

## The rise of distributed autonomous manufacturing

Digital Catapult and the High Value Manufacturing Catapult are working together, alongside academic and industrial leadership partners to investigate new ways of working and applying technology to grow the UK manufacturing industry. This paper looks at distributed autonomous manufacturing and how it may transform the manufacturing landscape of the future.

Over the next five to ten years distributed autonomous manufacturing, led by demands from the consumer sector, will be one of the mechanisms that drives disruption in traditional manufacturing business models. Distributed autonomous manufacturing will use technology to open up the manufacturing process. It will enable a customer to input requirements and receive an automatically generated design which can be customised. Once a design is finalised, it would then be made available, along with its bill of materials and associated operations, to the manufacturing ecosystem. Manufacturers will bid to perform an operation, supply parts or assemble the finished product.

Decentralised by its nature, distributed autonomous manufacturing will enable consumers to interact directly with manufacturers. Greater connectivity, data, trust and visibility will be enabled by next generation advanced digital technologies. It will foster more local, peer-to-peer production, micro manufacturing and collaborative production.

Distributed autonomous manufacturing has become a possibility because of transformative technologies such as 3D printing, blockchain, artificial intelligence and machine learning and IoT. These technologies enable the distribution of large parts of the manufacturing process to local facilities and even to the customer.

The UK manufacturing industry is ripe for disruption of the kind that has already been experienced in other industries. Distributed autonomous manufacturing would make use of the huge potential of emerging digital technologies creating huge opportunity for UK manufacturing to become more competitive.

The new manufacturing landscape that will emerge as a result of distributed autonomous manufacturing will be characterised by:

- Highly personalised / specialised finished goods
- Personalised combination services
- Evolution of a maker-consumer relationship
- Autonomous stock allocation
- Commoditised production of high value components across the supply chain
- Automated product design

### Highly customised/specialised finished goods

Highly customised/specialised finished goods in bio-medicine, clothing, furniture, fast moving consumer goods and highly specialist component production, will result in the development of massively distributed small-scale manufacturing and processing units, close to areas of urban consumption. They will be capable of reclaiming and reprocessing goods to create a circular economy with improvements in consumption of materials and energy.

### Personalised combination services

Personalised combination services in food distribution, consumer electronics and industrial supply chains will result in the rapid development of digitised aggregator services or marketplaces, presenting up-stream component manufacturers with an alternative route to market and creating new markets in data analysis based on the supply of parts or the recombination of parts into personalised service-led products.

### Evolution of a maker-consumer relationship

Buyer-design models will expand from an engineer/producer relationship to include a maker-consumer dynamic. Stock/build-to-order with 24/48hr lead times will become the norm, and the distinction between late-stage prototyping and final product will fall away with many successful products continuing to evolve their designs.

### Autonomous stock allocation

Autonomous stock-allocation across a mass distributed supply chain will create the opportunity for ultra-efficient inventory management and the establishment of proximity-based mass manufacturers (speed to supply will justify the margin uplift required to locate in consumption markets rather than traditional low-labour cost supply markets).

### Commoditised production of high value components across supply chain

Volume production of high value components for sectors such as aerospace and automotive will be commoditised and distributed across supply chains, with responsiveness being a key driver along with quality and price.

### Automated product design

Techniques such as generative design and using machine learning to solve design constraints, coupled with massive online marketplaces, will lead to more automated design and market testing of product variants, evolving new product categories.

Manufacturing companies that currently derive competitive advantage from their people and equipment will find it is imperative to transfer from a model of producing goods, to a model of building manufacturing systems, where competitive capability can be digitised and scaled. There will be a shift to a world where multi-skilled manufacturing engineers build systems and processes which, in turn, deliver high quality manufactured goods at the right price and time.

As increased speeds of production, autonomous allocation of stock, combined production / reclamation capabilities and new data-based layers of service providers become more common in highly specialised and consumer-facing markets, manufacturers upstream and those serving industrial markets will also see related challenges.

