



The Digitalisation of the UK Automotive Industry



Introduction

by Mike Hawes

The UK automotive sector has enjoyed unprecedented success in recent years. Car manufacturing is now at its highest level since 2005, exports are stronger than ever and the UK can boast an increasingly competitive supply chain, with cars built in Britain now having over 15% more UK content than they did five years ago.

The sector is, however, on the cusp of dramatic change. Technology is creating a host of opportunities which allow for new innovations and the development of cleaner, more efficient and safer vehicles. The rapid development of the digital economy is changing consumer expectations and old business models are being adapted, changed and even scrapped as a result. And political change is creating new challenges for the automotive sector as the UK prepares for its withdrawal from the European Union.

In the face of all this change, the primary objective of the automotive sector stays the same – to remain globally competitive. So the opportunities presented by the digitalisation of manufacturing will be critical. Many manufacturers are already embracing digitalisation by taking advantage of increasingly affordable technologies, such as sensors, using these to connect their factories and drawing on the data produced to improve processes and products. Digitalisation can help manufacturers save time, reduce costs and respond more effectively to customer demand, all as part of the culture of innovation and continuous improvement that is within the DNA of the automotive sector.

By fully embracing digitalisation, the automotive sector stands to gain £6.9bn every year by 2035. The cumulative total benefit to the economy could be £74bn by 2035. This is a significant prize, but there are challenges that need to be overcome, by the sector and by government, if it is to be realised. The UK's digital infrastructure needs to be improved, clear policies on cyber security must be developed, the skills gap must be addressed and investment in digitalisation must be accelerated.

If we are to succeed, the Government, the automotive sector and other stakeholders must work together. This means bringing digitalisation to the forefront of the Government's new industrial strategy and working in partnership to ensure we grasp the opportunities this technological shift presents. By doing this, we can help to ensure that the UK positions itself as progressive and innovative and retains its inherent global competitiveness.

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GLOSSARY

Blockchain – A new technology enabling a shared digital record to be maintained, making it nearly impossible to tamper with any individual record without being detected. It provides digital trust and automation in the exchange of information between supply chain companies.

Linbins – An inventory storage system.

MMOG-LE4 – A standard logistic language and assessment tool used throughout the automotive industry.

AMRC Factory 2050 – A digital manufacturing demonstration and support facility based in Sheffield.

Bill of materials – A list of the individual components that are assembled together to make a vehicle.

IIC – Industrial Internet Consortium, a US collaboration of industry, government and academic institutions exploring the digitalisation of manufacturing.

Industrie 4.0 – A German government led collaboration of industry and academic institutions, exploring the digitalisation of manufacturing.

IVCI – Industrial Value Chain Initiative, a Japanese collaboration of industry, government and academic institutions exploring the digitalisation of manufacturing.

MES – Manufacturing Executive System, software that enables physical production from a digital model.

MTC – Manufacturing Technology Centre, a digital manufacturing demonstration and support facility based in Coventry.

PLM – Product Lifecycle Management. Information management system that integrates data, processes, business systems and people within an extended enterprise.

SMMT – The Society of Motor Manufacturers and Traders, the leading trade association representing the UK automotive sector.

RFID – Radio Frequency Identification. The use of electromagnetic fields to automatically identify and track tags attached to objects.

Background to the report

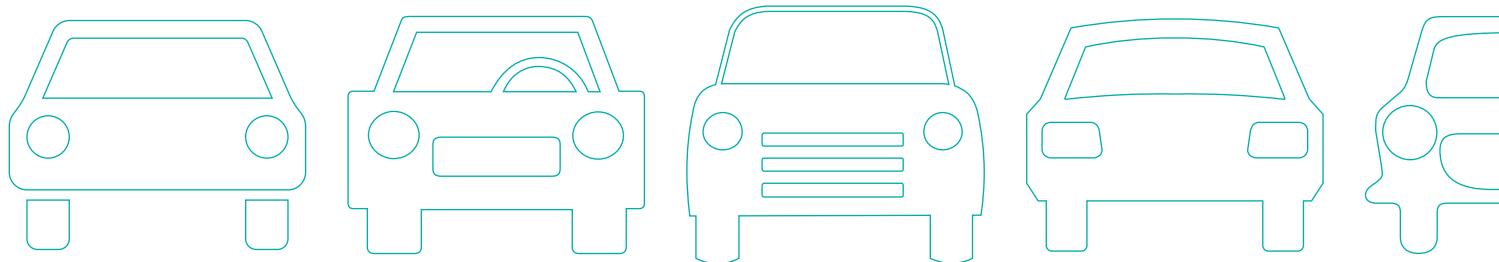
This report is an independent study commissioned by SMMT that aims to examine the digitalisation of automotive manufacturing in the UK. It estimates the economic impact of digitalisation, assesses the benefits to the wider economy, identifies barriers to adoption and sets out recommendations for the Government and the automotive sector. We consider 'digitalisation' as the application of digital technologies to realise a step change in process efficiency and decision-making. It is also referred to as "Industry 4.0", particularly in Germany, although this term has a broader meaning, and captures advanced materials which are not within the scope of this report. Digitalisation also encompasses the "Industrial Internet of Things", which refers to connected devices in a manufacturing context.

The context for this report is that the UK automotive industry has historically been a leader in the adoption of lean process techniques, but is facing consumer demand for greater personalisation and shorter lead times combined with increased competition from low cost countries notably in North Africa and Eastern Europe. The UK's planned withdrawal from the European Union may also add further challenges to the UK automotive sector's competitiveness. Digitalisation has been suggested by many commentators as a way for the UK automotive industry to enhance its competitiveness through productivity gains and improved customer service. This report will examine the evidence that supports this claim.

Our fieldwork, which commenced on 31 August 2016 and was finalised on 18 November 2016, comprised the following:

- 24 interviews with UK management of automotive manufacturers, their suppliers, academia, government and employee unions representatives;
- Desktop research and analysis of:
 - Publicly available information relevant to the objective of the study;
 - Non-public information including vehicle sales and production forecasts by AutoAnalysis and LMC Automotive, information received from SMMT, certain automotive manufacturers and their suppliers;
- A review of the results of a survey of 56 SMMT members (vehicle manufactures, suppliers and aftermarket providers) conducted separately by SMMT between 17 October and 13 November 2016.

For clarity, this study is based on the current market structure and does not include considerations or projections of scenarios relating to the UK leaving the EU.



Executive summary

We forecast that a more rapid development of digital technology within the automotive industry will give an annual benefit of £8.6 billion, which would cumulate to a total benefit of £74 billion by 2035. As it has the potential to significantly enhance the competitiveness of the UK automotive industry, digitalisation deserves, in our view, greater focus from both the Government and the industry. Globally, the automotive industry puts significant emphasis on digitalisation, considering the substantial initiatives underway most notably in Germany, US and Japan. It is our view that the UK automotive industry needs to become a leader in the application of digitalisation, in order to remain a credible competitive player on the global stage.

The UK is well-positioned to benefit from this digitalisation trend. There is a diverse range of vehicle manufacturers – Nissan, Toyota and Honda from Japan, BMW from Germany, Vauxhall (part of General Motors, a US based company) and local premium manufacturers including Jaguar Land Rover, Aston Martin, Bentley, McLaren and Rolls Royce amongst others. On average the UK's vehicle plants are the most productive in Europe and the majority of Formula 1 teams are based in the UK. These teams boast advanced real-time scenario modelling and analytics capability which supports race strategy. The UK also has many game developers who are collaborating with manufacturers and organisations such as the Digital Catapult and High Speed Sustainable Manufacturing Institute (HSSMI). The challenge is to turn these existing assets into a coherent strategy that makes the UK automotive industry an attractive destination for investment in digital technologies.

Our study found that many vehicle manufacturers, while recognising the importance of digitalisation, had only initiated a series of pilots so far. Some suppliers, notably SMEs had not begun any significant digital pilots. Manufacturers and suppliers both forecast substantial benefits from digitalisation including productivity gains, shorter lead times more personalised vehicles and enhanced services for customers. A key barrier to implementation was found to be a lack of knowledge and the necessary skills to design and

execute a company-wide digital strategy. Another key barrier is the trust needed between supplier and manufacturer to share data electronically. SMEs identified funding for investment as a concern.

There are a number of UK digital technology demonstration facilities that might be further developed into deep clusters of expertise. The Digital Catapult in London, the Manufacturing Technical Centre in Coventry and AMRC Factory 2050 in Sheffield all demonstrate industrial digital applications, and bring together manufacturers, entrepreneurs and start-ups. Some SME suppliers reported that a "first-step" programme would also be a helpful addition.

