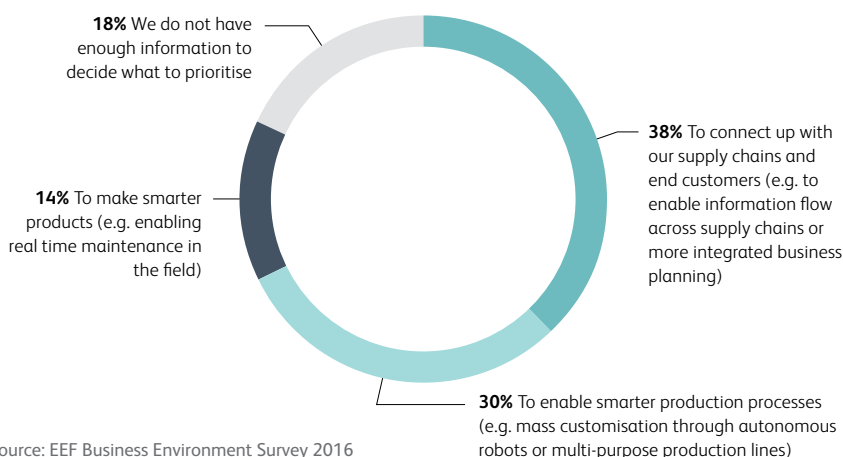
These examples use the smarter supply chains, smarter processes and smarter products structure we introduced earlier and looks at the concepts that can be adopted in the evolution phase. These were:

– Smarter supply chains – greater coordination and real time flow of information across supply chains and relationships allows better tracking of assets and inventory and integrated business planning and production. This unlocks new ownership and collaboration models across supply chains.
– Smarter production – the use of data analytics and new production techniques and technologies (such as autonomous robots, multi-purpose production lines and augmented reality) helps to improve yield and speed up production. This allows new business models to be pursued such as mass customisation.
– Smarter products – Rapid innovation and a faster time to market is enabled by data collected from products along with user feedback, whether direct or collected via social sentiment on the internet. This data also allows remote diagnostics and remote/predictive maintenance.

Where are companies planning to focus investment?

Chart 3: Initial priority for most companies will be on connecting up their supply chains

% of companies citing most likely area to prioritise adoption of new technologies and techniques associated with the 4th industrial revolution

18% We do not have enough information to decide what to prioritise

14% To make smarter products (e.g. enabling real time maintenance in the field)

38% To connect up with our supply chains and end customers (e.g. to enable information flow across supply chains or more integrated business planning)

30% To enable smarter production processes (e.g. mass customisation through autonomous robots or multi-purpose production lines)

Source: EEF Business Environment Survey 2016

Smarter supply chains

EEF's survey of manufacturers shows that the initial priority for most companies will be on connecting up their supply chains, with 38 % of respondents saying this is the area their company is likely to prioritise. In this space there are many approaches that can be taken.

Examples:

Creating a digitised warehouse inside and outside the factory using RFID tracking of inventory to create a smarter inventory management system
A large manufacturer is using RFID tagged inventory to know the precise location of components across their factory. The same boxes are used outside their factory to track deliveries across their supply chain to provide up to the second knowledge of the location of inputs to production.

The same manufacturer has also built on this to create a digitised inventory management system, which tracks the weight of hoppers of consumables and automatically orders replenishments based on future production.

By linking these systems together they have created a digitised warehouse that exists beyond just their factory floor to also encompass stores in their supply chain, giving them a deeper level of knowledge. This depth of knowledge is then useful for business planning and also allows them to compensate quickly for sudden interruptions.

Optimising fleet movements through greater tracking of other factors in addition to location to deliver the lowest cost
A volume manufacturer, using a telematics 'black box', tracks their logistics fleet to calculate an accurate cost per mile and cost per stop to work out the optimum mix of using their own delivery fleet compared to using an external contract fleet. Their focus is on getting the product to their customer as quickly and as cheaply as possible while managing inventory flows between their factory, warehouse and branches.

Smarter production

The area coming out as the second highest priority is enabling smarter production processes, with 30 % of companies choosing this option. In this area sensors and big data analytics offer the potential to understand in finer detail the entire production process, the unknown dependencies and how small changes can unlock huge production efficiencies and savings.

