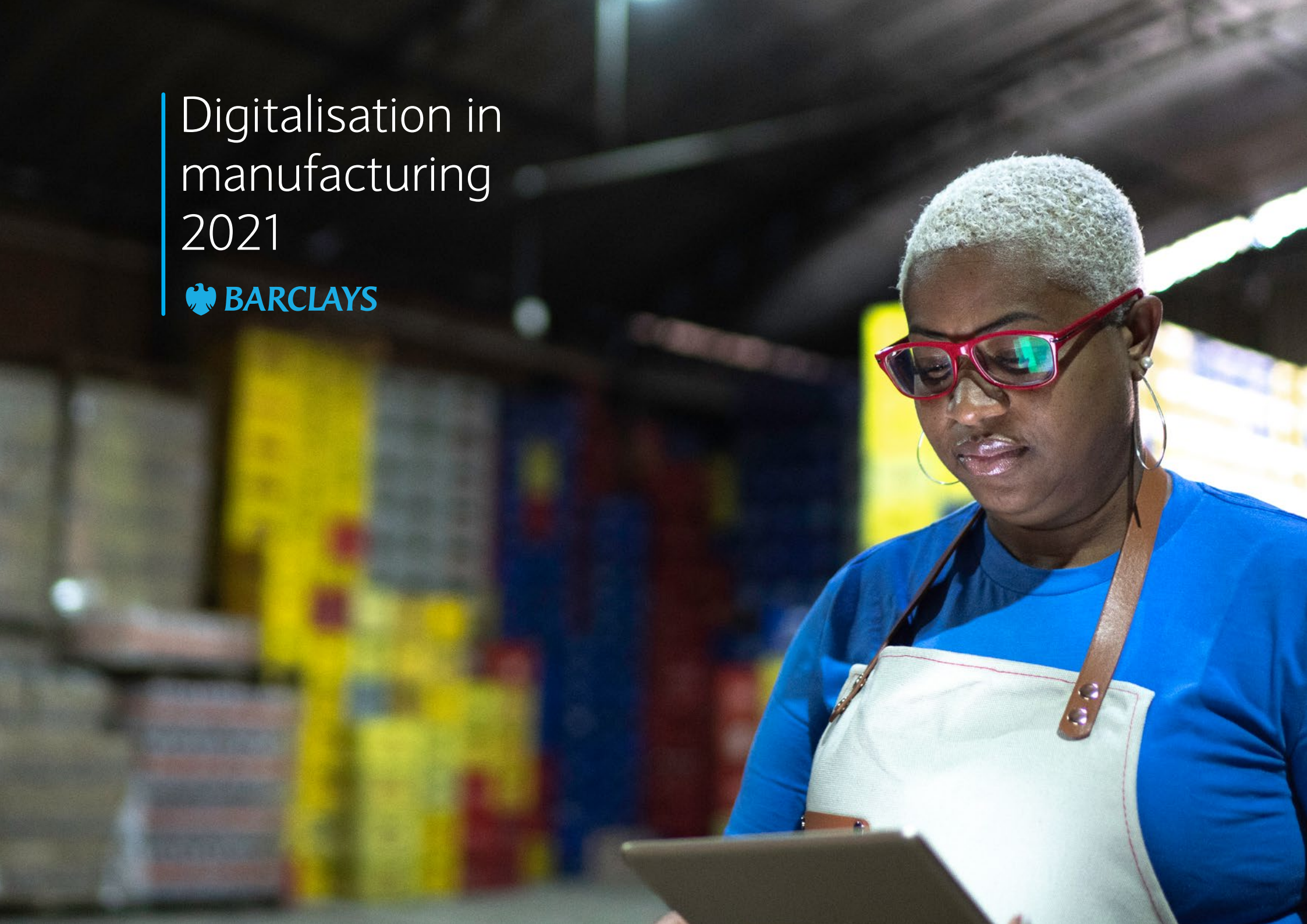
Digitalisation in manufacturing 2021

BARCLAYS



Introduction

Every manufacturing company in the UK today is an active participant in digitalisation: they may use engineering software and machines with digital controllers or, if they use analogue equipment like sewing machines, they still use computers, email and smart phones to execute business functions.

But the 'digitalisation of manufacturing' means going further – some may call the ultimate journey 'digital transformation'.

