CATAPULT
High Value Manufacturing

HVM Catapult technology strategy 2026

Innovate UK
University of Sheffield AMRC
cpi
mtc where progress happens
ncc
NMIS National Manufacturing Institute Scotland
WMG THE UNIVERSITY OF WARWICK

Foreword

Professor Chris Dungey
Chief Technology Officer, HVM Catapult

Advanced manufacturing is entering a decisive decade.

Across the world, nations are investing at scale in the technologies that will define future industrial leadership – whether that is artificial intelligence, autonomous systems, engineering biology or digital manufacturing. At the same time, supply chains are becoming more complex, sustainability pressures are mounting and the ability to turn innovation into industrial capability is fast becoming the key determinant of long-term economic resilience.

For the United Kingdom, this presents both a challenge and an opportunity.

The challenge is clear: we cannot assume that past industrial strengths will carry forward into the future. Leadership in advanced manufacturing will increasingly be determined by how effectively countries adopt, integrate and scale transformative technologies across their industrial base.

The opportunity, however, is equally significant. With the right focus, collaboration and investment, the UK has the potential not simply to adapt to this technological shift but to shape it.

This technology strategy sets out how the High Value Manufacturing Catapult will play its part in that mission.

From AI-enabled autonomy and digital twins, to advanced robotics, biomanufacturing and circular production systems, the technologies captured in our capability roadmaps represent more than incremental progress. Together, they point towards a step-change in how we design, make, move and maintain the products and infrastructure that underpin our economy and society.

Realising this vision will require more than technological invention. It demands adoption at scale across firms of all sizes and across every region of the UK. It requires the integration of digital and physical innovation, the development of new skills, and the creation of resilient supply chains capable of supporting emerging industries.

This technology strategy is not intended as a static plan, but as a living framework for industrial transformation that will evolve as technologies mature, markets develop and new challenges emerge. Its delivery is underpinned by formal cross-network governance through the HVM Catapult Technology Forum, ensuring coordinated strategic ownership across our centres, enabling the effective prioritisation and execution of key innovation activities, and fostering the partnerships required to support UK industry.

I would like to thank all those who have contributed to the development of this strategy. This work reflects extensive collaboration and consultation across the High Value Manufacturing Catapult, alongside valued insight from Innovate UK, EPSRC and most importantly our industry partners. Their expertise and engagement have been instrumental in shaping a roadmap that is both ambitious in its vision and grounded in practical industrial need.

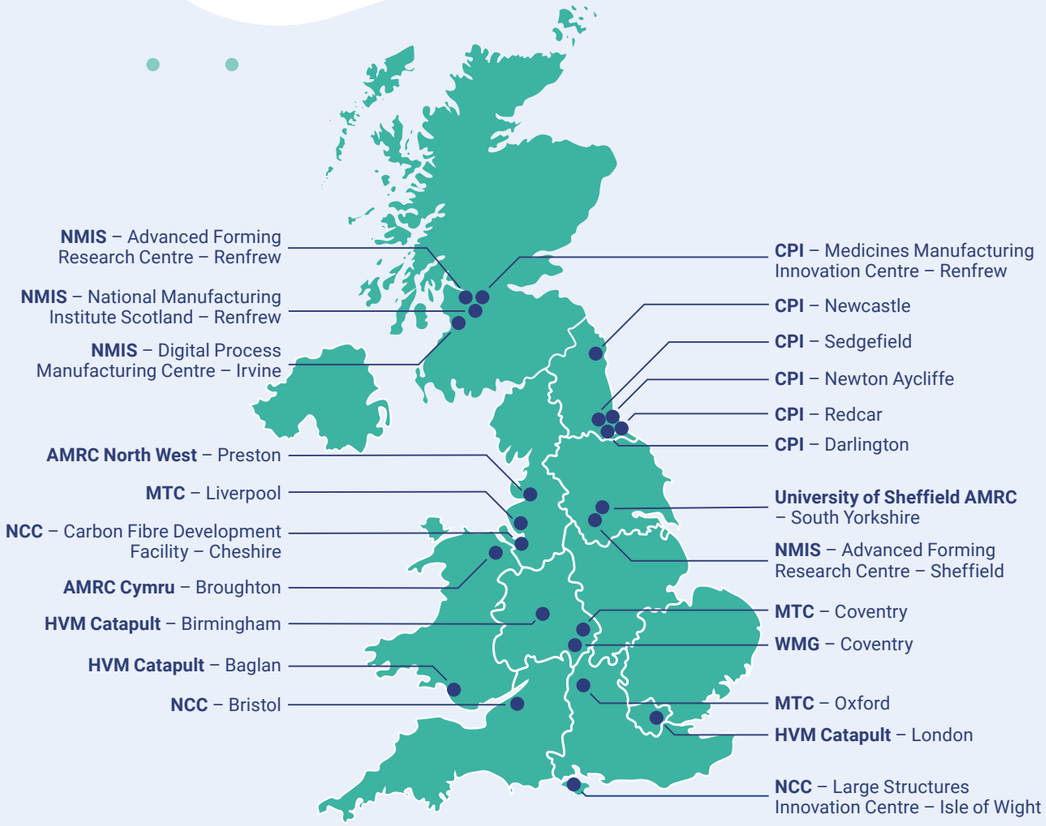
Contents

High Value Manufacturing Catapult

The High Value Manufacturing (HVM) Catapult helps drive economic growth across the country by keeping UK manufacturing innovative, productive and globally competitive.

Each year, thousands of businesses come to HVM Catapult seeking solutions to a particular problem or looking for ways to improve the products they sell, the way they make them and the skills of their workforce which could help them attract inward investment and prosper in the global marketplace.

HVM Catapult's national network of centres and 3,800 employees provide those companies with access to world-class facilities and expertise that would otherwise be out of reach. Working at scale and across the UK, our centres work together to accelerate industrial transformation.



Introduction

The High Value Manufacturing (HVM) Catapult technology strategy presents UK industry with unprecedented clarity on how our network of innovation centres will prioritise investment to pull through technologies in response to long-term industry needs.

Responding to the publication of the UK government's modern industrial strategy, we are guiding our capability development and the advanced manufacturing innovation ecosystem around shared technology priorities for the next 15 years.

Our direction-setting framework does this by responding to the market pull identified in the Innovate UK Materials and Manufacturing Vision 2050 and key sector plans such as those from the Aerospace Technology Institute (ATI) and Advanced Propulsion Centre (APC), before identifying where capability development is most needed to deliver against the industrial strategy's advanced manufacturing sector plan.

That enables us to better direct our unrivalled technical excellence to tackle national priorities and accelerate our ability to leverage our capabilities for high-growth sectors, such as unlocking the full potential of quantum technologies for the UK economy.