We recommend that the Government places digitalisation at the heart of its new industrial strategy, focusing in particular on skills, digital infrastructure, cyber security, access to finance and technology demonstrators.

We further recommend that vehicle manufacturers and their suppliers develop a digital strategy led by the CEO supported by cross-functional teams underpinned by new digital skills such as digital scientists, digital architects, digital engineers and operational development capability. These corporate digital strategies need to consider a whole value chain perspective as substantial benefits can be unlocked by establishing a digital thread that connects suppliers, vehicle manufacturers and customers together.



The automotive industry is critical to the UK

The automotive industry is a vital part of the UK economy accounting for more than £71.6 billion turnover and £18.9 billion value added. With some 169,000 people employed directly in manufacturing and 814,000 across the wider automotive industry⁽¹⁾.

The UK produced 1.7 million cars and commercial vehicles and almost 2.4 million engines in 2015, the highest production level since the recession in 2007. The output level is expected to reach 2.0 million vehicles by 2021⁽²⁾. The UK remains the second largest vehicle market and fourth largest vehicle manufacturer in the EU. It is also the second largest premium vehicle manufacturer after Germany⁽¹⁾.

77.3% of vehicles produced in 2015 were exported, with an average value of £20,900. Furthermore, automotive is one of the largest export sectors in the UK, accounting for 12% of total UK exported goods⁽¹⁾. Over 2,000 companies are currently operating in the UK automotive sector, the majority of whom are part of the supply chain and aftermarket⁽¹⁾.

In terms of productivity, the automotive industry contributed in 2015 £18.9 billion to the UK economy, leading to a real GVA per job figure of £111,900, which is twice the national average⁽³⁾⁽⁴⁾. The UK has the most productive automotive factories in the EU⁽⁵⁾.

About £2.4 billion are invested every year in automotive R&D⁽¹⁾. Notwithstanding this impressive picture of high productivity, investment and growth, the UK continues to face significant pressures from rival countries in Eastern Europe and Northern Africa, which are more competitive⁽¹⁾. If the UK is to continue to thrive then it must deliver high value-added, yet competitively priced vehicles. One way of achieving greater competitiveness is through strategic investment in digital manufacturing capability.

Germany has galvanised its digitalisation project called “Industrie 4.0” under the leadership of Chancellor, Angela Merkel with many major industrial companies participating in this Federal Government initiative since 2013. In the US, the Industrial Internet Consortium of companies exchange best practice since 2014. Digitalisation also features prominently in the “Made in India” and “Manufactured in China 2025” government strategies. This report considers the situation here in the UK and considers recommendations for the UK industry and government.

Sources:

(1) Motor Industry Facts 2016, SMMT (Available at: <http://www.smmt.co.uk/wp-content/uploads/sites/2/SMMT-Motor-Industry-Facts-2016.pdf>, Accessed on 07/11/16)

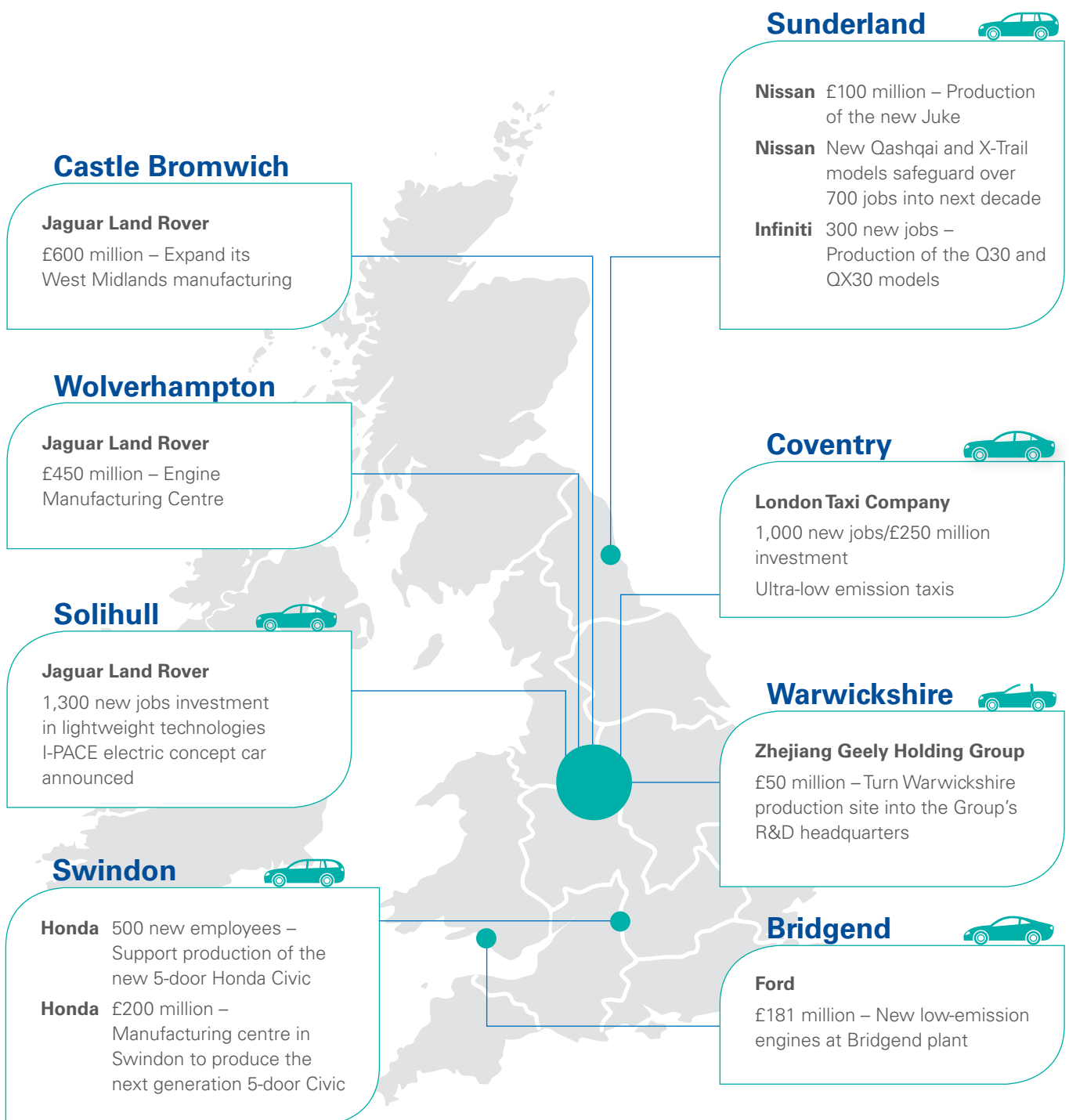
(2) Auto Analysis forecast

(3) ONS, 2015 (Available at: <http://webarchive.nationalarchives.gov.uk/20160105160709/http://www.ons.gov.uk/ons/rel/abs/annual-business-survey/car-production/sty-car.html>, Accessed on 07/11/2016)

(4) 2016 UK Automotive Sustainability Report, SMMT (Available at: <http://www.smmt.co.uk/wp-content/uploads/sites/2/SMMT-Sustainability-Report-FINAL.pdf>, Accessed on 07/11/2016)

(5) UK Automotive International Competitiveness Report 2015

Investment during 2016



A new industrial era

Digitalisation of manufacturing

The digitalisation of manufacturing is already underway. Both manufacturers and their suppliers could benefit from productivity gains, quality improvements, greater flexibility and shorter times to market. Customers are also likely to benefit from more personalised, higher-quality vehicles with a greater level of product content and connectivity.

In truth manufacturing has been increasingly using data to raise productivity for decades, but many commentators now foresee an exponential growth in the use of this data, driven by five new disruptive technologies.

1. Firstly, connected devices and sensors using Radio Frequency Identification (RFID) technology have become sufficiently affordable allowing a physical system to be replicated in digital form and visualised in real time
2. Secondly, predictive analytics, cognitive computing and artificial intelligence powered by algorithms that have become sufficiently sophisticated and validated through real-world examples are now able to make decisions and predictions based on this real time data. In the future, the advent of deep learning – a high performance, dynamic way of computerised decision-making that can learn patterns automatically and more accurately with the more data you give it – will enable further augmented decision-making.
3. Thirdly, the human-machine interface has developed to a point where widespread adoption of mobile, touchscreen and now virtual reality allow for more intuitive interaction between physical and digital worlds.
4. Fourthly, the ability to directly produce from a digital construct through technologies such as 3D printing and intelligent robotics have enabled an entirely new flexible system of production to be imagined.
5. Finally, despite a rise in cybercrime, significant improvements in cybersecurity technologies and the blockchain are giving companies the confidence to connect their factories and store vast amounts of intellectual property-sensitive data in the cloud.