Asif Moghal, Senior Industry Manager at Autodesk, describes this concept as "doing everything you are doing today better, quicker and with less waste, by connecting business processes with digital technology, for the benefit of the company and the empowerment of its employees."

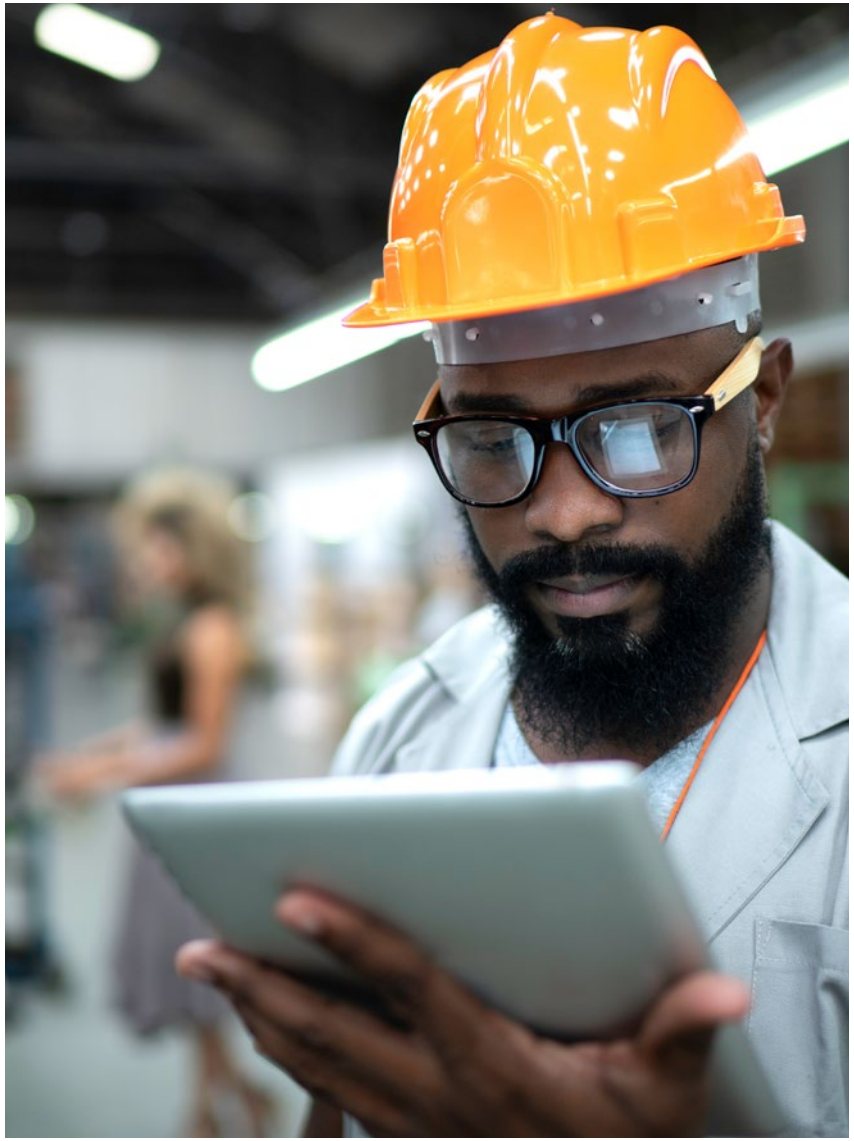
The connections between machines, products, processes, people and – crucially –customers is the detail within this transformation.

For example, if a digital tool like a Manufacturing Execution System can monitor both the operating time and productivity of each machine tool on the shop floor, the site managers can see which machines have capacity and which are running sub-optimally. They can also see the quality defects produced per machine. They can then intervene to give under-utilised machines more work, or improve a machine that has low output with maintenance, tool changes, etc.

Similarly, a product like an intelligent knee and leg prosthetic can tell the customer or patient how the prosthetic has performed, measured by distance and loads, enabling them to monitor whether the post-surgery recovery plan is on-track, or if the prosthetic is being used sub-optimally. And a connected train or aircraft engine – the famous example of Power by the Hour – can be sold to a customer on a service model, where the company pays the manufacturer for availability and usage, not an out-of-the-box product.