HVM Catapult provides the UK with nationally significant scale-up and pilot-scale capability, enabling businesses to transition technologies from laboratory validation to industrial deployment. Facilities such as the Advanced Materials Battery Industrialisation Centre (AMBIC) and National Advanced Semiconductor Packaging and Integration Centre (NASPIC) allow companies to prove manufacturability, validate processes at scale and accelerate routes to market in strategically important sectors.

At the centre of the strategy sit our technology capability roadmaps which have been developed in close collaboration with industry, academics and the wider innovation ecosystem. Critically, they are shaped by our industry partners who have helped identify capability priorities and the pathways to deliver them.

The industrial strategy pinpointed the HVM Catapult technology strategy as a key milestone to deliver the advanced manufacturing sector plan and its ambition is to nearly double annual business investment in the sector. Its value is already being leveraged to support the development of sector-specific roadmapping workshops, HVM Catapult's capital investment plan and engagement with other research organisations.

But this is an aspirational strategy, not a static one, a baseline designed to inspire ongoing discussion and debate. We are embarking on a long-term system-level partnership, alongside our work supporting supply chains and anticipating future skills needs, with this strategy as an evolving strategic asset that continuously clarifies our priorities, aligns with our partners and shapes our future direction.

Skills anticipation – understanding future skills requirements

Recognising the importance of people and skills to the successful adoption and use of technology, in 2026 HVM Catapult will examine how developments in technology capability will impact people and skills.

People roadmapping is an emerging strategic methodology for how HVM Catapult can identify workforce impacts and skills requirements with the aim of preparing the UK skills landscape for change and addressing future gaps between skills demand and supply.

The project will use our technology capability roadmaps to model and trial a people roadmap approach.

Delivering the modern industrial strategy

Our technology strategy goes beyond a conventional roadmapping exercise. It is a systems-level framework designed to support the delivery of HVM Catapult's strategic priorities and the UK's modern industrial strategy.

Our priorities for UK manufacturing harness our network's core strengths as a group of world-leading innovation centres and are built upon the foundation of unparalleled technology capability and leadership.

Our technology strategy will guide that capability development and support us to deliver those priorities by identifying practical technological solutions to tackle industry needs, including the pathways to translate novel technologies into market-ready products.

As the strategy evolves, the next step will be to develop a complementary set of frontier technology roadmaps – covering areas such as artificial intelligence, quantum, and semiconductors – to ensure the framework continues to reflect the technologies most likely to shape future industrial competitiveness, capability development and investment priorities.

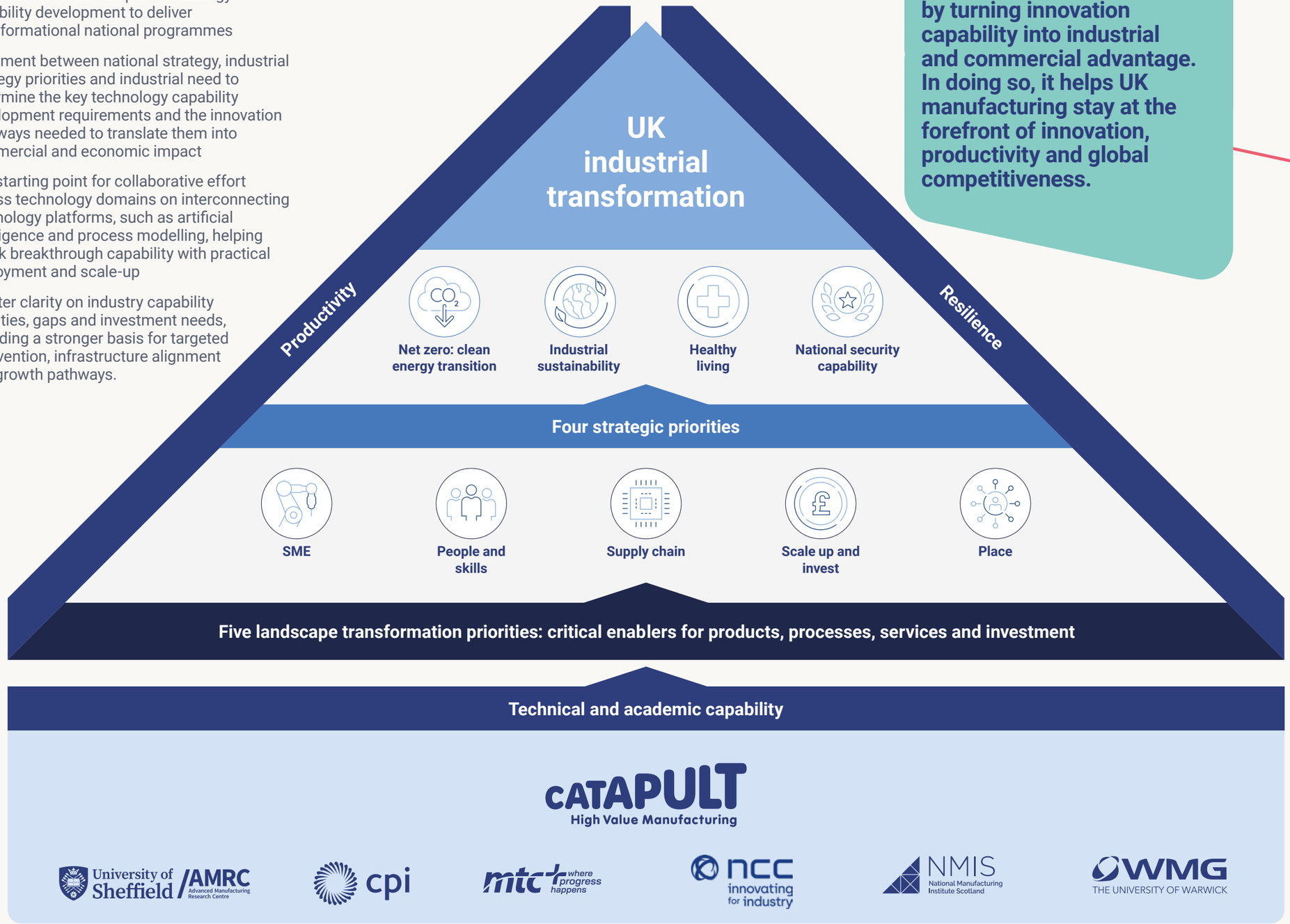
Our technology strategy presents our industry partners with:

- A comprehensive view of HVM Catapult's current capabilities and future demands
- Transparency on how HVM Catapult will prioritise investment into core technologies in response to long-term industry needs identified in the modern industrial strategy
- Alignment between our centres and the wider innovation ecosystem around shared technology priorities
- The foundation for deeper collaboration between our centres and partners to address the UK manufacturing industry's most complex innovation challenges.