Digitalisation technologies

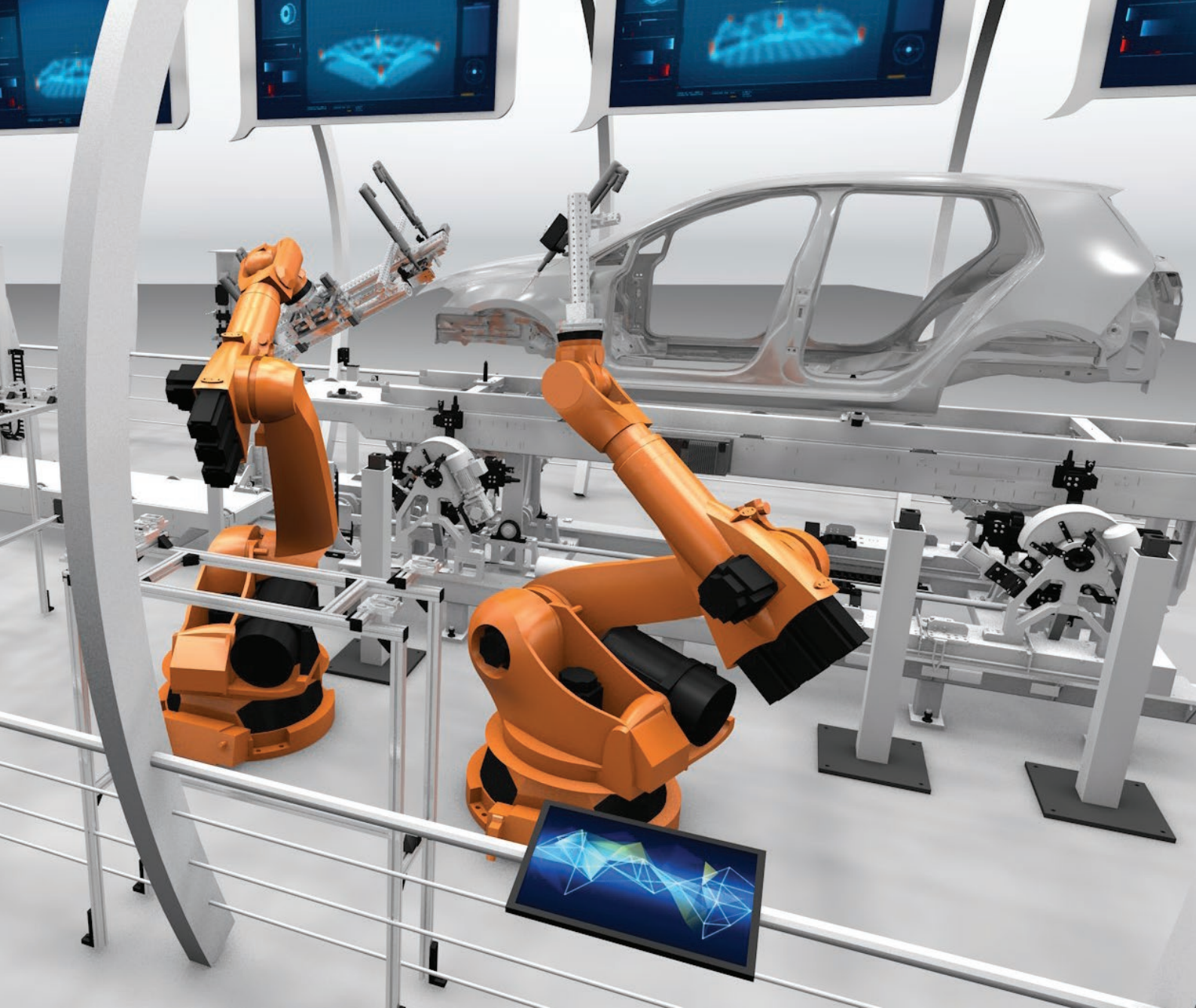
Digitalisation technologies have found applications across the manufacturing value chain and have had beneficial impact on suppliers, OEMs and end-customers. While some technologies have more focused applications (e.g. robotics on production), others such as cloud computing, analytics and cybersecurity are progressively leading to an unprecedented sharing of information and new applications across the value chain.



Digitalisation activities	Key technologies
Collect, store and transmit data	Sensors and tracking (e.g. RFID) Communications interface & standards (enabling cyber physical digital transfer) Cloud based storage and service models 5G
Analyse data	Predictive Analytics PLM Software
Interact with data	Virtual reality Mobile/Tablet/Watch Visualisation tools (e.g. Tableau) Crowdsourcing (e.g. sentiment analysis)
Produce digitally	Additive manufacturing techniques (e.g. 3D printing) Advanced Robotics (e.g. collaborative robots & cyber physical systems) MES software
Protect data	Cybersecurity & digital trust Blockchain



Source: Siemens



Application in the automotive industry

Digitalisation applications often involve the creation of a “digital twin” of a physical product, manufacturing process, factory or supply chain. Once the digital twin is created it can be analysed for many purposes. Changes can be made easily in digital form allowing for the simulation of different scenarios.

Ultimately these scenarios can help in a multitude of applications that span the value chain to:

- Design production lines more quickly and with greater certainty through the use of virtual reality and analytics to optimise the flow of materials and movable assets;

- Better execution of new vehicle model launches through the use of sensors and exchange of product development and pre-production data;

- Optimise throughput in a factory by creating a digital twin and then simulating alternative production processes and techniques in alternative scenarios to better plan production and remove bottlenecks;

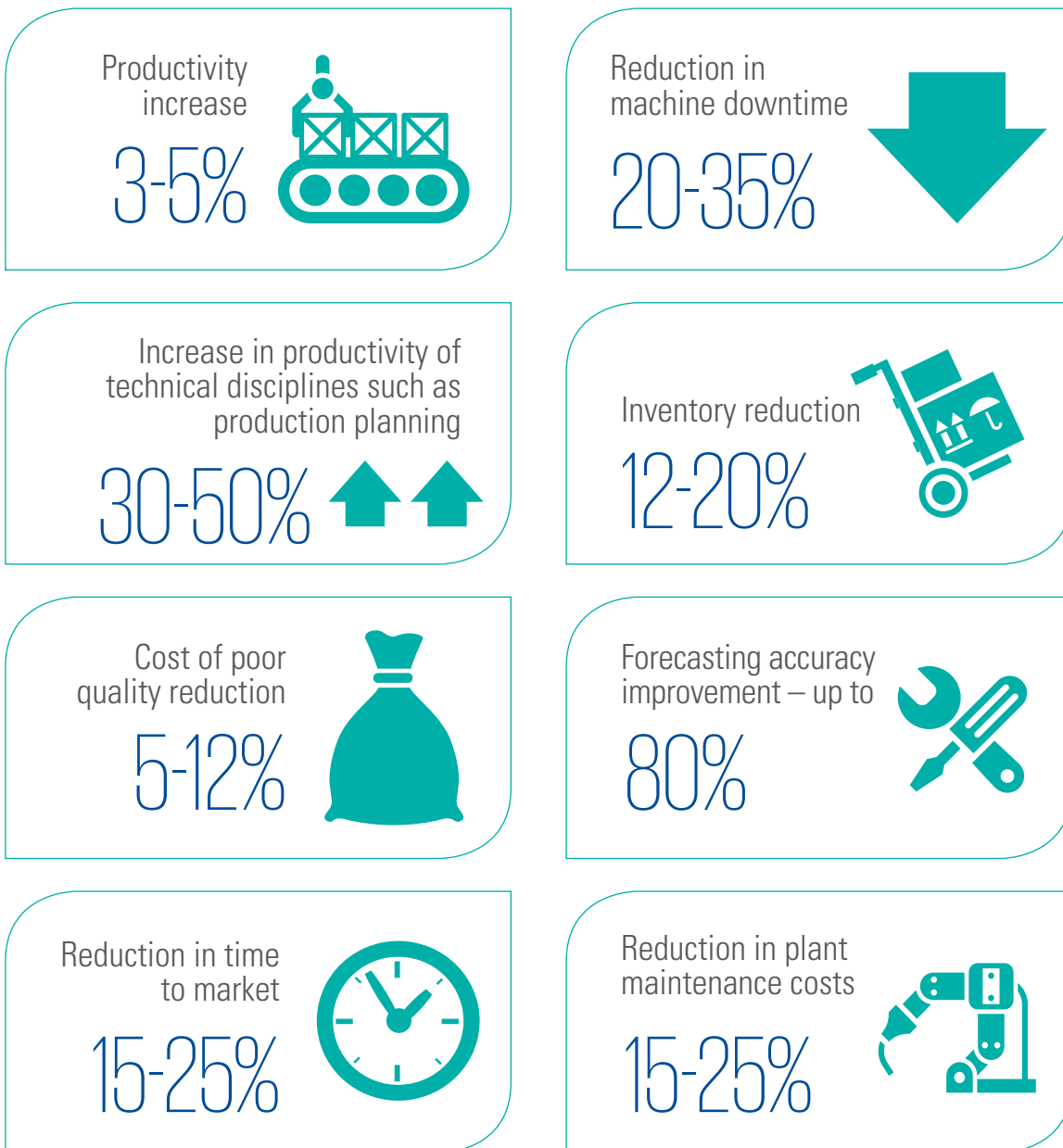
- Eliminate defects through the use of connected sensors and in-vehicle diagnostics to better understand the factors leading to component failures leading to faster root-cause identification;