More and more UK manufacturing businesses are using new digital technology – think augmented reality tools for training and maintenance, generative design software to quickly see optimal engineering designs, and sensors in components to monitor performance – all the time. In this report we look at some good and varied examples of manufacturing companies that are doing this.

Lee Collinson
Head of Manufacturing, Transport and Logistics



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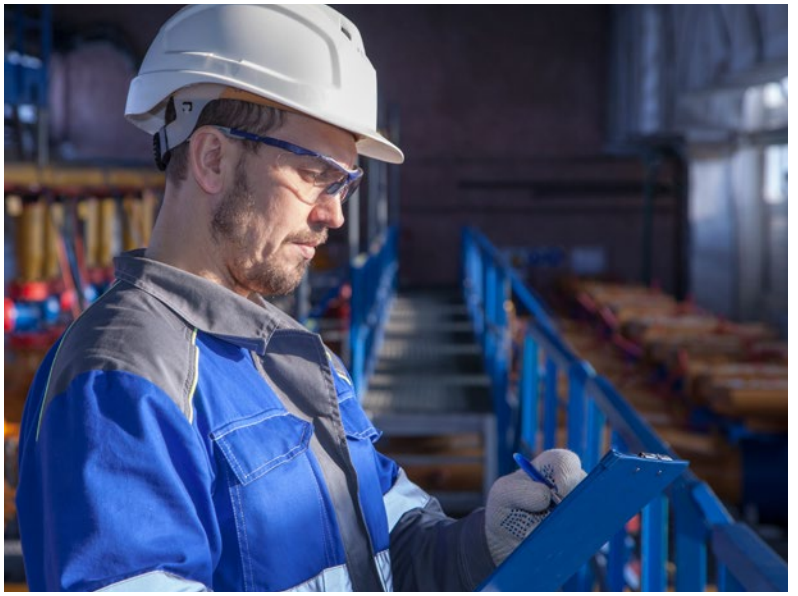
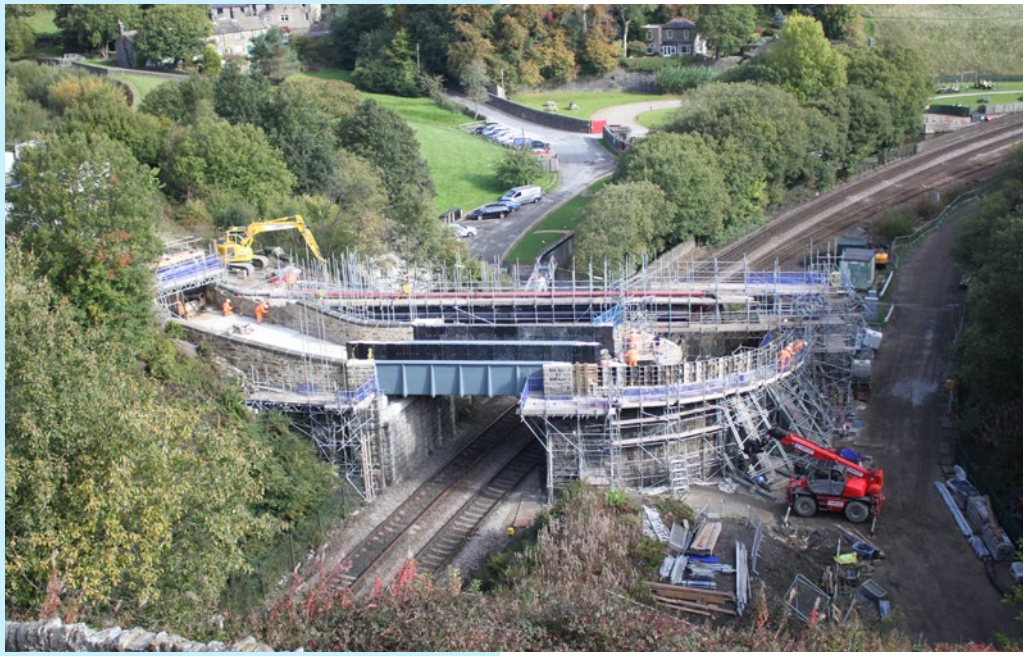


Fiber Glass Systems
NOV Completion & Production Solutions

NOV Fiber Glass Systems

Sometimes the best companies, even with highly skilled people and premium equipment, still struggle with customer delivery because their workflows cannot match their design and manufacturing quality.