Examples:

Using multi-functional robots and cobots to perform more complex tasks
Robots are already used in some sectors to undertake repetitive but precise tasks as part of the assembly line process. However multi-functional robots and collaborative robots (cobots) are a step up. One large scale manufacturer is using these to undertake dextrous tasks such as assembly and packaging of products. Using sensors and cameras these robots are able to work alongside humans with programming done onsite.

Production line simulation/virtualisation to identify the most efficient layout for production
A volume manufacturer with long order cycles frequently changes their factory layout to meet new demand or to incorporate the production of new units. Instead of changing the layout and then spotting problems and inefficiencies as they go along, they have invested in a virtual reality suite. Using this enables them to test the layout, run a production cycle based on historic equipment data and spot errors and inefficiencies before they occur.

Augmented reality for operational tasks, warehouse and logistics staff
Augmented reality is being used across manufacturing to reduce the need for niche technical knowledge and enable the

production of more customised products. One manufacturer has adopted the technology, which sees workers field of vision being 'augmented' by projected computer images, to speed up navigation in their warehouse by showing directions using augmented reality glasses.

Another manufacturer is using the technology to project onto equipment where parts have to be fitted during the manufacturing process. Using this approach allows each product to be tailored to the specific requirements of end customers at each stage of the production process rather than at the end – maintaining yield but offering customisation.

Digitising quality management using sensors to speed up the identification of the causes of failures
A global high tech manufacturer in the semiconductor industry has embedded sensor technology across their entire production line to track the physical state of production equipment at the time of manufacture. Following irregular low yield in some production cycles, they were able to isolate the sensor profile (e.g. torque or temperature) and compare it against the normal profile. Using this information they were then able to modify production cycles to ensure consistent yield.

Another manufacturer in the metal fabrication sector, supplying the automotive sector, has created a bespoke visual sensor to track the progress of the fabrication of parts through the entire production process. Each part is automatically checked against a blueprint after each fabrication stage to ensure millimetre precision. Defects can then be spotted earlier in production, reducing wastage and allowing the manufacturer to deliver as part of a just-in-time supply chain.

Speeding up time to market using cloud based platforms
A toy manufacturer, using an innovation management system based on a cloud platform was able to speed up time to market by gathering, evaluating, selecting and developing new product ideas from across the world. Using the cloud, ideas could be rapidly shared and developed by teams around the world helping to streamline cost control, better align manufacturing with distribution and wider market demand. The change allows the company to deliver new product releases every four to six months keeping them ahead of the curve in their industry.

Smarter products
Smarter products was seen as something that will come at a later stage with only 14% of companies choosing this option as their main focus. While processes and supply chains can be driven by manufacturers themselves, companies will need to have pull through demand from customers to develop smarter products. This may explain why this isn't a focus according to our survey.

EEF's Manufacturing Ambitions report showed manufacturers working now and even more in the future with their supply chains to collaborate on product design and development and to customise offers for customers.

Examples:

Products with embedded sensors to enable remote monitoring and control
An automotive manufacturer, as part of its connected car solution, monitors the health of the vehicle providing prognostics on the need for servicing based on customer use. This allows the customer to adjust operations accordingly and avoid downtime.

Always connected products that allow predictive maintenance
A print manufacturer knows the usage times and consumable levels of its machines and sends replacement for consumables without the need for ordering. As part of this they are also able to manage upgrades on their own schedule and based on the data from all machines predict when maintenance will be required and schedule this. This allows them to sell the 'service' rather than the product to the end customer.

Revolution

The real revolution in manufacturing will come in the third phase.

In our focus groups manufacturers felt the real revolution will come in terms of how technologies will enable new business models. There are many examples of these trends and at this stage it is possible to highlight those that are being talked about. However new business models will be difficult to predict.

Examples of these business models include the ongoing trend towards servitisation. Instead of selling the equipment or a product, manufacturers sell its use and guarantee uptimes or outcomes. The example above of the print manufacturer is an example of this.

Other models emerging include mass customisation. This is the ability to use some of the technologies set out above, including others such as additive manufacturing, to deliver highly customised products at the same cost and efficiency of mass production.

These changing business models are explored in greater detail in EEF's report *Manufacturing Ambitions - an industrial strategy for a stronger economy*, and are set out in the box opposite.