- Better plan plant maintenance through the use of sensors on machinery and algorithms to predict future usage, substantially reducing unplanned machine downtime;

- To reschedule production and automatically communicate changed production plans to suppliers in response to crises such as a major logistics disruption or supplier failure;

- Reduce inventories and lead times through track-and-trace inbound supplies which give real-time estimated times of arrival.

The benefits of digitalisation are substantial. Interviews with vehicle manufacturers and suppliers suggested that the following benefits were achievable:



Further qualitative benefits were identified including greater personalisation of vehicles, the ability to design safer products and provide additional services to the customer, the improvement of health and safety of employees and the replacement of mundane tasks with more interesting work.

World map

US



US carmakers are participating in the Industrial Internet Consortium with leading academic institutions and government. Universities such as MIT and Stanford and IT companies such as IBM, Intel and Cisco have placed the US at the forefront of digitalisation. Over US\$1 billion has been invested by the government in digitalisation. The IIC is working with Industrie 4.0 to set standards for industrial connectivity and security.

UK



The UK benefits from a diverse mix of manufacturers bringing German, Japanese and US perspectives on digitalisation. The UK motorsport sector has significant real-time simulation and advanced analytics capability and the gaming industry is collaborating with manufacturers to enable new virtual product and process validation techniques. Smart factory demonstrators for example, the MTC in Coventry provide technology demonstration to suppliers.

Germany



The birthplace of *Industrie 4.0*, a German government led collaboration with industry and academic institutions. The Fraunhofer Institute and Aachen University are key research facilities and SAP and Siemens have produced the world's leading digital manufacturing software solutions. VW, BMW and Daimler are actively pursuing digitalisation strategies. Germany is arguably the global leader in the digitalisation of manufacturing and has established substantial local innovation clusters with significant supply chain participation.

France



Industrie du Futur is a broad government programme to boost manufacturing competitiveness that incorporates digitalisation. French manufacturers spend high amounts of R&D funding on the digitalisation of manufacturing and there is good participation by SMEs too.

The European Union



In April 2016 the European Commission launched *Digitising EU Industry*, the first industry related initiative of its Digital Single Market package. *Digitising EU Industry* aims to build on existing national initiatives. The European Commission will help coordinate national initiatives, focus investments in the EU's public/private partnerships on digitalisation, invest €500 million in a pan-EU network of digital innovation hubs, set up large scale pilot projects to strengthen the internet of things, adapt legislation to support the flow of data and develop an EU digital skills agenda.

Summary

Globally, Germany, US and Japan are seen as the leaders of digitalisation of manufacturing. These three countries have the most developed industrial digital applications and are leading the efforts to promote a common data and communications standard within digital manufacturing. Beyond these three countries, there are several countries with Industrial Strategies which incorporate digitalisation but applications are limited to isolated pilots. We did not find any example of a fully digital factory or demand-driven supply chain. Many other countries have yet to embrace digitalisation to any meaningful degree.

The UK is not presently seen as a leader in digitalisation within manufacturing and lacks a deep, co-ordinated national strategy but has many important ingredients that could underpin the rapid acceleration of digital technologies.

Netherlands



Phillips is a leading proponent of digitalisation and the Nedcar vehicle manufacturing facility is implementing several digitalisation pilots. The Dutch Government has a strategy to deliver 40% of manufacturers implementing and a further 40% aware of Smart Factory technology by 2018.

China



Made in China 2025 and the *13th five Year Plan* are an ambitious government strategy to improve industry and emphasises digitalisation. China plans to create over 40 innovation centres to demonstrate new technology and serve as a cluster. Many global vehicle manufacturers and suppliers are planning to build new smart factories in joint ventures with local Chinese suppliers. We believe that China will become a leader in digitalisation during the next decade.

Japan



In June 2016, the Industrial Value Chain Initiative was launched with 30 founding members including Nissan, Panasonic and Fujitsu, leading academic institutions and government. The IVCI is seeking to collaborate with the US and Germany on digital standards setting. Japan's substantial technology industry is a global leader in R&D into the industrial internet of things.

India



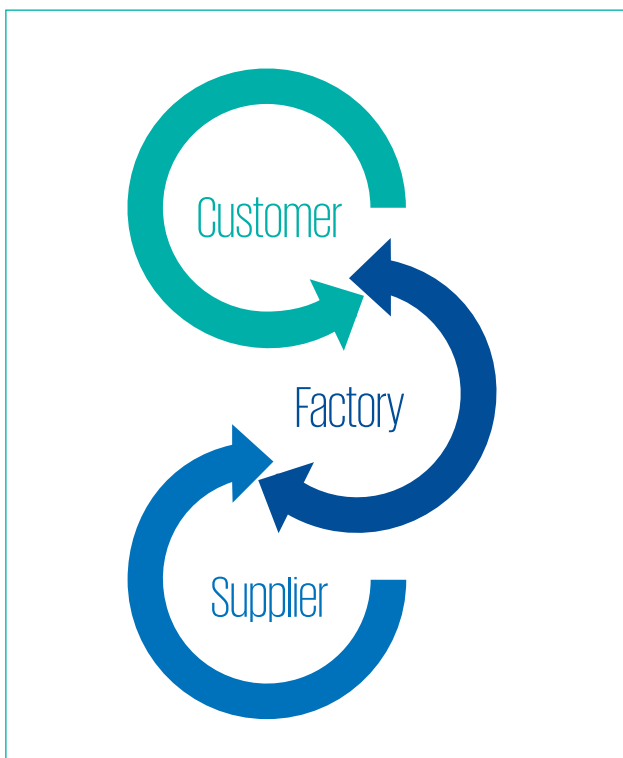
Made in India is a government strategy to substantially grow manufacturing and includes an ambition to become the "smart factory of the world". India's automotive industry is today about double the size of the UK's but is expected to grow dramatically through investment from global vehicle manufacturers and suppliers in the coming decades as economic growth boosts domestic demand. India's successful IT sector is collaborating with manufacturers and government on digitalisation.

Current status of digitalisation

Our interviews revealed a number of digitalisation pilots at vehicle manufacturers and suppliers but we did not find any fully digital factory implementations in progress. Connecting supply chains and customers digitally was at an even earlier stage of progress. In this regard, the UK automotive industry might be less mature compared to Germany according to our interviewees and desktop research.

We consider the impact of digitalisation from a value chain perspective, looking separately at the factory, suppliers to it and then customer related impacts.

Convergence of the value chain



Digital factory

Significant benefits will be unlocked through a single data model shared between the technical disciplines of engineering, production planning, manufacturing, procurement, finance and sales and marketing. If engineering product models are directly linked to the bill of materials and vehicle specifications then many corporate processes can be modelled in the simulation such that the full implications for every change in customer demand can be instantly simulated recommending a new production schedule, purchase order and accounting entries creating a truly 'Digital Factory'. Siemens has developed software with this aim.

CASE STUDY

Siemens has developed a digital enterprise software suite on a platform called Teamcenter which provides a common digital thread through all phases of product development and manufacturing using Product Lifecycle Management Software. This links to a production execution software called Manufacturing Execution System which allows for the digital control of sequencing, production and maintenance. Data is stored in the cloud called Mind Sphere based on SAP HANA.