Allowing the design team and shop floor to work smoothly together



NOV Fiber Glass Systems (NOV FGS) in Plymouth makes large marine and civil structures like gangways and bridges. It had CAD design software, skilled people, capable machinery and a good order book, but was plagued by a lengthy workflow and version control between the models updated in the design studio and those creating toolpaths on the factory floor.

To improve these metrics, the company invested in powerful design-for-manufacturing software from Autodesk, including Vault for PowerMill, a product lifecycle management tool.

Part of the solution was to separate the product design models into low fidelity and high fidelity (final) versions, and supply the former to the manufacturing department so they could start work sooner.

When an engineering model is prepared for machining, it is converted into a computer assisted manufacturing (CAM) model. The manufacturing engineers can put their CAM projects into Vault, allowing better traceability and a relationship to be created between the low fidelity models and the CAM solution PowerMill. This CAM software is used to define the entire machining process before work begins, using a digital twin simulation of the CNC machine. At the same time, the design team uses Inventor to finesse the design with up-to-the-second client changes.

Thanks to the traceability created between the two types of files, the manufacturing team is informed of any updates and replaces the low fidelity designs with high fidelity ones. Now PowerMill uses built-in automation – customized macros – to generate all the 3- and 5-axis machining toolpaths using 'tried and tested' machining practices from years of previous NOV FGS toolpaths. By doing this, CAM programming time and the risk of human error is greatly reduced, and machining consistency is improved.

The entire machining process is simulated and validated to check for collisions, again using digital twins of the machine. Once approved, the correct NC programs are exported to Vault and shared with the shop floor team to allow milling to start. This completes the digital workflow, from design to manufacturing to shop floor, with all the data stored in a single repository with full traceability.

And the technology runs quicker, saving time. "Before using these intelligent tools, we wasted 30% of our engineering time waiting for data files to open, save or close," says Ben Holmes, Digital Design Manager at NOV FGS. "Now we are able to open the data we need in seconds – the wait time is almost zero."

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> **Ben Holmes, Digital Design Manager, NOV Fiber Glass Systems**

A science lab to build future fighter jets

BAE Systems

One major purpose of digitalisation in manufacturing is to enable flexible and agile factories. These factories are designed to reconfigure or 'flex' to allow for the manufacture of different products in the same space.

An important benefit of delivering a more flexible manufacturing solution is also helping BAE Systems deliver against its sustainability commitments and net zero targets by removing the amount of material used and by introducing innovative, digitally driven processes that create less emissions and waste.

This principle was applied by BAE Systems and a group of universities and partners to design the Factory of the Future, described as a 'connected intelligent factory for military aircraft technologies'. More than 40 blue chip companies, SMEs and academic institutions are collaborating with BAE Systems on the project.

As a demonstrator for a connected, agile factory, the Factory of the Future has many bases covered. Robot-assisted assembly means a re-configurable assembly approach replaces the need for traditional fixed tooling and offers a more sustainable and agile solution for manufacturing. The factory also has 'intelligent workstations', where human-augmented technology guides operators through their tasks, driving efficiencies and minimising process deviation. Digital work instructions are deployed from connected engineering toolsets, making assembly easier to follow.

Craig Turnbull, Engineering Director at Electroimpact UK, a supplier of aerospace tooling and automation, is helping commission robots to match the needs of the smart factory.

"The two big tasks we're looking at are: how we position the pieces of the aircraft, and how we fasten them together. It is an interesting challenge because it's not production focused, it's more of a science lab in which to build fighter jets, in the sense that we're trying to create a production laboratory."

"There's no design handbook for this. We haven't done anything like this before — nobody has," adds Craig. "It's unique partly because this idea of a reconfigurable factory is only useful for certain industries, like future fighter aircraft production."

The factory also uses additive manufacturing machines, and is developing new processes for joining materials, to 3D-print a range of aircraft parts. It's already printing customised aircraft ground equipment parts, replacing heavy and costly ground equipment with lightweight 3D-printed alternatives.

An intelligent logistics system also connects the factory's supply chain to an 'intelligent store' to deploy materials and tools to the factory accurately, reducing stock. And autonomous mobile robots can perform autonomous multi-functional assembly operations and parts delivery, reducing the need for operators to manually collect parts from stores.