Selected examples – future business models in manufacturing

Personalisation of products/Mass customisation	Using information and technology advances to enable products and services to be tailored with greater customer-specificity. Information-enhanced products and services will offer opportunities for additional value creation.
Service-enhanced business models	Part of the current move towards servitisation, with increasing revenues derived from services related to the final product sold.
Service-oriented business models	Part of the current move towards servitisation, where a high proportion of revenues are service derived through charging for access to a product and exploiting technology to manage equipment performance.
Factory-less goods producer	Design and sale of products with outsourcing of production. Expenditure on R&D will be recouped not just from selling products but the sales or licensing of design and development.
The circular economy	Driven by resource security and changing customer demand, this will lead to a shift in the design of products to reduce costs and also different ownership models. Re-manufacturing will be commonplace with more standardisation and initial design considering re-manufacture from the outset.

IN SUMMARY:

Manufacturers will be prioritising the adoption of technologies associated with the 4th industrial revolution in the areas of smarter relationships and smarter production processes. In these areas there are early examples of approaches being taken by manufacturers to deliver benefits for their business. Some of these technologies will help to unlock new business models as part of a 'revolution' of manufacturing.

4IR won't just be about getting new technologies and manufacturing techniques, there are some other cultural changes needed within companies to enable them to take advantage and benefit from this transformation. The next section explores the steps that manufacturers can take now to ensure their company is geared up for this.

WHAT ELSE NEEDS TO HAPPEN?

When looking at 4IR enablers, drivers and barriers, there are some clear areas where action can be taken by companies which are linked less to technology, but are more to do with fostering the right culture for eventual technology investment to deliver expected benefits.

Understandably, customers will drive expectation. The vast majority of manufacturers in our survey – 63% – say that customer requirement will influence when they invest in 4IR technologies. But the response to 4IR will need to be more than just a passive one of customer requirements and be more of an active one of going to existing and new customers to sell the 4IR approach and the benefits that they can also derive from this.

In our discussions with manufacturers and from our focus groups there are three key areas identified by Managing Directors and Chief Executives where they feel the culture within UK manufacturing will need to change to enable 4IR technologies to foster competitive advantage. These are the culture towards innovation, the role of technology as part of business planning and the need for a reorientation of leadership away from day to day operations and towards shaping an uncertain future.

1. Culture towards innovation
Manufacturers are by nature innovators, they carve out niches and find ways to create value, enabling their companies to reduce the costs of production, boost sales and enhance margins.

Manufacturers of all types are

innovators but there will be differences in the approach to innovation taken by companies depending on their size and what they are trying to achieve. Innovative activities may focus narrowly on certain areas such as product development whilst other companies may have a broad brush approach to innovation.
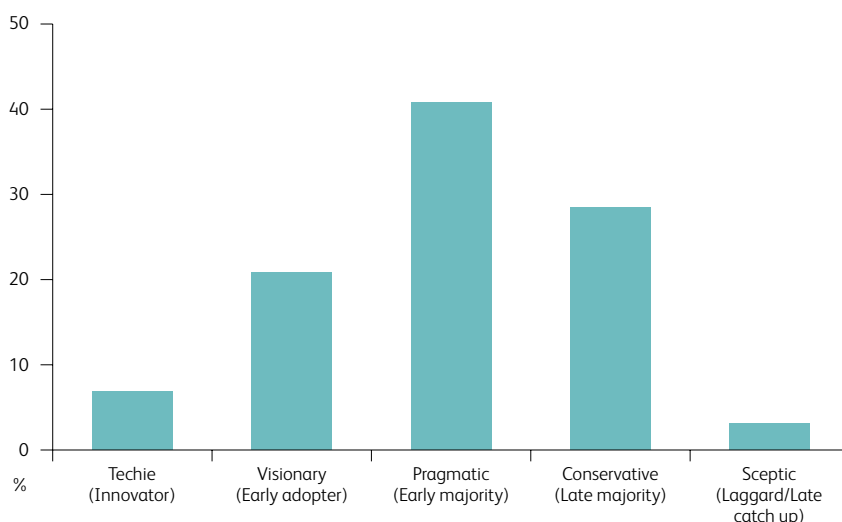
Manufacturers have to constantly evolve in order to remain competitive and meet customer needs, and there is no sign that this requirement will

change in the years to come.

However, innovation is a resource intensive activity, and firms must choose where to focus their efforts. In some cases that will mean that companies adopt a cautious approach to certain aspects of innovation and investment. However, in order for 4IR to be a reality in the UK, and for the UK to become a major player in this arena, a fresh and perhaps different focus on innovation will be needed.