The strategy will accelerate industrial capabilities by providing:

- Direction for HVM Catapult technology capability development to deliver transformational national programmes
- Alignment between national strategy, industrial strategy priorities and industrial need to determine the key technology capability development requirements and the innovation pathways needed to translate them into commercial and economic impact
- The starting point for collaborative effort across technology domains on interconnecting technology platforms, such as artificial intelligence and process modelling, helping to link breakthrough capability with practical deployment and scale-up
- Greater clarity on industry capability priorities, gaps and investment needs, providing a stronger basis for targeted intervention, infrastructure alignment and growth pathways.

Our strategy supports UK businesses to scale, grow, thrive and compete by turning innovation capability into industrial and commercial advantage. In doing so, it helps UK manufacturing stay at the forefront of innovation, productivity and global competitiveness.



The strategy structure

Our technology strategy is a direction-setting framework designed to align our centres and the wider innovation ecosystem around shared technology priorities.

Identifying industry needs and then establishing the pathways to deliver innovation priorities, it will guide capability development and investment to support the delivery of the UK's modern industrial strategy. It consists of four key components: landscapes, technology capability roadmaps, priority pathways and connected technology platforms.

Innovate UK's Materials and Manufacturing Vision 2050 | **Sector strategies**

HVM Catapult technology strategy

Landscapes

Aligned to Innovate UK Materials and Manufacturing Vision 2050

- World class production
- Longer in use and reuse
- Materials for future economy
- Smart design
- Clean energy
- Resilient supply chains

Market pull ↓ ↑ Technology push

Technology capability roadmaps

Advanced manufacturing process technologies

- Additive manufacturing
- Biomanufacturing
- Composites engineering
- Joining engineering
- Near net shape
- Subtractive manufacturing

Cross-cutting enabling technologies

- Advanced materials*
- Assurance
- Digital engineering*
- Digital manufacturing
- Robotics and automation

Priority pathways

Connected technology platforms

UK's modern industrial strategy

*Advanced materials and digital engineering roadmaps will be published at a later date.

Landscapes

Our six landscapes represent the strategy's market pull – innovation driven by clear demand, regulation or commercial need.

Corresponding to Innovate UK's Materials and Manufacturing Vision 2050's themes and informed by key sector plans, they are the high-level market and societal needs which create industry demand for new technologies.

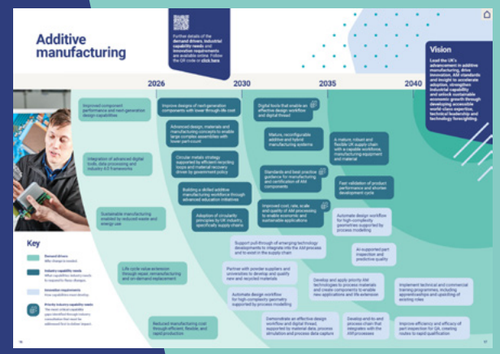
Technology capability roadmaps

Nine roadmaps have been developed corresponding to HVM Catapult's current core strengths and competencies. They are categorised as:

- **Advanced manufacturing process technologies:** Core production technologies that physically create products
- **Cross-cutting enabling technologies:** Capabilities that support and enable many manufacturing technologies

Our roadmaps provide a structured view of how specific manufacturing technology capabilities need to evolve to meet the industry demand identified by the landscapes over the next 15 years.

Summaries of the technology capability roadmaps are illustrated in this document and explored in greater detail online.



Each roadmap details:

Why: Demand drivers

External pressures or opportunities that create the need for new or improved manufacturing capabilities.

What: Industry capability needs and priorities

The practical abilities industry must have to remain competitive in the future and the priorities for HVM Catapult.

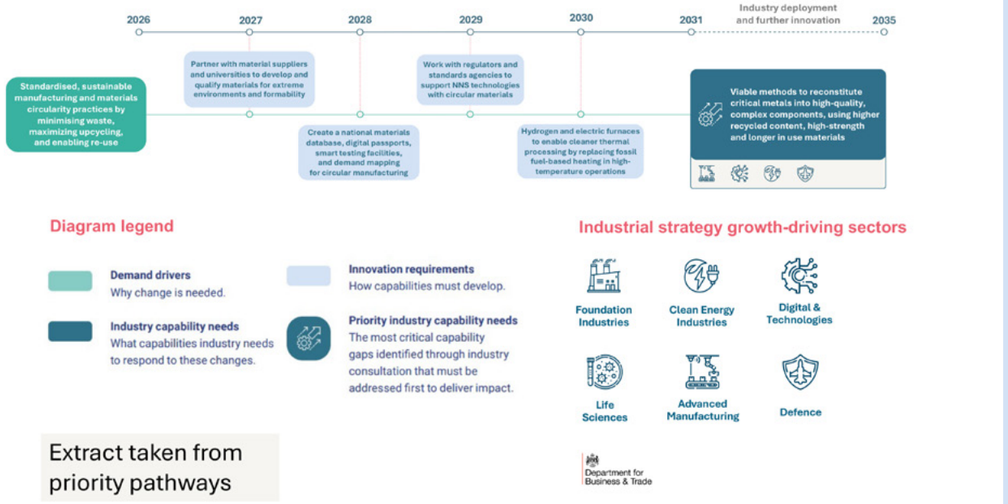
How: Innovation requirements and priorities

The specific technologies, tools, processes, data, skills or system enablers that must be developed, improved or integrated to meet future industry capability needs, and the priorities for HVM Catapult.

Priority pathways

Our technology capability roadmaps provide a structured view of how our priority manufacturing technology capabilities must evolve to meet the industry demand identified through the landscapes over the next 15 years.

Through extensive industrial consultation, we have identified the priority capability needs and the underpinning innovation requirements. The relationships between these are articulated through our priority pathways, which define HVM Catapult's focus areas for capability development.



Extract taken from priority pathways

Priority pathways can be accessed online via this QR code. You can also **click here**.

Connected technology platforms

Through cross-domain analysis, eight connected technology platforms have been identified. They underpin both the core advanced manufacturing process technologies and the cross-cutting enabling technologies set out in this strategy.

They provide a shared foundation of insight and collective capability, showing where coordinated effort across our domains can best strengthen, connect and accelerate the technologies that matter most to UK industry.

An industrial AI for advanced manufacturing UK adoption plan is now being developed in partnership between Made Smarter, Make UK, HVM Catapult and the Department for Business and Trade, led by the AI Champion for Advanced Manufacturing.

Priority: Artificial intelligence enabled advanced manufacturing

Enhancing human capabilities with industrial AI technologies applied across the product development and operational life cycle.

Harmonised life cycle analysis

Standardising assessment methods and data formatting to consistently measure environmental impact across a product life cycle.

Intelligent manufacturing assurance and regulatory engagement

Leveraging smart systems to ensure quality and compliance, and early-stage dialogue to decrease barriers and accelerate validation and verification.

Manufacturing with advanced materials

Accelerating the deployment of next-generation materials across the full value chain and supporting the development of an agile and responsive UK supply base.