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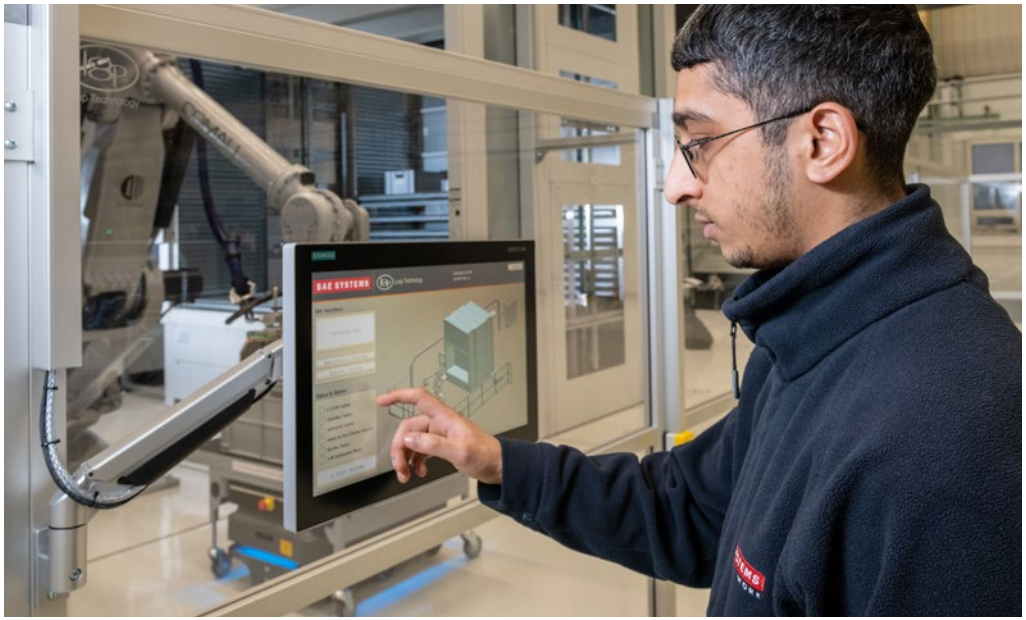

Augmented reality helps pump manufacturer with pandemic-related challenges

Watson-Marlow Fluid Technology Group

Watson-Marlow Fluid Technology Group, a leading manufacturer of peristaltic pumps and associated fluid path technologies, has faced several challenges during the Covid-19 pandemic.

The company had to manage softening in its industrial markets with increased demand from the healthcare industry, including orders for specialist pumps used in feeding the fermentation tanks that are used to produce potential COVID-19 vaccines. At the same time, management wanted to develop a new way of marketing and selling its products.

Watson-Marlow turned to augmented reality (AR) technology, using Vuforia solutions by PTC, to support the transfer of production and assembly skills at new manufacturing sites, provide remote technical support, and enable a virtual approach to sales and marketing.

A new factory was being commissioned and, in normal circumstances, a team of people would be deployed to implement the factory set up. Instead, as a result of the pandemic, the company used the Vuforia platform, where an AR headset is used to show someone remotely how something works, for training to reduce headcount on the ground.

"Skills transfer was our immediate priority and we needed to find a solution that would allow us to take the expertise of our engineers and replicate it at new manufacturing locations without having staff on site," says Martin Johnston, Strategic Business Development Director at Watson-Marlow.

"Vuforia Expert Capture enables us to record the processes of an established production line, edit it in the cloud, and then, via wearable technology such as Microsoft HoloLens glasses, impart all this knowledge through a step-by-step guide for new engineers."

The sales team is also using AR to demonstrate product features and benefits to customers.

In addition to training employees on production lines, Watson-Marlow is also keen to retain the skills of its older staff for the next generation of graduates and apprentices. Martin adds: "The pandemic has changed the way every manufacturing business operates and, in my opinion, has accelerated our need for digital transformation by two to three years."

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MovAid provides intelligent prosthetics in a mass customisation model

Blatchford & Sons

Digitalisation is about connecting machines in factories, and connecting products to customers and services. By enabling products to be monitored, paid-for services can be created that are linked to a product's performance.

Blatchford & Sons manufactures prosthetic and orthotic solutions for amputees. Its LiNX product, a microprocessor-controlled prosthetic knee, won the MacRobert Award in 2016, regarded as the leading prize recognising innovation in UK engineering.