This solution has been implemented at a number of facilities and in the UK, can be seen operating at the Manufacturing Technology Centre in Coventry, the UK's first digital factory demonstrator.

“Digital design is enabling unprecedented agility in automotive – virtual prototyping helps makers bring the right vehicle to market faster.”

Brian Holliday (Siemens Digital Factory’s MD in the UK)

Advanced robotics is starting to play a key role in supporting human operators. While robots could take over some of the more routine tasks, interaction between them and human workers will become more seamless, enabling production line operators to collaborate with, train and manage robots on the production line.

CASE STUDY

KUKA has recently developed the LBR iiwa (Intelligent Industrial Work Assistant), an advanced robot design for human machine collaboration. It incorporates several key innovations:

- Advanced sensors (torque sensors incorporated in all 7 joints) allow the robot to “feel” contact and interactions with its environment, resulting in an increased level of operational safety (eliminating the need for physical safety fences or external sensor systems) and an ability to conduct precision assembly tasks and handle fragile items;
- Advanced algorithms enable the robot to learn tasks through its operator showing the robot the operation that it needs to perform. Operators program the robot just through physical interaction, eliminating the requirement for IT programming skills.

LBR iiwa has already been used in factories such as Ford’s and Siemens’ plants in Germany, where the robots operate collaboratively with human workers. Bruce Hettle (VP of Manufacturing and Labour at Ford) said “the workforce is really helping us define how they can contribute more by using the collaborative robots to do some of the more mundane, simple, heavy-exertion tasks, which in turn allows them to use more of their creativity and their minds to take us to the next level.”

CASE STUDY

SelSus is a collaborative project with a vision to create a new paradigm for highly effective, self-healing production resources and systems to maximise their performance over longer life times through highly targeted and timely repair, renovation and up-grading. The Manufacturing Technology Centre are building a demonstrator that showcases a self-healing component based on smart materials and a decision-support system that allows for self-diagnosis and prediction of equipment failures and product non-conformance.



Source: Festo

CASE STUDY

Conjure is a small software company based in London that has helped vehicle manufacturers to develop new ways for drivers and vehicle occupants to interact with the vehicle.

As part of its product development process, Conjure developed a virtual reality simulator of the interior of a vehicle which enabled the collaborative testing of new interaction features by vehicle manufacturers in an immersive digital environment that simulated real vehicle ergonomics. It allowed the manufacturer to remotely assess impacts of changes in cockpit design to reduce driver distraction.

Demand driven supply chain

The next step of digitalisation is to connect a vehicle manufacturer with its supply chain. The automotive industry benefits from a common logistics language, MMOG-LE4, facilitating data sharing between manufacturers and suppliers. This enables manufacturers to monitor supplier deliveries real-time and some have developed digital models to immediately assess the impact of traffic disruption to the production schedule.

CASE STUDY

The Nissan Sunderland plant is the UK's biggest car maker. It has produced over 500,000 vehicles in each of the last 3 years with 80% of its production being exported. Sunderland has a fully integrated manufacturing site with many main line and process shops running 3 shifts to meet customer demand. The maintenance team responsible for meeting the challenging plant targets currently use established preventative maintenance techniques, but these require automation and intelligence to speed up analysis time and reduce labour required. The team is now looking to analytics solutions to move from a predictive to a proactive approach.

In a pilot activity and working with an external partner, facility data is being uploaded into a data cloud where it is analysed by algorithms which have been developed to predict failure in advance. Processes can then be optimised based on predictions and potential costly breakdowns avoided. Following this successful pilot the approach, titled "Condition Based Monitoring" is now being targeted for deployment across the site.

By giving suppliers greater visibility over changes in customer demand, the whole supply chain is able to improve scheduling, reducing downtime, overtime and inventory buffering. Supplier readiness for new model launches is a significant challenge within the industry and still involves substantial manpower from the manufacturer to assess the readiness of suppliers. By sharing data on production test runs, new model launch readiness can be remotely monitored giving greater confidence to the manufacturing function, thereby reducing cost and development time.

CASE STUDY

Siemens has introduced a weight measuring system within component "linbins" in one of its factories in the UK, which informs the suppliers when stock levels are diminishing. The system delivered benefits both for Siemens and its suppliers, as it results in optimised inventory management at the factory and reduced risk of stockouts. Given the cross-supply chain benefits, suppliers have also provided some of the finance for the required investment.

As customer demand changes, the vehicle manufacturer will reconsider its vehicle production schedule. One consideration is the supplier's ability to respond and meet increased supply volumes. Vehicle manufacturers are developing supply chain models with capacity information to facilitate this decision.

CASE STUDY

Jaguar Land Rover supplies global markets from its three UK factories. Political instability in the Middle East and the Chinese market downturn in 2014 were offset by buoyant UK, US and recovering European demand. These regional shifts had a significant impact on the model mix in demand. JLR subsequently developed an analytic to assess the capacity of its tier 1 suppliers to meet potential changes in the production schedule. Alternative scenarios can be run to assess the optimum production schedule and purchasing requirement to meet changing customer demand.

“Our prime focus should not be on getting more data. What we need are better ways of using the data we have. For example, people should be taking action using data, rather than gathering data itself – this can be automated.”
Mohammed Zameer, VP of Industry 4.0, GKN Driveline, Redditch UK

Customers

The final step in digitalisation, completing the whole value chain, incorporates data collected from the car and the customer. Most new cars manufactured in the UK are now connected to the internet. Cars collect increasing amounts of data from onboard diagnostics units, sensors and cameras. In the future as onboard diagnostics improve, vehicle manufacturers will be able to provide a remote vehicle-health monitoring service to vehicle owners. Such a service works by collecting data about wear and tear and malfunctions and using data analytics to assess driving style and distance travelled can then predict when components might fail or the brakes, exhausts and tyres wear out. The driver can be contacted through the connected car interface and a service appointment scheduled with the local dealer at the customer’s convenience. The manufacturer can automatically order the replacement parts from its supplier which delivers them direct to the dealer just in time for the repair. Several UK vehicle manufacturers are developing such a solution which may become available to customers by the turn of the decade.

This is an example of an additional service that can be offered to customers by using data collected from the vehicle. Many industry commentators have noted that making use of data to provide additional services is expected to generate significant value added for the UK automotive industry and customers in the future. A further example is the personalisation of vehicles to customer demand. It is expected that digitalisation will further enable vehicle manufacturers to offer ever greater levels of personalisation.

CASE STUDY

Rolls Royce in Goodwood manufactures cars to customer’s personal tastes. Customers are encouraged to create their own paint colours, perhaps matching a particular favourite item of clothing, to design their own patterns to be crafted in the wood fascia. Such levels of personalisation present challenges for production planners as each vehicle is unique requiring different operations at each stage of the production line. Rolls Royce has developed a fully flexible production line allowing individual vehicles to be moved in and out of sequence as necessary, automatically adjusting the downstream inventory and sequencing impacts.



Source: Festo

CASE STUDY

SigmaGuardian is an Early Warning and Prevention system created by Warwick Analytics, which can find and resolve faults in a vehicle as they occur by processing raw data, which it then analyses through algorithms. Its key benefit is that it can help to reduce the time from fault detection to resolution. A recent application removed the need for the car dealer to intermediate between the vehicle owner and manufacturers; when the vehicle identified a defect, the system predicted when the fault required repair as well as the root cause of failure. As a result, the fault was repaired promptly, design engineers correspondingly changed the vehicle specification in less than half the time and the manufacturer reported 22% cost savings in its warranty remediation activities.

CASE STUDY

Since 2015, GKN, a global supplier of driveline technologies, has been piloting RFID (Radio Frequency Identification) tagging system combined with data collected from heat treatment, welding and assembly build data including which machine and operators were involved in its production. In the future GKN plans to use this dataset to achieve a better understanding of specific faults in service, enabling better design. Service response times can be reduced through automated ordering by the dealership workshop from the GKN warehouse. Eventually, this technology, combined with use of sensors, will give GKN and its suppliers visibility over part use, fatigue and environmental conditions in real time.

GKN expects demand data shared by vehicle manufacturers to enable greater 'in sequence' production delivery. This will reduce inventory levels and reduce cost to better organise its production plan.