Capability development

Advanced and interconnected process modelling

Integrating detailed simulations and enabling interoperability across the value chain to optimise manufacturing performance.

Automation of processes and digital integration

Streamlining manufacturing processes through digitally connected systems and interoperability.

Digital thread

A seamless flow of data connecting design, production and operations across a product life cycle.

Value retention

Preserving the life of products, components and materials through recycling, repair and remanufacturing (Re-x).

Our technology capability roadmaps

The following pages contain summaries of the technology capability roadmaps we have developed with our industry partners.

Follow the QR code or click here to read the technology capability roadmaps in detail.

Advanced manufacturing process technologies

- Additive manufacturing
- Biomanufacturing
- Composites engineering
- Joining engineering
- Near net shape
- Subtractive manufacturing

Cross-cutting enabling technologies

- Assurance
- Advanced materials*
- Digital engineering*
- Digital manufacturing
- Robotics and automation

Each technology has a summary page, a roadmap visualisation where three industry priorities have been highlighted, and links to greater detail online.

Additive manufacturing

Manufacturing processes that join materials to make parts from 3D model data, layer upon layer.

HVM Catapult is accelerating the UK's leadership in additive manufacturing, advancing design (DfAM), next generation materials, digital workflows and scale-up production. Building on our extensive network capabilities we have enhanced performance, cost efficiency and value retention. In partnership with industry and academia, we are shaping a future of resilient, circular and data-driven manufacturing – unlocking scale-up opportunities for additive manufacturing.

Why: Demand drivers

- Improved component performance and next-generation design capabilities
- Reduced manufacturing cost through efficient, flexible and rapid production
- Sustainable manufacturing enabled by reduced waste and energy use
- Life cycle value extension through repair, remanufacturing and on-demand replacement
- Integration of advanced digital tools, data processing and industry 4.0 frameworks.

What: Priority industry capability needs

- Improved cost, rate, scale and quality of additive manufacturing processing to enable economic and sustainable applications
- Digital tools that enable an effective design workflow and digital thread
- Standards and best practice guidance for manufacturing and certification of AM components
- A mature, robust and flexible UK supply chain with a capable workforce, manufacturing equipment and material
- Building a skilled additive manufacturing workforce through advanced education initiatives.

How: Priority innovation requirements

- Develop and apply priority additive manufacturing technologies to process materials and create components to enable new applications and life extension
- Develop end-to-end process chain that is with the additive manufacturing processes
- Demonstrate an effective design workflow and digital thread, supported by material data, process simulation and process data capture
- Support pull-through of emerging technology developments into the additive manufacturing process and to exist in the supply chain
- Implement technical and commercial training programmes, including apprenticeships and upskilling of existing roles.

Key HVM Catapult capabilities in additive manufacturing

National Centre for Additive Manufacturing, MTC (Coventry)

End-to-end additive manufacturing capability, combining metal, polymer and ceramic additive manufacturing systems with process validation and advanced powder characterisation to support industrial adoption.

Large-scale DED and solid-state additive manufacturing, NMIS (Renfrew)

Supporting manufacturing and remanufacturing with precision micro-deposition through to high-rate, large-scale production using DED-laser and DED-arc technologies, supporting hybrid manufacturing workflows. Advanced high-pressure cold-spray technologies for solid-state coatings, cladding, feature addition and full AM builds, delivering high-integrity surface enhancement with reduced heat input and integrated digital control systems.

Large-scale solid-state additive manufacturing, AMRC (Samlesbury)

Friction stir and related processes to produce defect-free, high-integrity components with minimal thermal distortion, integrated with digital process control, real-time monitoring and automated handling.

Multi-material additive manufacturing, WMG (Coventry)

Enabling the integration of dissimilar materials within a single build to optimise performance, functionality and lightweighting, supported by digital design tools, process simulation and scalable manufacturing routes for rapid industrial deployment.

ReMake Value Retention Centre, NMIS (Renfrew)

Pioneering circular manufacturing and value-retention through advancing reuse, remanufacture and refurbishment of high-integrity assets with systems-level collaboration, cutting waste and emissions, strengthening supply chains and accelerating net-zero impact.

Advanced med tech product design and development, CPI (Sedgefield)

Additive manufacturing for med tech, enabling rapid prototyping, design iteration and scalable production of regulated medical devices through materials expertise, validation and translational product development support.

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Additive manufacturing

Further details of the **demand drivers**, **industrial capability needs** and **innovation requirements** are available online. Follow the QR code or **click here**.

Vision

Lead the UK's advancement in additive manufacturing, drive innovation, AM standards and insight to accelerate adoption, strengthen industrial capability and unlock sustainable economic growth through developing accessible world-class expertise, technical leadership and technology foresighting.

2026	2030	2035	2040
Improved component performance and next-generation design capabilities	Improve designs of next-generation components with lower through-life cost	Digital tools that enable an effective design workflow and digital thread	
Integration of advanced digital tools, data processing and industry 4.0 frameworks	Advanced design, materials and manufacturing concepts to enable large complex assemblies with lower part-count	Mature, reconfigurable additive and hybrid manufacturing systems	A mature, robust and flexible UK supply chain with a capable workforce, manufacturing equipment and material
	Circular metals strategy supported by efficient recycling loops and material recovery driven by government policy	Standards and best practice guidance for manufacturing and certification of AM components	Fast validation of product performance and shorten development cycle
	Building a skilled additive manufacturing workforce through advanced education initiatives	Improved cost, rate, scale and quality of AM processing to enable economic and sustainable applications	Automate design workflow for high-complexity geometries supported by process modelling
Sustainable manufacturing enabled by reduced waste and energy use	Adoption of circularity principles by UK industry, specifically supply chains	Support pull-through of emerging technology developments to integrate into the AM process and to exist in the supply chain	AI-supported part inspection and predictive quality
Life cycle value extension through repair, remanufacturing and on-demand replacement	Partner with powder suppliers and universities to develop and qualify new and recycled materials	Develop and apply priority AM technologies to process materials and create components to enable new applications and life extension	Implement technical and commercial training programmes, including apprenticeships and upskilling of existing roles
	Automate design workflow for high-complexity geometry supported by process modelling		
Reduced manufacturing cost through efficient, flexible, and rapid production	Demonstrate an effective design workflow and digital thread, supported by material data, process simulation and process data capture	Develop end-to-end process chain that integrates with the AM processes	Improve efficiency and efficacy of part inspection for QA, creating routes to rapid qualification

Key

Demand drivers
Why change is needed.

Industry capability needs
What capabilities industry needs to respond to these changes.

Innovation requirements
How capabilities must develop.

Priority industry capability needs
The most critical capability gaps identified through industry consultation that must be addressed first to deliver impact.

Biomanufacturing

A process of production which uses both natural and engineered biological systems, such as microorganisms and cell cultures, to produce materials across numerous sectors including industrial biotechnology, materials, pharmaceuticals and food.