Part of a consortium of companies under the Horizon 2020 EU programme, Blatchford & Sons developed technologies for manufacturing intelligent, 'passive' and very personalised kineto-dynamic equipment – a Movement Assistive Device framework, or MovAid. This equipment is designed to feel and function like a real limb.

The primary drivers for MovAid were an ageing population and the rising number of industry workers affected by workplace-related incidents. Furthermore, standard components used in building prosthetics are difficult to be adapted perfectly to the individual. The aim of MovAid is to provide suitable limb and back support, customised to each patient, in a repeatable or 'mass production' regime.

To cope with the variability, the quality of the customised product should rely on the biometric data of the individual, directly connected to intelligent tools, smart materials and flexible machines. The product must also be affordable, and easily adapt to the body for the best comfort.

MovAid envisages factories that mass-produce custom-made and bespoke prosthetics, designed around a person's body. Crucially, the project integrates a service platform, helped by embedded sensors, data-driven design, advanced materials and additive manufacturing machines. These allow for the products to be closely integrated into services, or servitisation, so the prosthetic user pays for the service or 'life enhancement' rather than an out-of-the-box product.

Affordable scanners capture body shape, inertial measurement units attached to the body record motion, and, together with a 'smart' pressure mat, these create a dynamic model for the design of the limb. Users also receive alerts on their phones about good and poor device usage to help them with best posture and walking gait.

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Plug and play machine monitoring in the cloud

FourJaw

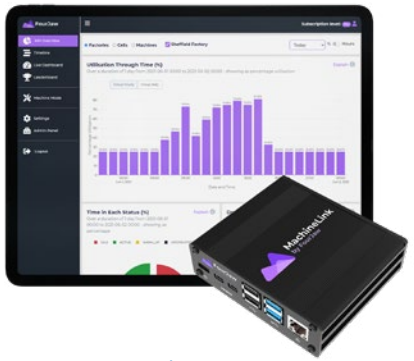
FourJaw is a tech start-up that offers plug-and-play CNC machine monitoring in the cloud.

Powered by the MachineLink, an inexpensive edge computer that can be easily installed onto a CNC machine by a maintenance engineer in a matter of minutes, the FourJaw platform gives manufacturers of any size the chance to take the first step on their journey to becoming a digital factory. The FourJaw platform works with any machine, of any age, from any manufacturer.

The digital manufacturing solution begins by passively and reliably tracking utilisation data generated by the machine during production. This data is securely sent into the FourJaw cloud systems, where it is processed by seven layers of analytics, before it is presented via an intuitive web app. This enables the production team to see what was previously unseen, and track the productivity across the entire shop floor.

The most common question asked after seeing utilisation data is “what are my main reasons for lost productivity?” FourJaw places tablet computers next to each CNC machine, which automatically ask the operators for a downtime reason following a period of inactivity. This enables operators to highlight bottlenecks in the production process that can be removed by the supporting production teams.

By measuring, manufacturers can finally track improvement initiatives to validate they are having the desired effect. This continuous improvement process means that manufacturers of any size are able to truly compete internationally.



> By measuring, manufacturers can finally track improvement initiatives to validate they are having the desired effect.

MADE SMARTER

Cookson & Clegg

Does your factory want to reduce running costs by up to 20% during peak periods?

Make things smarter

When TV sewing expert and tailor Patrick Grant and his sister Victoria rescued textiles business Cookson & Clegg (C&C) from collapse in 2016, they quickly recognised digital technology was the key to survival and growth.

Victoria Grant, Operations Director, says: "We acquired C&C because we believed it was a quality business with some extremely skilled employees. However, the traditional ways of doing things and embedded inefficiencies have held back the business from keeping up with the rapid changes in textile manufacturing."

The government-funded Made Smarter Adoption programme in the North West, which helps SMEs digitalise and grow, provided a digital transformation workshop for the management team and supported adopting a system to help the company track manufacturing data.