Source: Festo

Small and medium enterprises

One aspect of digitalisation is that it is scalable to smaller suppliers. A data analytic can be created using a simple spreadsheet which collects data from an ERP system or from a customer EDI (Electronic Data Interchange) feed. Many SME suppliers use data analytics to support cost estimation for component part tenders. Cost data is extracted from the ERP system and combined with planned production levels and cost models to estimate the price to tender and the resulting financial implication for the supplier. Although simple, an effective cost model is widely recognised as a valuable investment throughout the supply chain.

However, our interviews revealed that generally suppliers have a far lower adoption of digital technologies than vehicle manufacturers.

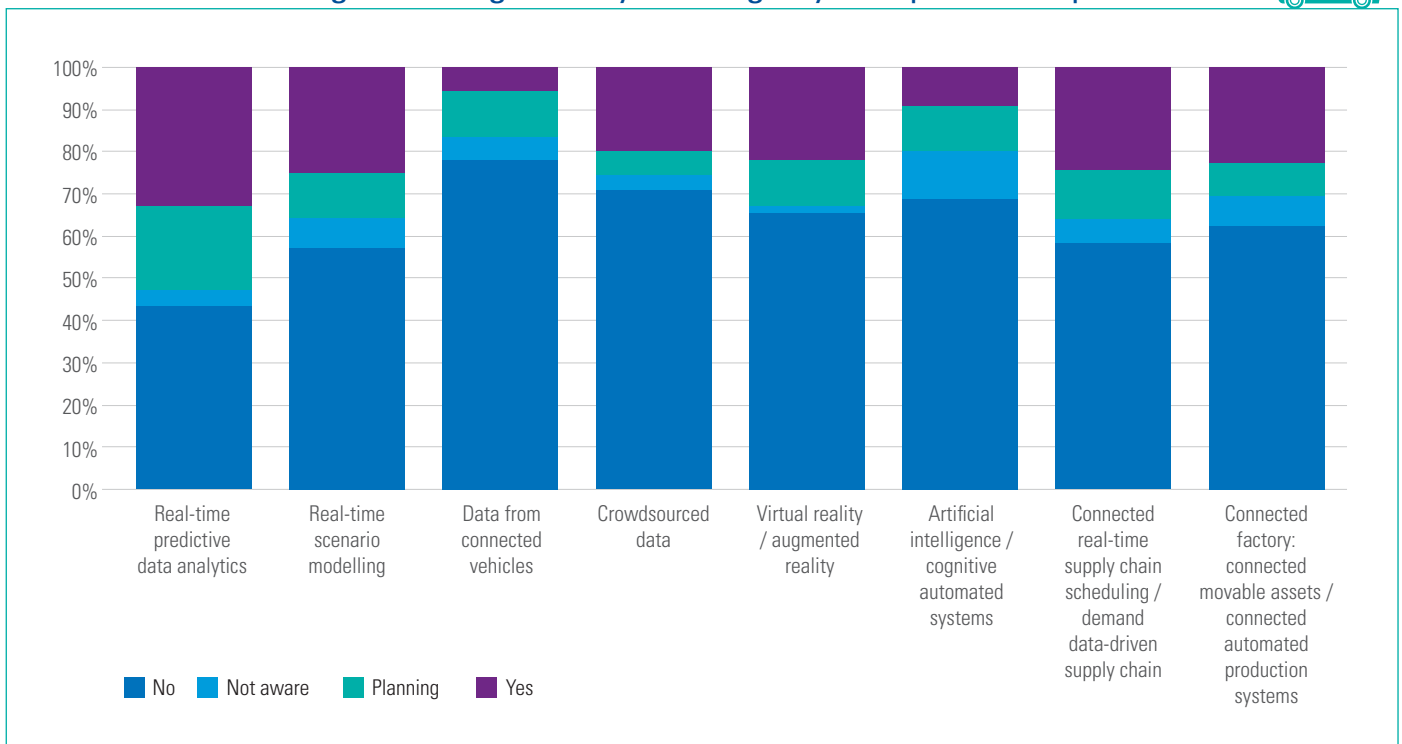
CASE STUDY

A small press shop facility in the West Midlands is embracing digitalisation by fitting low-cost sensors to its 1970s presses. The sensors communicate via broadband to the tablet of the shopfloor operations management allowing the performance of the presses to be monitored remotely. Management is now implementing a simple algorithm which takes the historic patterns of usage and compares that to the historical patterns of wear and tear to predict future downtime and plan press maintenance in a more structured way. Management estimates that machine downtime has decreased by approximately 20% and payback is less than three months.

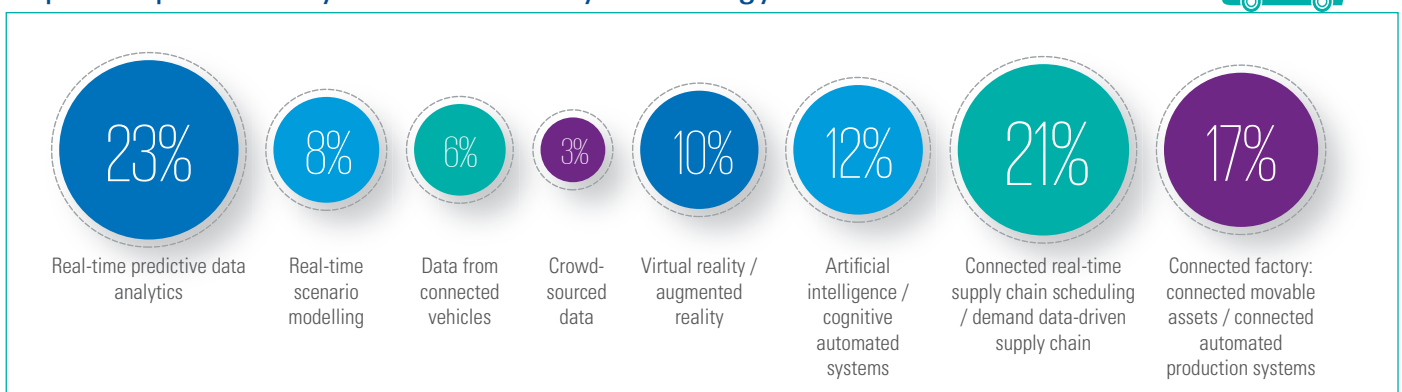
Respondents to the survey of SMMT members revealed that most companies are yet to implement advanced digital technologies in their manufacturing operations. As can be seen in the graph below real-time predictive analytics had the most take-up and use of data from connected cars had the least. Compared to other surveys in Germany and the US, this suggests the UK currently has a lower rate of digitalisation.

The second graph shows that the industry expects the largest benefits to come from connected factory and supply chain technologies allied to real-time predictive data analytic technologies.

Which of the following technologies are you using in your operational processes?



Expected productivity enhancement by technology



Generating substantial economic benefits

Impact on the UK economy

Our forecast is that if the UK automotive industry were to make a step change towards embracing digital technologies leading to fully digital vehicle manufacturing factories within the next 20 years, then by 2035 gross value added in the UK would be higher by £8.6 billion (at today's prices) which represents 0.3% of GDP. Cumulatively, by 2035, the UK economy would have benefited by £74 billion (at today's prices).

£4.3 billion of the annual £8.6 billion benefit is derived from UK vehicle manufacturers increasing their competitiveness and being able to offer additional vehicle functionality to consumers without increasing vehicle prices. The remainder is derived mainly by suppliers increasing their output (£2.6 billion) and the wider economy also benefits from enhanced disposable income (£1.7 billion).

There may well be further spill over benefits as digital technologies spread more rapidly to other sectors of the economy but we have not included these within our forecast. We therefore believe the full resultant economic benefits under this scenario are underestimated.

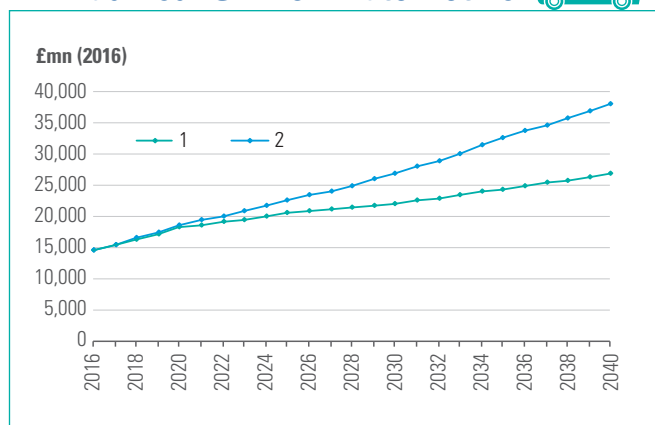
Our model demonstrates that rapid adoption of digitalisation techniques has the potential to bolster the UK automotive industry's competitiveness which would protect the number of vehicles manufactured and the number of jobs in the UK from the threat of international competition.