Biomanufacturing and engineering biology are unlocking a new era of sustainable, high-value production for the UK. By uniting HVM Catapult capability with world-leading academic partners, material innovators and industrial end-users, we are accelerating the scale-up of biologically derived materials, therapeutics, green chemistries and circular processes. From novel bio-based feedstocks to sustainable and economic manufacturing pathways, there is a clear opportunity to position the UK as a global leader in clean, resilient, bio-enabled industry.

Why: Demand drivers

- Next-generation therapeutics require innovative biological production methods
- Biomanufacturing processes seek optimisation for efficiency and sustainability
- Global food systems need sustainable and secure production solutions
- Industries are transitioning to sustainable bio-based materials and chemicals
- Healthcare diagnostics require biomanufactured components for reliable, precise and innovative detection and monitoring.

What: Priority industry capability needs

- Sustainable and cost-effective biomanufacturing advancing greener production methods to replace traditional processes and reduce environmental impact
- Alternative antimicrobials enabling innovative biological approaches to combat resistance and protect global health across diverse applications
- Food, feed and agri-biologicals production for sustainable, secure and resilient supplies supporting human and animal nutritional needs
- Circular material systems using waste as feedstocks to develop next generation green materials
- Develop and maintain a world-class UK workforce.

How: Priority innovation requirements

- Develop novel biomanufacturing capabilities including new modalities, bioreactors, analytics, formulation, characterisation and access to scale-up or scale-out for innovative production processes
- Leverage digital capabilities including digital twins, integrated analytics and automated process control to enhance biomanufacturing efficiency
- Support cutting-edge biomanufacturing facilities and capabilities underpinning public health and strategic priority response
- Develop agreed tests and standards across sectors from chassis to feedstock, improving efficiency and adoptability of biomanufacturing.

Key HVM Catapult capabilities in biomanufacturing

Intracellular Drug Delivery Centre, CPI (Sedgefield)

Specialises in advanced intracellular delivery technologies, including lipid nano particles (LNPs), offering formulation, characterisation and translational expertise to enable next-generation therapeutics.

Medicines Manufacturing Innovation Centre, CPI (Renfrew)

Provides state-of-the-art medicines manufacturing, enabling collaborative innovation, regulatory engagement and sustainable production methods to reduce time-to-market for life-changing pharmaceuticals through pilot-scale development, advanced processing facilities.

National Biologics Manufacturing Centre, CPI (Darlington)

Delivers biologics manufacturing capability, across therapeutics and vaccines bridging academia and industry. Home of the RNA centre of excellence, the UK's first RNA-LNP phase one GMP facility.

National Formulation Centre, CPI (Sedgefield)

Enables advanced formulation development, including food, feed and agribiologicals to commercialise next-generation formulated products efficiently at reduced technical and scale-up risk for industry. Home of the IDDC.

National Industrial Biotechnology Facility, CPI (Wilton)

Provides industrial biotechnology scale-up, de-risking sustainable bioprocesses through specialist facilities for product development, commercialisation, process innovation and pilot scale manufacturing. Home of the Novel Food Innovation Centre.

Novel Food Innovation Centre, CPI (Wilton)

Provides pilot-scale processing, fermentation and scale-up capabilities for novel foods, feeds and nutraceuticals, enabling rapid development, validation and commercialisation of sustainable food technologies.

Connect with us

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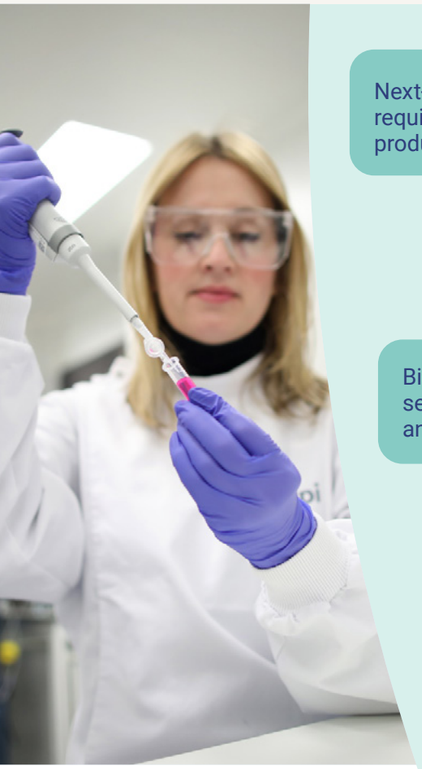
Biomanufacturing

Further details of the **demand drivers**, **industrial capability needs** and **innovation requirements** are available online. Follow the QR code or click here.

Vision

Build UK resilience through sustainable biomanufacturing that delivers chemicals, materials and therapeutic products via efficient, low-impact processes, scalable technologies and renewable feedstocks. This will ensure cost competitiveness, food security and health innovation while supporting economic growth, national security and environmental sustainability.



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2026

- Next-generation therapeutics require innovative biological production methods
- Biomanufacturing processes seek optimisation for efficiency and sustainability
- Global food systems need sustainable and secure production solutions
- Industries are transitioning to sustainable bio-based materials and chemicals
- Healthcare diagnostics require biomanufactured components for reliable and innovative detection and monitoring

2030

- Manufacturing skills and workforce development across the value chain
- Develop and maintain a world-class UK workforce
- Early detection and diagnostic standardisation to develop reliable, standardised diagnostic workflows and reagents to enable earlier disease detection and intervention
- Food, feed and agri-biologicals production for sustainable, secure and resilient supplies supporting human and animal nutritional needs
- Alternative antimicrobials enabling innovative biological approaches to combat resistance and protect global health across diverse applications
- Sustainable and cost-effective biomanufacturing advancing greener production methods to replace traditional processes and reduce environmental impact
- Support cutting-edge biomanufacturing facilities and capabilities underpinning public health and strategic priority response
- Establish agreed quality standards and consistent laboratory methods to ensure reliability and reproducibility in biomanufacturing
- Develop novel biomanufacturing capabilities including new modalities, bioreactors, analytics and formulation

2035

- Accelerating safe, ethical therapeutic approval through standardised regulations, virtualised manufacturing and robust data governance
- Circular material systems using waste as feedstocks to develop next-generation green materials in localised ecosystems
- Scaling cost-effective, GMP-compliant manufacturing for complex biologics and personalised medicines to meet growing demand
- Enable access to scale-up for novel innovative products and production processes
- Leverage digital capabilities including digital twins, integrated analytics and automated process control to enhance biomanufacturing efficiency
- Develop integrated multi-omic analytical capabilities and harmonised data systems for genomics, proteomics and metabolomics insights
- Develop standardised digital models, in-line analytics and fast computational tools to optimise biomanufacturing quality
- Develop scalable drying, purification and formulation technologies – including bioprinting – to enable efficient production of alternative proteins and advanced materials

2040

Composites engineering

Advanced materials that blend different material types to achieve superior strength, reduced weight and enhanced performance.