Chart 4: The 4th industrial revolution will need more visionary companies

% of firms describing their company's approach to adopting new technologies

Source: EEF Manufacturing Ambitions Survey 2016

Twenty-nine percent of companies describe themselves as conservative when thinking about their approach to adopting new technology (chart 4). These companies are more likely to be SMEs, and in our survey all the companies describing themselves as 'sceptics' were small.

The UK lags behind its main competitors in terms of business innovation, and every effort should be made to boost innovation, both by government adopting positive support mechanisms and by companies embracing a culture of innovation in all areas of their business.

Innovation is not just about new products and it is crucial to acknowledge the whole scope of innovation activities to ensure there are the right tools to foster it. It has been shown that UK businesses are falling behind their international counterparts in terms of process innovation[2] and the gap is significantly larger for SMEs as they are more likely to lack the necessary funds to adopt new or improved processes.

This conservative outlook may hold back companies, leaving them behind in the digitalisation race. Companies must be willing to take a step, not completely into the unknown, but into an area where not all the outcomes might be known.

The culture to try new things with the view that it might work but not to get stuck if they don't work, will be needed for 4IR take up. The concept of taking a small step, evaluating the lessons learned and then building on that to decide what to do next will be

the best approach when starting out in 4IR. But manufacturers will need to ensure they are taking many small steps simultaneously, in many areas, and learning the lessons quickly if they are to stay one step ahead.

2. IT – from back office to front and centre

The role of technology and the IT department within companies will become ever more important as more and more of the factory floor, processes, tasks and products become connected. Manufacturers will increasingly need to think of themselves as digital companies, rather than viewing digital capabilities as an add-on to existing processes.
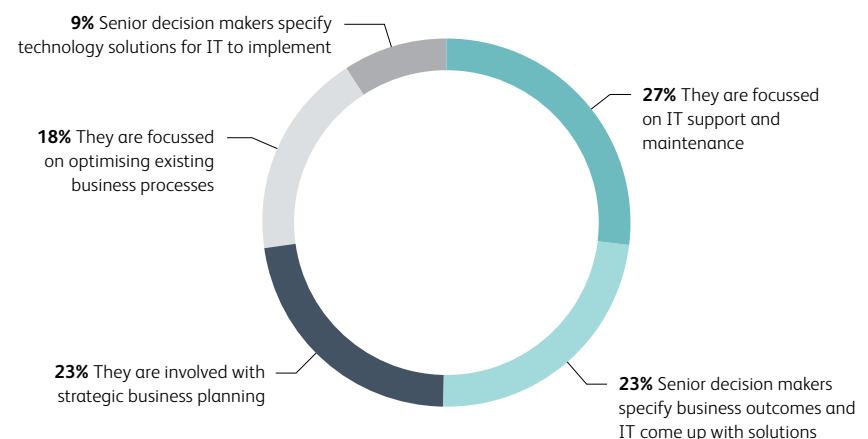
In many cases, the IT department is seen as the ones who help when the

printer is broken, or something has happened to your laptop – essential IT support and maintenance. But they play an important role in helping firms to become connected, and the relationship needs to become more strategic within an organisation. This will need to be either through expanding the role of the IT department or creating a distinct function to manage data and connectivity across the organisation.

As it stands, nearly three-fifths of companies in our survey do not have a director or senior manager with responsibility for developing and implementing new technology solutions. Whilst this cannot be a task just for one person, it is key that there is a driving force within the business to look at what is possible technologically with a strategic eye.

Chart 5: Mixed picture on the role of IT

% of companies describing role of IT operation in business planning within their company

9% Senior decision makers specify technology solutions for IT to implement

18% They are focussed on optimising existing business processes

23% They are involved with strategic business planning

27% They are focussed on IT support and maintenance

23% Senior decision makers specify business outcomes and IT come up with solutions

Source: EEF Business Environment Survey 2016

[2]Community Innovation Survey 2012, Eurostat

There is currently a reasonably mixed picture on the role of IT within firms (chart 5). Just over a quarter say they are focussed on IT support and maintenance, which is a similar picture across all sizes of firms.

Small companies are more likely to focus on optimising existing business processes whilst medium and large companies have more of a solution based relationship where senior decision makers specify business outcomes and IT can research and identify solutions.