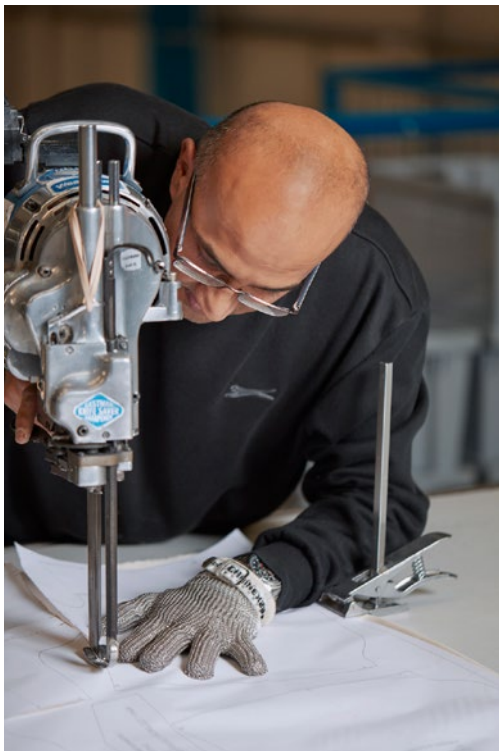
"The digital transformation workshop process helped us acknowledge that the shop floor was a black box and the first vital step for our business was to get hold of all that valuable data, so we could understand and better control the inner workings of our operations," says Victoria.

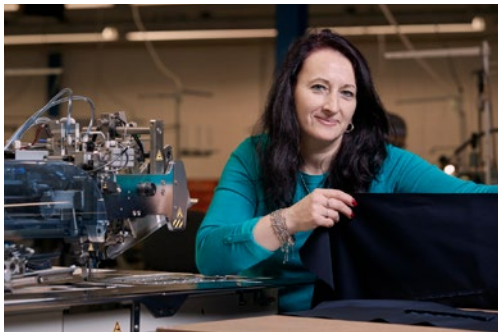
C&C is now implementing a production management system that documents the whole journey of a garment from sampling to delivery, called Galaxius. Data is transmitted, processed and displayed in real-time on a web-based platform, which gives the leadership team visibility of the production line.

By breaking down a garment's production into separate elements and applying a timing for each part, the business will know exactly how long it will take to produce a set number of garments and the manufacturing cost.

C&C will be able to plan its production effectively, accurately assess factory capacity and provide customers with realistic delivery dates.

The simpler production planning system will also enable the factory manager to focus on improving processes further. The improved efficiencies will remove the need for overtime, reducing the factory's running costs by up to 20% during peak periods.





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> **Victoria Grant, Operations Director at Cookson & Clegg**

Product variation busting technology to boost seal manufacturer's 'customer first' model

AESSEAL

Rotherham-based manufacturer of mechanical seals AESSEAL's business model is based on product configurability and customer service. Its range of products is huge, running into tens of thousands of parts numbers that can result in an even bigger amount of different configurations of finished products, some of which require customisations.

The company and its products and processes are designed in accordance with AESSEAL's business methodology of DCVIL: Designed to be Configurable, and assembled to order, with a high level of Vertically Integration, providing control over its own destiny by employing Lean practices.

A customer can, in effect, order specifying features onto a range of modular seal variants. These are then either assembled from inventory or, in the case of customised seals, made and despatched within industry-leading delivery times. However, this requires hundreds of thousands of product variations to be delivered at speed, which can be a headache for the manufacturing department to process.

The award-winning company is currently introducing two digital innovations to flatten the variation and productivity curve. One is the AESSEAL Super Cell. A multi-national automation supplier advised the company to use digital twins and full product manufacturing information (PMI) modelling to help its machining cells cope with the variation, but the supplier said AESSEAL had too many product variants to make the system work.

"Each part we make, in very small batches of 2-20, might need a different type of workholding in the machine, different tooling, CAM programmes, different cycles, different inspection techniques – and we want to give the cell literally hundreds of thousands of different parts," says Group Engineering Director Stephen Shaw.

After some research and company visits, AESSEAL worked with a partner to author manufacturing software that identifies an order and converts this to actions in the Super Cell, which reconfigures the tooling, fixtures, CAM paths, etc., for an infinite number of product variants with no human intervention. When fully commissioned, the Super Cell, or multiple cells, can machine customised orders 24/7 365 days a year.

And that's just one aspect of AESSEAL's digital transformation. To identify an order, the company has developed in-house software called eVE that organises and accesses a series of knowledge databases, including a 3D model parts library, and automates the part-design process, creating 3D models, CAM programmes and CMM programmes to satisfy the order. Whether it gets the order or not, all the information is then captured and fed back into the knowledge databases for future use.