Only by using advanced composites engineering will the UK unlock opportunities in next-generation aerospace, energy, transport and defence. HVM Catapult is determined to maintain the UK's position as a global leader in composite solutions. This means supporting a resilient supply chain in adopting and exploiting new technologies like digitally-connected engineering, high-temperature materials, automated production processes and sustainable industrial approaches.

Why: Demand drivers

- Improved productivity through enhanced quality, rate and cost of manufacture
- Enhanced UK supply chain resilience and reconfigurability in imperative materials and products
- Reduced embodied carbon of materials and products, and reduced waste
- Emergence of new generation products with increased size and/or complexity
- Materials and products tailored for harsher environments.

What: Priority industry capability needs

- Deploy highly automated manufacturing processes for scalable, cost-effective production with composites
- Adopt new fibres and matrix materials with secure supply that optimise properties and performance
- Employ technologies and products that avail and use reclaimed composites
- Install tooling systems with advanced materials, integrated sensing and rapid fabrication
- Exploit tailored composite structural concepts for step-change performance enhancement.

How: Priority innovation requirements

- Industrialise next-generation manufacturing systems and factories that prioritise production rate at required quality and increasing scale
- Accelerate ceramic matrix composites for breakthrough performance in extreme environments
- Mature recycling technologies, especially in service of establishing circular supply chains and business models
- Design and manufacture functionalised tooling systems, considering heating, sensing, reconfigurability and more
- Design and manufacture with non-conventional laminates including tow shearing and 3D architectures.

Key HVM Catapult capabilities in composites engineering

National centre of excellence for composite technologies, NCC (Bristol)

World-leading, open-access composites R&D, providing cutting-edge technologies, expert engineering support and broad innovation capabilities to accelerate high-performance, end-to-end composite development and industrial adoption across aerospace, automotive and energy sectors.

Composites centre, AMRC (South Yorkshire)

Wide-ranging composites capability with in-house weaving, moulding, curing and new thermoplastic tape research. Includes AMRC's COMPASS facility, which leverages high-rate composite processing, robotic assembly, in-process inspection and digital twins to optimise accuracy, throughput and large-scale production.

Centre for polymers and composites, WMG (Warwick)

Focuses on simulation, testing, high-volume manufacturing and shredding and compounding for recycling, to enable sustainable, multifunctional polymer and composite solutions from fundamental to full-scale industrial validation.

Large Structures Innovation Centre, NCC (Isle of Wight)

New opportunity for a dedicated, open-access environment to de-risk and validate full-scale manufacturing of massive composite components. Focuses on automation, digital twins and sustainable recycling for sectors like wind energy and maritime.

Composites centre, NMIS (Renfrew)

Low-cost, lightweight, high-rate manufacture of material agnostic products with maximum value retention enabling resilience through the product life cycle developing the future of composite repair and industrial scale continuous feed recycling and reformatting verified and validated through testing facilities.

Carbon fibre development, NCC (Northwich) and CPI (Wilton)

Co-developed end-to-end capabilities, specialising in the chemistry, formulation and scale for carbon fibre precursors and dope (CPI), through spinning to oxidisation and carbonisation and sizing application of carbon fibre (NCC) for specialist composite manufacturing.

Connect with us

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Composites engineering

Further details of the **demand drivers**, **industrial capability needs** and **innovation requirements** are available online. Follow the QR code or click here.

Vision

Maintain the UK's global position in composites by advancing high-performing, rapid, and sustainable engineering and production for resilient, high-performance solutions across transport, energy and defence.

2026	2030	2035	2040
Materials and products tailored for harsher environments	Install tooling systems with advanced materials, integrated sensing and rapid fabrication	Adopt new fibres and matrix materials with secure supply that optimise properties and performance	Use materials discovery through advanced computational and experimental methodologies
Emergence of new generation products with increased size and complexity	Employ joining techniques for composites to similar and dissimilar material systems	Execute integrated, through-life digital twin systems for design, manufacturing and operational performance	Implement methods to robustly measure and use environmental impact data of materials and processes
	Apply advanced testing and assurance methods and equipment for accelerated design	Employ technologies and products that avail and use reclaimed composites	Exploit tailored composite structural concepts for step-change performance enhancement
Enhanced UK supply chain resilience and reconfigurability in imperative materials and products		Deploy highly automated manufacturing processes for scalable, cost-effective production with composites	Use methods for concurrent, accelerated product development and certification
	Engineer solutions with mixed-material integration, including co-curing and overmoulding	Design and manufacture functionalised tooling systems, considering heating, sensing, reconfigurability etc.	Mature technologies for new tapes, intermediates and matrix materials
Improved productivity through enhanced quality, rate and cost of manufacture	Industrialise next-generation manufacturing systems and factories that prioritise production rate at required quality and increasing scale	Mature recycling technologies, especially in service of establishing circular supply chains and business models	Design and manufacture with non-conventional laminates, tow shearing, etc.
			Embed trusted LCA approaches and standards into supply chain activity
Reduced embodied carbon of materials and products and reducing waste	Drive concurrent engineering with fully integrated, intelligent digital platforms	Establish cutting-edge UK carbon fibre development facilities to support sovereign production	Accelerate ceramic matrix composites for breakthrough performance in extreme environments

Key

Demand drivers
Why change is needed.

Industry capability needs
What capabilities industry needs to respond to these changes.

Innovation requirements
How capabilities must develop.

Priority industry capability needs
The most critical capability gaps identified through industry consultation that must be addressed first to deliver impact.

Joining engineering

The engineering process of integrating materials into complex structures using chemical, electrical, thermal or mechanical methods to reliably combine similar and dissimilar materials to enhance design freedom, enhance performance, improve sustainability and underpin automation, digital assurance and high-integrity advanced manufacturing.

Joining engineering is a core pillar of advanced manufacturing, enabling the creation of lighter, cleaner and high-integrity products across critical UK industries. Covering advanced welding, brazing, soldering, adhesive bonding and mechanical fastening, these capabilities support the manufacture of both very large structures and ultra-miniaturised components essential to modern life. As products become more complex and performance requirements intensify, next-generation joining is delivering higher quality, improved sustainability and greater production agility.

Why: Demand drivers

- Advanced design practices that improve sustainability and circularity
- Through-life assurance that leverages data-driven technologies
- Accessibility to skills – from technicians to engineers
- Process automation to boost productivity and reduce manufacturing costs
- Digitalisation technologies for predicting and optimising manufacturing processes.

What: Priority industry capability needs

- Capabilities for dissimilar materials and recycled materials
- Advanced design practices to support through-life and end-of-life disassembly and recycling
- Advanced automation integrating digital twins, modelling and in-situ monitoring to capture and control joining integrity in real time
- Robust certification, qualification and standardisation processes to support adoption of recycled materials and end-of-life product responsibility
- Standardised high-fidelity design models enabling a whole life cycle engineering ethos – sustainability, repair, maintenance repair and overhaul optimisation, and disassembly.