Indeed, IT skills will need to step out from a single department and cross into all areas and disciplines of manufacturing. There will be a blurring of lines between engineers and IT specialists. Many focus group participants saw the importance of young people coming into the industry – so called digital natives – as ones who will be able to help with implementation and execution of new technologies.

" Great leaders are needed for this to be a revolution "

EEF 4IR focus group participant

" Two thirds of companies say being able to demonstrate adequate return on investment will influence their decision to invest in new technologies. "

EEF Business Environment Survey 2016

3. Leading from the front

Nearly all the companies we have spoken to have raised the importance of business leaders in driving through change. The culture of innovation and the role of IT will not change unless it is driven and has buy in from the top.

While uncharted waters lay ahead, UK manufacturers are adept at managing change and manufacturers recognise that for 4IR to be a success, they must lead by example. Boards must outline a vision for the future, their ambitions and goals and drive this strategy through the business.

However at the moment there is too much of a focus on 'return on investment' – which may see some manufacturers missing out as they wait for the risk to minimised. There needs to be a view to the strategic vision of the company, and what not investing in something will mean as well.

A worry from companies we spoke

to was their ability to understand all that is possible under the 4th industrial revolution topic. There was a recognition that help and advice was needed but there was universal agreement that those at the top of the business were the ones who should be setting the right course for the business. There will be a need for board members to be digitally literate in order to make 4IR a reality.

As we have already discussed in this report, the speed at which change will happen will be the identifying factor in this industrial revolution. As things happen quickly, businesses may also find out quickly that they are being left behind, and prompt decision making and vision setting must happen.

And this may not only be setting the vision within a company, but OEMs and supply chain leaders must also set out their views, in order for their suppliers to come with them on the journey and continue to have a seat at the table.

IN SUMMARY:

Not all change associated with the 4th industrial revolution will be technology focused, there has been a clear steer from manufacturers that they recognise the need to foster the appropriate culture at all levels of the business in order for any endeavours to be a success. And, as no manufacturer is an island, there will also need to be this culture embedded in companies across supply chains for 4IR technologies to deliver the competitive advantage and step change in performance that can be achieved.

CONCLUSION

The 4th industrial revolution (4IR) is happening and happening quickly. This creates new opportunities for industry in terms of discovering and acting on insights from data to revolutionise their business performance and what they can deliver for their customers.

But 4IR also brings risks for manufacturers from new customer expectations, greater levels of competition and more uncertainty about the future. Manufacturers will need to discover what 4IR means for their business and how they can take advantage to achieve higher levels of productivity in the future.

Despite the pace of change the sector is only on the cusp, offering some breathing space. There is still time for industry leaders to understand what 4IR means for their business and using this knowledge to develop a business strategy that can be enabled by the technologies and techniques associated with 4IR.

Manufacturers can of course choose to ignore this change – some companies may decide this is not for them, or may decide to carve out a niche for a select number of customers. Regardless of the final choice made it will be best to make this an informed decision.

To support manufacturers with that decision, this report set out some use cases to demystify the technologies at the forefront of this revolution. These technologies will enable smarter supply chains, smarter production processes and smarter products.

However 4IR is not all about technology, manufacturers will need to look at the culture and leadership change needed within their companies. This includes their approach to innovation, their ability to be visionary and look beyond a hard return on investment and the need to boost data driven decision making right across their organisation.

The sector is very much at the start, as the representative organisation for manufacturers we'll be working to support and advise our members on 4IR in the years ahead.

VIEWPOINT

ORACLE®

THE FOURTH INDUSTRIAL REVOLUTION – THE POWER OF SMART TECHNOLOGIES

Cost savings are important, but the game changer is to fundamentally increase customer lifetime value, to tap additional revenue potential and develop new business models.

Experience is king

It's no secret that the needs and demands of customers today have completely changed. The advent of digital technologies has firmly placed ROI and quality of experience at the forefront of customer needs, and every organisation, regardless of sector has had to adapt to this. The have had to realise that a one-size fits all approach simply is not good enough any longer, and that they need to provide services and offerings that are designed to meet the very specific needs of each customer.

On top of this, the competitive landscape has also changed. Today's markets move at a rapid pace and it can be hard to know which direction competitive disruption will come from. Organisations need to respond much quicker to this, or risk losing ground to competitors that can offer the ROI or quality of experience that customers are now demanding.