Methodology

We prepared two scenarios:

1. A base case that assumes vehicle manufacturers and suppliers would continue to execute their current digitalisation plans

Annual real GVA UK Automotive



2. A 'rapid digitalisation' case where manufacturers and suppliers make a step-change in digitalisation, leading to the establishment of fully digital vehicle manufacturing factories by 2035 with a fully integrated digital supply chain.

The technology assumptions used in our rapid digitalisation case were generally more cautious than other commentators have found in recent interviews of the automotive industry – for example PwC's April 2016 survey and McKinsey's January 2016 surveys.

We assumed that technology would be gradually adopted over the 20 years of the forecast and we used official data for all our other key economic assumptions. Our model estimated the impact of both productivity benefits and incremental revenue opportunities which led to an increase in vehicle production arising from enhanced vehicle functionality without a corresponding increase in vehicle price (at today's prices). This continues recent trends seen in the industry. We did not change the model mix in vehicle production, nor did we make any changes for the impact of the UK's withdrawal from the EU.

Annual total economic benefit by 2035 **£8.6billion**



£4.3billion of which relates to vehicle manufacturers



£2.6billion to suppliers



£1.7billion and relates to the wider economy



Cumulative total economic benefit by 2035 **£74billion**



Challenges to overcome

Barriers to implementation

Industry participants highlighted many challenges to the implementation of their digitalisation plans.

Skills

Most prominent was a lack of knowledge and digital capability within their organisation. In the more advanced companies, pockets of digital expertise were found in most of the main functional areas such as manufacturing, engineering, production planning, procurement and finance. However digital skills were not sufficiently spread within the functional area nor were the different functional areas sufficiently integrated and working together.

This situation was largely replicated at board level. Few companies had an overarching digital strategy and responsibility at Board Level was either unclear or was vested in the CIO. Although this situation may well be sufficient in the early stages of digitalisation, where the organisation is learning from a few isolated pilots, meaningful factory-wide implementation of digitalisation will require co-ordinated action, sponsored by the CEO, that includes key elements such as cyber security, articulated in a corporate digital strategy and supported by the creation of a new digital support function where new roles will be created.

We see the key new digital support roles required to be:

- **Digital scientists** – responsible for designing digital models of physical systems – requires advanced mathematical capabilities to develop algorithms to translate the real world into digital form;
- **Digital engineers** – responsible for implementing the digital models created by the digital scientists – requires familiarity with coding and advanced robotics;
- **Digital architects** – responsible for holding, sharing and managing data assets. Supports comparability of data formats within the organisation and its supply chain;
- **Development Operations** – responsible for creating the company's digital infrastructure such as cloud, virtualisation and automating interfaces with ERP;
- **Cyber Security engineers** – responsible for ensuring digital trust is established.

CASE STUDY

In the UK, Jaguar Land Rover is at the vanguard of digitalisation and has constructed many analytics tools that are in use within its business as part of its "Analytics Revolution". It is now turning its attention to linking analytics between functions to unlock even greater value, providing augmented decision-support to management across the business.

To facilitate this JLR is creating an Analytics Support function to help the business build effective analytics and assess business cases. This team will provide technical expertise to colleagues in production, purchasing and sales & marketing developing analytics.

Cyber threat

Another important barrier is concern regarding cyber-attack. A number of UK manufacturers have suffered cyber-attacks which they believe had the intention of interrupting networked production equipment. Almost all companies we spoke to recognised this as an important matter and are strengthening their cyber security. A similar fear is of network unavailability although almost all companies we spoke to had a contingency plan for this eventuality. The industry is working hard to ensure that its connected cars are protected against cyber-attack and have generally severed any link between the in-car internet connections from the systems that control the vehicle's physical movements.

Companies are also concerned about intellectual property theft if they store significant amounts of data in the cloud, in addition to sharing sensitive production data across the supply chain. While the advent of new private clouds operated by IT companies with the latest cryptographic controls maintained in local data centres may address some of these issues, cyber threats will continue to be an ongoing concern for the industry.

First steps into digital

For many smaller suppliers, digital is not on the agenda at all. Many of these companies are focused on short-term operational pressures and have yet to invest into digital technology or skills. However, we also found several smaller companies who had implemented low-investment analytics often based around spreadsheets that extracted data from ERP systems and low-cost sensor data feeds combining them to predict maintenance, improve throughput and for root-cause analysis. It seems therefore that there is a need for greater promotion of technology demonstrators such as AMRC Factory 2050 in Sheffield and the MTC in Coventry in order to demonstrate and help quantify the return on investment of a digitalisation initiative.

Data comparability and standards

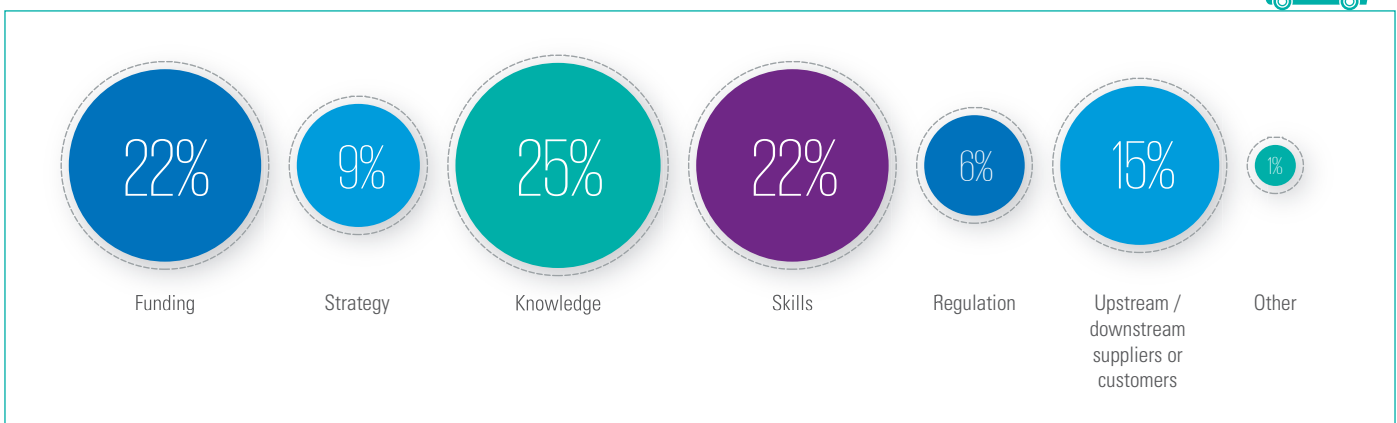
Data format discrepancies between different technical disciplines such as manufacturing and engineering represent a challenge as does different data formats used by different machine and sensor manufacturers. There is a need for common technical standards (such as the emerging Hypercat standard for IOT interoperability) to further assist in data comparability.

CASE STUDY

A previously manual specifications process was causing significant delay in machine design and commissioning and leading to delays in start of production. By replacing it with an interactive online-based platform, a major UK OEM has realised a reduction in design and snagging delays of 93%

A controls and automation supplier, Festo has developed an online tool that enables its customers to implement up-front communication protocols in order to ensure conformity and uniformity in the use of factory equipment across the entire supply base. According to Festo's analysis, a high proportion of production problems occur due to workers' misinterpretation of standards and procedures on the use of equipment and technology. This can result in a disruption of operations, production delays and has a negative impact on productivity. Festo have developed an online tool – the 'Project Book' – that improves the accuracy of standards' usage, through provision of pictorials, videos, and single point lessons, all accessible via mobile by the end-users at the point of production.

Which of the following do you perceive as barriers to implementation?



Recommendations

Industrial strategy

The benefits of digitalisation, not just to the automotive sector, but across the whole economy should be in no doubt. However, these will not be realised unless the Government works in partnership with industry to support this technological transformation. The Government should, therefore, place digitalisation right at the heart of its new industrial strategy.

Other leading economies, such as Germany and the United States, already have well established programmes which bring industry and government together to deliver the shared objective of digitalisation. These countries have recognised, not only the potential economic benefit of doing this, but also the importance of being the first mover globally. The UK must not be left behind. The development of a comprehensive strategy which addresses all the critical issues related to digitalisation – skills, infrastructure, standards, cyber security, finance and technology demonstrators – and sets out how the UK can build on its unique strengths including predictive analytics in Formula 1 and virtual reality in the gaming sector, will help ensure that this does not happen.