## HOW DISTRIBUTED AUTONOMOUS MANUFACTURING COULD TRANSFORM MANUFACTURING, AN EXAMPLE.

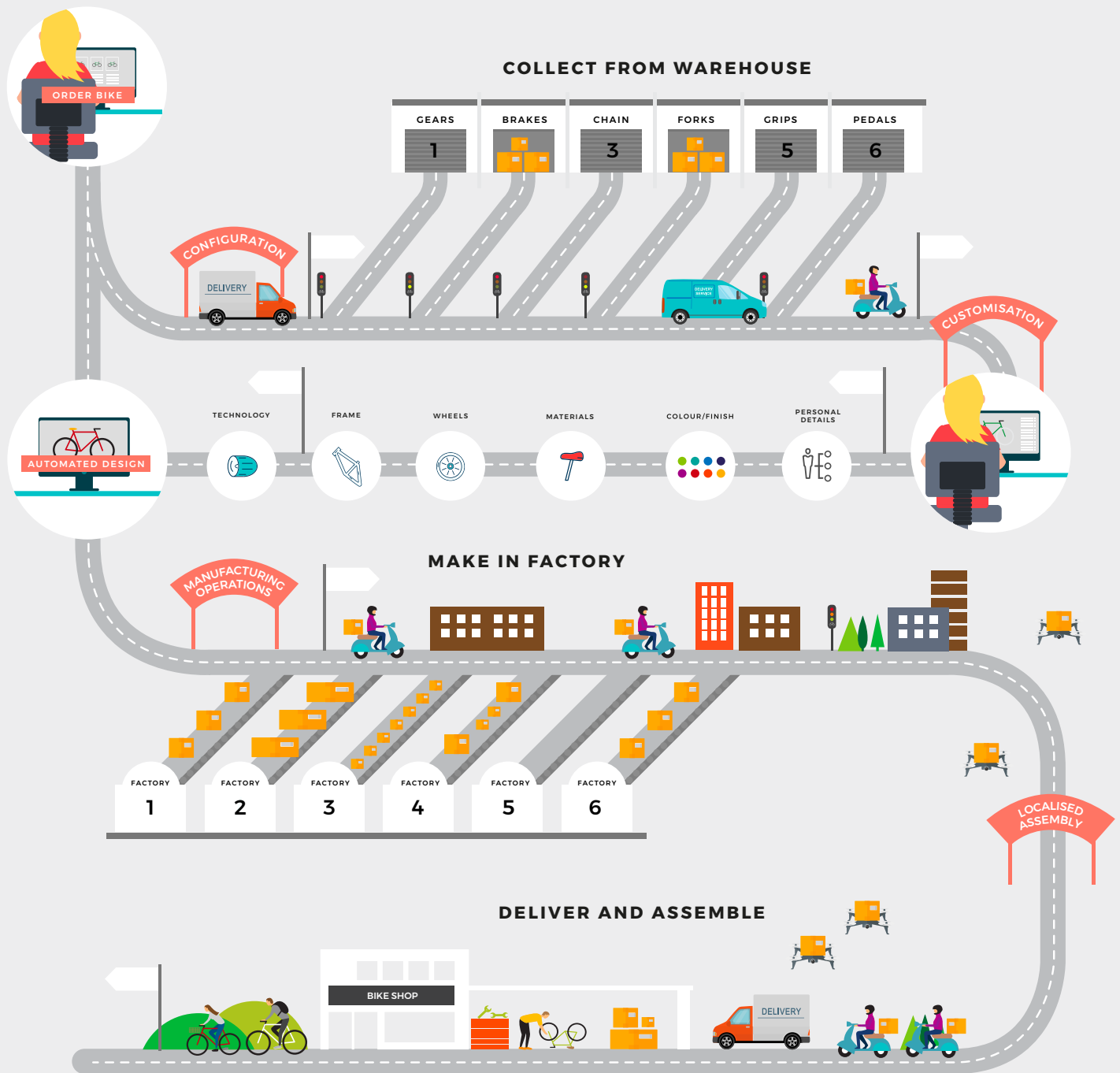
To better articulate how the characteristics already discussed may impact the manufacturing process, it is helpful to examine a specific example. In this case, bicycle manufacture. Imagine the journey the humble bicycle goes through to be designed, manufactured and sold to a UK consumer. A company, usually an original equipment manufacturer, conducts research to identify a trend or opportunity in the market. They would likely use their own engineering capability, which has been developed over many years, to design and test a new product. It uses relationships in the supply chain to source components as cheaply as possible, and retailers to sell the products.

A UK consumer chooses a bicycle, from a range of specified configurations, as close as possible to what they would like within their budget. There are few opportunities to personalise the configuration, size or colour so the consumer must select the closest fit for their needs. It is likely that over 30% of the price paid is mark-up for the retailer and intermediaries, and there are also logistics costs as many bikes are now made in Asia.

What if distributed autonomous manufacturing was adopted by UK manufacturers? Could the technology be used to enable the production of bicycles in the UK in local manufacturing facilities across the UK, utilising spare capacity and capability? Could a system be created to enable the consumer to have complete control over the product they purchase including customisation and personalisation such as stipulating a bespoke frame? Digital Catapult and the High Value Manufacturing Catapult believe distributed autonomous manufacturing is an opportunity with potential worthy of deeper exploration. While a few innovators such as the MTD Network, Unmade and Make Works are starting to show development of the concept and technology in the UK, enabling the transformation of an early majority has the potential to disrupt the market and create a competitive advantage for the nation.

## THE MANUFACTURING LANDSCAPE OF THE FUTURE

The future landscape established by distributed autonomous manufacturing, will provide both opportunities and risks to the UK manufacturing community. It is likely that this landscape will include companies that have transformed from a traditional manufacturing base, through to new entrants that will drive digital innovation.



## A JOINT RESPONSE TO BUILD REAL OPPORTUNITIES

Working together, Digital Catapult and the High Value Manufacturing Catapult, alongside academic and industrial leadership partners, will be holding a series of consultation sessions in Autumn 2018 to define the UK opportunity for distributed autonomous manufacturing. Following these consultation sessions, we will research which areas within the manufacturing sector have the ability to be transformed by this concept, publishing our results in 2019. This is expected to align with the start of Made Smarter and provide an opportunity to create technology demonstrators to accelerate distributed autonomous manufacturing into industry.

We will be actively looking for participants to help define the role for distributed autonomous manufacturing in the future of UK manufacturing. If you're a disruptive company, or one that is keen to embrace technology to transform an industry, then please get in touch with us.

[dam@digicatapult.org.uk](mailto:dam@digicatapult.org.uk)