Mass customisation and mass production

The brands that have been the most successful at engaging new customers have been the ones that have dealt with them on a personal level, and taken the time to really understand their business. For manufacturers, to do this means a fundamental shift away from production-centric thinking and design to a strategy that is completely customer-centric. They need think about the needs of each customer on

an individual basis, and provide with them with an entirely personalised experience.

This is easier said than done. However, to begin the journey to the 'holy grail' a strategy where the customer is a 'segment of one', manufacturers need to understand their customers at much more granular level to begin designing their supply chains to provide them with a high quality of experience but to do this at no extra cost.

Personalised experience - understanding the complete customer lifecycle

## The Fourth Industrial Revolution – connectivity is the key

The delivery of a high-quality customer experience, at a mass production price point, rests upon an organisation's connectivity as it controls their ability to understand and respond to industry shifts and customer demands. This connectivity is what The Fourth Industrial Revolution (4IR) technologies primarily provide. They are bringing together every part of an ecosystem to provide a complete and holistic understanding, which allows organisations to make considered and informed decisions about their business and how to act in any given scenario. Connectivity ensure the steady flow of this information, making it the beating heart of the delivery model today.

Progressive companies have already deployed 4IR technologies to solve business issues and needs; and more and more businesses are following in the footsteps of these early adopters. They are leveraging these new technologies to produce smarter products, more sophisticated manufacturing systems and intuitive supply chains.

Cloud – the key enabler

Powering these 4IR technologies is the cloud. It is enabling companies to work in a more flexible, scalable and cost effective manner, and allows for the easy integration of 4IR technologies into existing systems and work streams. However to deliver a truly modern supply chain, organisations need to consider building a cloud-based solution from the ground-up. This will allow them to effectively deliver connectivity through all key business processes, and ultimately provide superior experiences to their customers and differentiate themselves from the competition.

Connectivity through 4IR - Benefit Areas
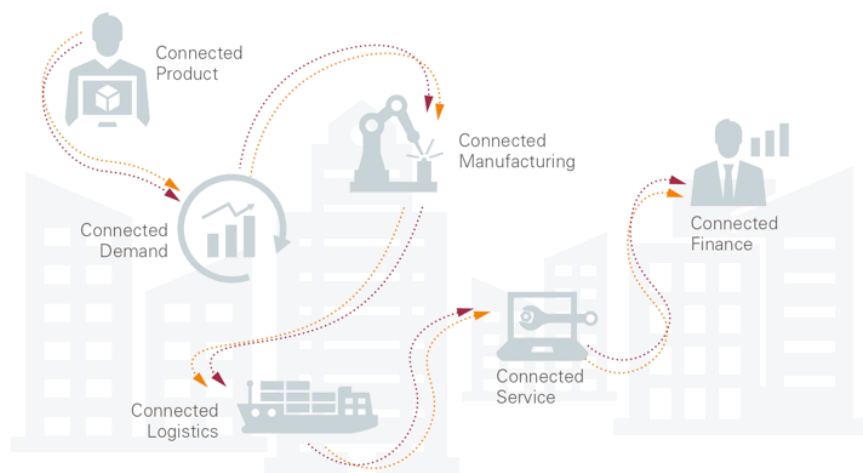
Cloud - Delivering connectivity through key business processes

eef The manufacturers' organisation

EEF is dedicated to the future of manufacturing. Everything we do is designed to help manufacturing businesses evolve, innovate and compete in a fast-changing world. With our unique combination of business services, government representation and industry intelligence, no other organisation is better placed to provide the skills, knowledge and networks they need to thrive.

We work with the UK's manufacturers from the largest to the smallest, to help them work better, compete harder and innovate faster. Because we understand manufacturers so well, policy-makers trust our advice and welcome our involvement in their deliberations. We work with them to create policies that are in the best interests of manufacturing, that encourage a high growth industry and boost its ability to make a positive contribution to the UK's real economy.

Our policy work delivers real business value for our members, giving us a unique insight into the way changing legislation will affect their business. This insight, complemented by intelligence gathered through our ongoing member research and networking programmes, informs our broad portfolio of services; services that unlock business potential by creating highly productive workplaces in which innovation, creativity and competitiveness can thrive.

www.eef.org.uk/fourthindustrial

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