Skills

Both the Government and industry need to act quickly to ensure that the automotive workforce is equipped with the necessary skills to support digitalisation. Companies should adopt a digital strategy which includes consideration of the new skills that will be needed, what training should be offered to existing employees and what recruitment strategy is needed to fill the remaining skills gap. The sector should also consider how it can work together to ensure that it has a digitally capable labour market to draw upon. This could mean developing new technical accreditation and standards and creating a new National Centre for Excellence in Digital Manufacturing. The National Centre of Excellence could act as a cluster to deepen the technical capability of industrial digital skills and train employees of manufacturers in digital skills.

The Government should consider whether or not the UK labour market is able to support digitalisation. It should undertake a comprehensive review to assess the prevalence of critical digital skills within the labour market and set out an ambitious strategy to address the skills gap. As part of this, it should build upon already existing commitments to amend the National Curriculum to support the digital economy, and

consider reforms at all levels of education so as to ensure that a child starting school in 2017 can have all the skills they need to begin a career in digital automotive manufacturing by 2035.

Digital infrastructure

Digitalisation is only possible if the infrastructure is in place to support it. This means reliable, high speed internet connections through broadband, 4G and, in future, 5G technologies. The Government's recent commitment to invest £1 billion by 2020-2021 to support internet connectivity is welcome. In delivering on this commitment, it should prioritise in particular, connectivity in critical manufacturing hubs, including those populated by automotive manufacturers and their supply chains.

Digital standards

Sharing data between different companies is a critical part of digitalisation. This can be facilitated by developing digital standards that apply across the automotive sector and to critical adjacent industries. The development of such standards should be industry lead, but Government can play an important convening role, bringing all relevant sectors to the table. The Government also has a critical role to play in shaping international standards and it must ensure that it participates in discussions that are already taking place between the US and Germany regarding standards for industrial connectivity and security.

Cyber security

Companies need to develop a 'bottom-up' methodology for assessing cyber threat use cases and then develop a cyber security strategy in response to significant threats. Government can also support the adoption of the Digital MOT by collecting data on vehicle usage to share with customers and car manufacturers to aid future vehicle design.

Financing and investment

Digitalisation will require investment. SMEs, in particular, may struggle to secure the financial backing needed to take full advantage of digitalisation. The Government can help address this by using money from the British Business Bank to support SME's in the automotive sector that wish to invest in digitalisation. This would be consistent with its existing commitment to use the British Business Bank to support innovative firms.

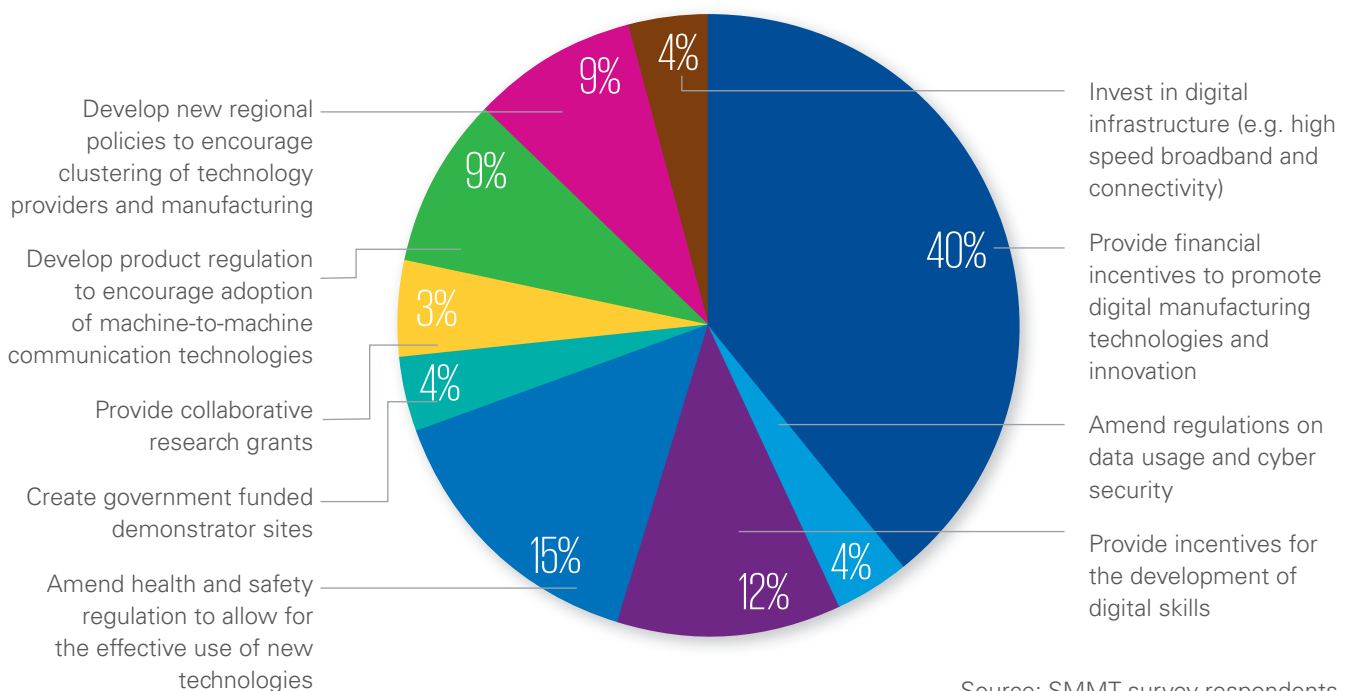
Government and the industry should also work together to showcase the successful application of digitalisation. This would have two benefits. First, it will help manufacturers make the business case, within their organisations, for digitalisation. Second, it would help manufacturers make the business case to retail banks from whom they may seek investment. One option for doing this would be to run national competitions which bring together vehicle manufacturers, suppliers and technology providers to use digital technology to solve manufacturing problems.

Technology demonstration

The take-up of digitalisation among SMEs requires local demonstration and access to associated technologies. The UK already benefit from AMRC Factory 2050 in Sheffield and the Manufacturing Technology Centre in Coventry, but if it is to be a world leader in digitalisation, many more demonstrators are needed in a diverse range of locations, covering a wide range of different technologies. The Government should work with the automotive industry to identify how many new demonstrators are needed, which technologies they should focus on and where they should be located.



Which action should Government take to promote the digitalisation of manufacturing?



Source: SMMT survey respondents

Closing remarks

“Digitalisation is the path to securing the UK automotive industry’s future.”

Our study has established that the UK is ready to capitalise on the digitalisation of manufacturing. We have the most productive automotive factories in Europe, a diverse range of manufacturers, fantastic real-time predictive analytics capability in the motorsport sector and game developers already collaborating with industry. What we lack however is a fully co-ordinated, government-led digital strategy unlike our German, US and now Japanese competitors.

Vehicle manufacturers need also to develop a digital strategy led by the CEO, that seeks to connect not just manufacturing processes but also functions such as engineering, production planning, procurement, sales and marketing and finance. It is a substantial undertaking, for many vehicle manufacturers are only just starting and it requires extensive cross-functional collaboration.

At the same time vehicle manufacturers are now collecting substantial amounts of data from their connected cars. Manufacturers are piloting ways to make use of this data to design safer and more personalised vehicles and offer enhanced services to customers such as a remote vehicle health-check. Customer data promises substantial benefits for manufacturers and consumers alike but such benefits will only be realised if it can be trusted. Greater investment in cyber security and blockchain technologies is required by government and industry alike to realise these benefits.

Vehicle manufacturers also need to encourage their suppliers to adopt digitalisation and connect the supply chain. Substantial benefits can be achieved through sharing demand data with the supply chain, sharing design and pre-production data during pre-launch readiness and tracking logistics movements.

SMEs need also to invest in digitalisation – many sensors and analytics are low cost yet provide substantial benefits. The main barrier to implementation at SME level is a lack of knowledge and skills. SMEs can visit the Factory 2050, MTC or Catapult demonstrators and Government can further encourage the development of digital skills.

There is much to do – digitalisation is a journey that starts in this decade and promises substantial benefits next decade and thereafter. In truth, digitalisation is unstoppable, the only option is to be an early adopter. We are in a fantastic position – let’s act now to claim our future.

John Leech

Head of Automotive for KPMG in the UK



Notes

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