How: Priority innovation requirements

- Characterisation of joining performance in advanced, recycled and dissimilar materials
- Integrated in-process monitoring and inspection systems for enhanced manufacturing reliability and efficiency
- Integrated cost estimation, sustainability assessments and data governance for environmentally and economically sustainable joining practices
- Developing and validating advanced design and simulation techniques – including digital twins, predictive and life cycle assessment models
- High-fidelity data capture, simulation and AI-assisted validation leveraging large-scale digital twin models for optimisation of joining processes.

Key HVM Catapult capabilities in joining engineering

Adhesive formulation and bonding, CPI (Sedgefield)

Advanced adhesive formulation and bonding expertise, enabling tailored chemistries, scalable processing, rigorous testing and reliable performance for high-value manufacturing and industrial applications worldwide.

Automated and mechanised fusion welding, AMRC (Rotherham) and MTC (Coventry)

Automated and mechanised arc and power beam welding solutions, providing precision control, high productivity, consistent quality and scalable processes for advanced manufacturing and industrial applications.

Brazing and soldering, NCC (Bristol)

Advanced brazing and soldering for composites, delivering robust joining, enhanced thermal performance, precision processing and reliable, scalable solutions for high-performance manufacturing applications.

Hot isostatic bonding and hot plate bonding systems, AMRC (Rotherham)

Delivering precision joining, scalable processing, material integrity and reliable solutions for demanding industries worldwide.

Large and small-scale mechanical fasteners, WMG (Coventry)

Specialist equipment and expertise in precision large and small-scale mechanical fasteners, delivering reliable quality, tailored solutions, rapid turnaround and expert support for industrial, engineering and manufacturing applications worldwide.

Large-scale rotary and inertia friction welding, NMIS (Renfrew)

State-of-the-art capabilities, providing precision-engineered cells, process expertise, rapid deployment and reliable performance for demanding industrial manufacturing environments.

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Joining engineering

Further details of the **demand drivers**, **industrial capability needs** and **innovation requirements** are available online. Follow the QR code or click here.

Vision

HVM Catapult, alongside industry, academia and partner RTOs, will champion innovation in sustainable joining technologies to enable modular, repairable and recyclable structures through advanced design, digital integration and workforce upskilling to secure UK manufacturing global competitiveness.

Key

- **Demand drivers** — Why change is needed.
- **Industry capability needs** — What capabilities industry needs to respond to these changes.
- **Innovation requirements** — How capabilities must develop.
- **Priority industry capability needs** — The most critical capability gaps identified through industry consultation that must be addressed first to deliver impact.

2026

- Advanced design practices that improve sustainability and circularity
- Through-life assurance that leverages data-driven technologies
- Accessibility to skills – from technicians to engineers
- Process automation to boost productivity and reduce manufacturing costs
- Digitalisation technologies for predicting and optimising manufacturing processes

2030

- Capabilities for dissimilar materials and recycled materials
- Advanced design practices to support through-life and end-of-life disassembly and recycling
- Modular architecture and agile tooling
- Remote and portable robotic joining and inspecting systems in standard and specialised habitats
- Advanced automation integrating digital twins, modelling and in-situ monitoring to capture and control joining integrity in real time
- In-process monitoring and real-time assurance
- Develop AI as a strategic tool for optimisation
- Accelerating transfer of cross-sector joining technology
- High-fidelity data capture, simulation and AI-assisted validation, leveraging large-scale digital twin models for optimisation of joining processes
- Integrated in-process monitoring and inspection systems for enhanced manufacturing reliability and efficiency
- Creation of a central processing repository for dissimilar material joining and respective procedures to optimise performance
- Characterisation of joining performance in advanced, recycled and dissimilar materials
- Developing and validating advanced design and simulation techniques – including digital twins, predictive and life cycle assessment models
- Integrated cost estimation, sustainability assessments and data governance for environmentally and economically sustainable joining practices
- Technology-enhanced training and haptics
- Standardising and creating a data infrastructure for cross-sector interoperability
- Designing and proving of advanced consumables to facilitate joining dissimilar and recycled materials