Over many months, the company has compiled full 3D models of mechanical seals with every function, size, material and end-use that its customers have ordered, pooling and organising tens of thousands of general arrangements (GA) drawings, or 'assets', on its database. Each asset might have 2-10 different seal dimensions, multiplying the possible variants.

By automating the library and the design process, creating a new GA of a customer's order can be reduced from five days on average, including delays, to just minutes. In addition, a customer quotation including a GA drawing, price and delivery and in any language can be delivered over the web using handheld phones and tablets.

By automating the library and the design process, creating a new GA of a customer's order can be reduced from five days on average...to just minutes.

Data and measurement – the core of digital manufacturing

The Future Metrology Hub

Measurement and data gathering is at the heart of digitalisation in manufacturing. As the pre-eminent engineer Joseph Whitworth said: "You can only make as well as you can measure."

Researchers at the spoke universities of The Future Metrology Hub, an EPSRC-funded centre for advanced metrology, bring specialist expertise together to create new technologies and sensors for gathering data about components, as well as developing sophisticated methods for interpreting and analysing it effectively.

Measuring a part post-manufacture, called product verification, consumes time and cost. The National Physical Laboratory estimates that traditional product verification processes typically account for 10% to 20% of finished product costs, representing over £15bn a year in the UK alone.

The focus of research at the University of Sheffield spoke is metrology informatics.

The spoke's aim is to extract maximum useful information from in-process data from the multiple stages of manufacturing a part, towards providing a health assessment of the parts being manufactured. "We achieve this by deploying sensor fusion and machine learning methods and making predictions on the dimensional and surface metrology parameters of the product," says Professor Visakan Kadirkamanathan, spoke lead at the University of Sheffield.

This can be seen as providing a 'virtual metrology measurement', which is used in a new strategy at the Hub called Inspection by Exception. The idea behind Inspection by Exception is that the time-consuming inspection stage of manufacture is excluded for products that are predicted to categorically conformed to, or categorically violated, manufacturing tolerances – in essence, don't bother measuring the parts that you know will conform to pre-set measurements during their manufacture. "We believe this approach can increase efficiencies in metrology-driven manufacturing," Visakan adds.

Industries that need this level of inspection include aerospace, nuclear, automotive, medical and more. It's believed that the savings from applying this in-process inspection technology could be huge.

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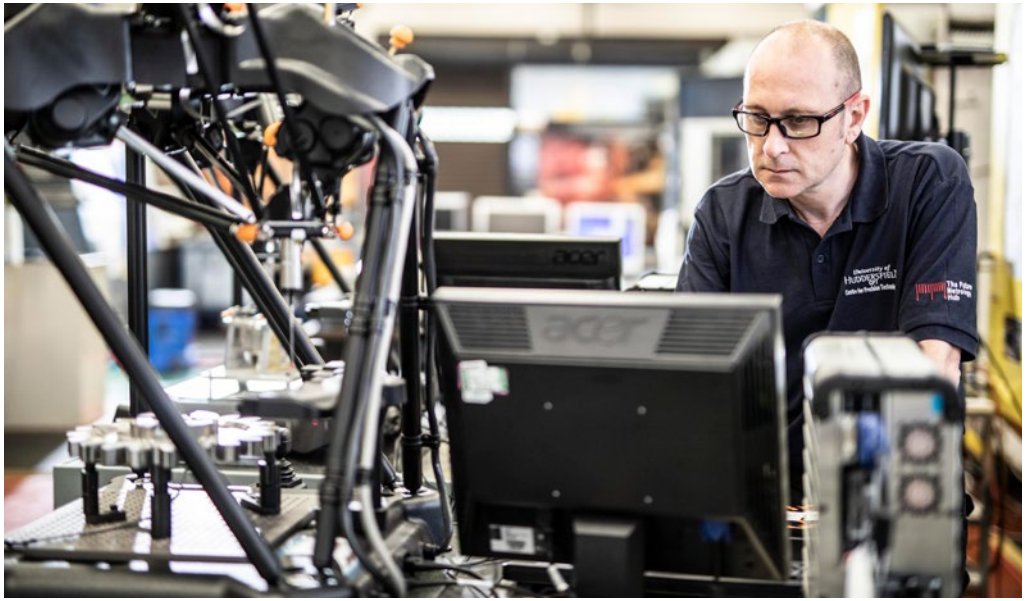

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