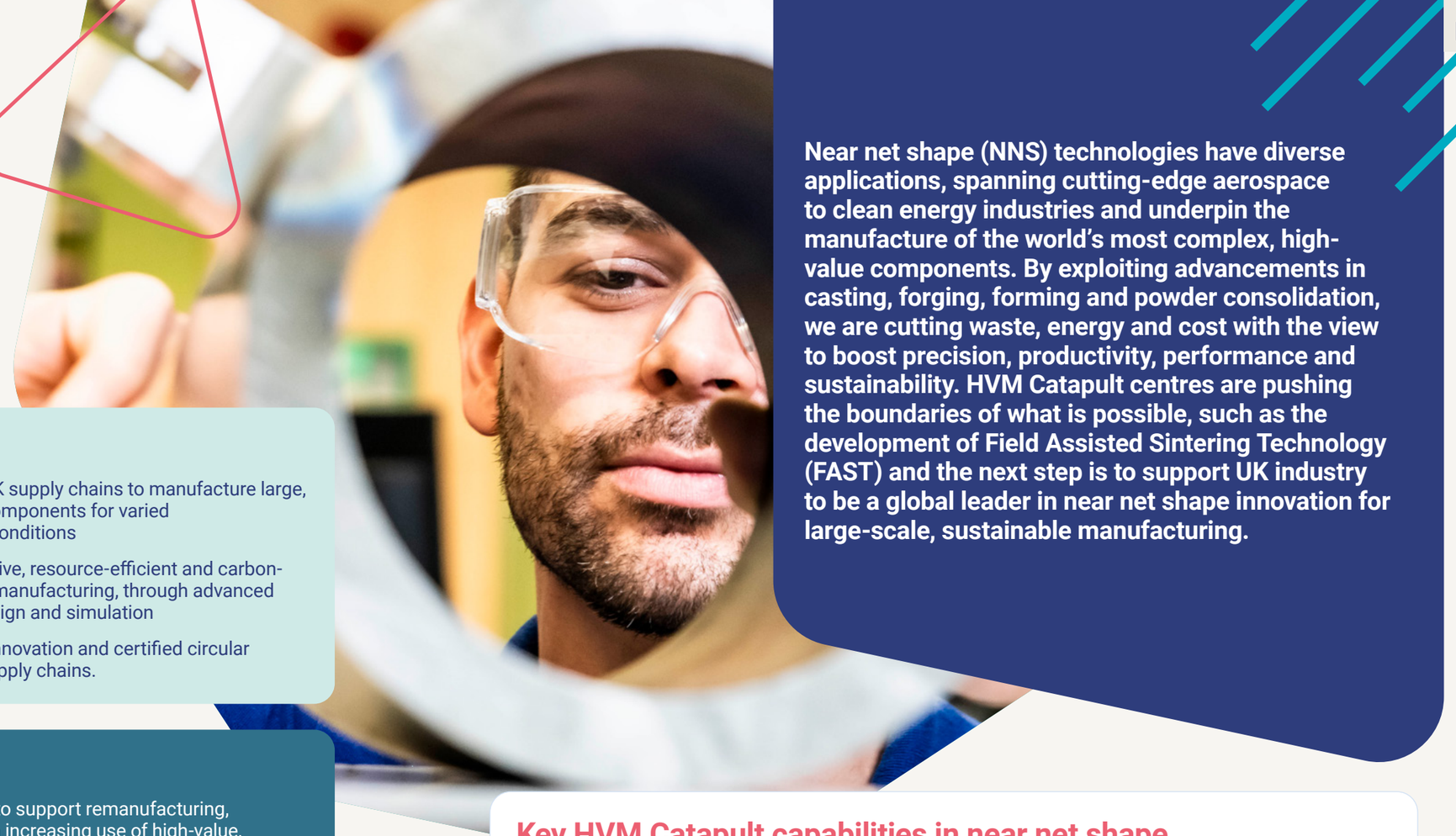
2035

- Standardised high-fidelity design models enabling a whole life cycle engineering ethos – sustainability, repair, maintenance repair and overhaul optimisation, and disassembly
- Robust certification, qualification and standardisation processes to support adoption of recycled materials and end-of-life product responsibility
- High-integrity joining and certification by analysis

2040

Near net shape

Forging, forming, casting and powder consolidation technologies that produce complex components close to final shape.



Near net shape (NNS) technologies have diverse applications, spanning cutting-edge aerospace to clean energy industries and underpin the manufacture of the world's most complex, high-value components. By exploiting advancements in casting, forging, forming and powder consolidation, we are cutting waste, energy and cost with the view to boost precision, productivity, performance and sustainability. HVM Catapult centres are pushing the boundaries of what is possible, such as the development of Field Assisted Sintering Technology (FAST) and the next step is to support UK industry to be a global leader in near net shape innovation for large-scale, sustainable manufacturing.

Why: Demand drivers

- Standardised, sustainable manufacturing and materials circularity practices by minimising waste, maximising upcycling and enabling re-use
- Increased capacity for large-scale advanced manufacturing for aerospace, nuclear, offshore and hydrogen sectors
- Resilient UK supply chains to manufacture large, complex components for varied operating conditions
- Cost-effective, resource-efficient and carbon-optimised manufacturing, through advanced tooling, design and simulation
- Materials innovation and certified circular material supply chains.

What: Priority industry capability needs

- Viable methods to reconstitute critical metals into high-quality, complex components, using higher recycled content, high-strength and longer-in-use materials
- Improved process control and assurance through intelligent monitoring, metrology, self-calibrating tooling and AI-enabled interoperability
- Accelerated at-scale process development, optimisation and qualification through advanced process modelling and digitalisation
- Standards to support remanufacturing, enabling an increasing use of high-value, recycled materials
- Low-carbon feedstocks, electrified heating systems, energy-efficient tooling and precise digital process controls to reduce emissions and material waste.

How: Priority innovation requirements

- Hydrogen and electric furnaces to enable cleaner thermal processing by replacing fossil fuel-based heating in high-temperature operations
- Advanced, localised heating technologies to improve energy efficiency and precision in forming, forging and casting processes
- Integrated modelling, digital twins and system architecture to support real-time process optimisation and predictive control across manufacturing stages
- Scaled-up testing and prototyping capabilities to accelerate the validation of sustainable manufacturing technologies and complex component designs
- Increased automation and digitalisation to enhance production efficiency, consistency and data-driven decision making.

Key HVM Catapult capabilities in near net shape

Advanced Forming Research Centre, NMIS (Renfrew)

Advanced forming and forging capabilities, including superplastic forming and flow forming and friction welding, plus Europe's largest digital hot-forging platform with FutureForge, real-time data and robotic automation.

Design and encapsulation for hot isostatic pressing, MTC (Coventry)

The UK's largest R&D powder hot isostatic pressing encapsulation line, delivering world-leading canister fabrication, powder filling, vibration, evacuation and sealing for large, near net shape components.

Powder metallurgy hot isostatic pressing, AMRC (Rotherham)

Advanced powder metallurgy and hot isostatic pressing capabilities, enabling near net shape components with superior density and performance, supported by integrated process modelling, real-time monitoring and fully automated handling for high-integrity applications.

AMRC Castings, AMRC (Rotherham)

Unique ferrous and non-ferrous casting capabilities, including Europe's largest titanium capacity, with in-house pattern and mould manufacture, serving unavailable applications while developing low-carbon casting processes.

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Near net shape

Further details of the **demand drivers**, **industrial capability needs** and **innovation requirements** are available online. Follow the QR code or click here.

Vision

Leading innovation for near net shape technologies and strategies by pioneering new techniques, reducing waste, digitalisation and enabling sustainable, large-scale manufacturing across the UK's high-growth sectors.

Key

Demand drivers
Why change is needed.

Industry capability needs
What capabilities industry needs to respond to these changes.

Innovation requirements
How capabilities must develop.

Priority industry capability needs
The most critical capability gaps identified through industry consultation that must be addressed first to deliver impact.

2026

- Standardised, sustainable manufacturing and materials circularity practices by minimising waste, maximising upcycling and enabling re-use
- Materials innovation and certified circular material supply chains
- Resilient UK manufacturing supply chains to manufacture large, complex components for varied operating conditions
- Increased capacity for large-scale advanced manufacturing for aerospace, nuclear, offshore and hydrogen sectors
- Cost-effective, resource-efficient and carbon optimised manufacturing, through advanced tooling, design and simulation

2030

- Innovative end-of-life strategies, optimised material usage through simulation, and design for sorting and remanufacture
- Build UK supply chain intelligence, material datasets and demand forecasts aligned to high-performance applications
- Recycled content for hybrid and sustainable forming processes
- Expand UK strategic capability in incremental forming
- Create national materials database, digital passports, smart testing facilities and demand mapping for circular manufacturing
- Hydrogen and electric furnaces to enable cleaner thermal processing by replacing fossil fuel-based heating in high-temperature operations

2035

- Viable methods to reconstitute critical metals into high-quality, complex components, using higher recycled content, high-strength and longer-in-use materials
- Efficient heating for hybrid and sustainable forming processes
- Improved process control and assurance through intelligent monitoring, metrology, self-calibrating tooling and AI-enabled interoperability
- Accelerated at-scale process development, optimisation and qualification through advanced process modelling and digitalisation
- Advanced, localised heating technologies to improve energy efficiency and precision in forming, forging and casting processes
- Integrated modelling, digital twins and system architecture to support real-time process optimisation and predictive control across manufacturing stages
- Scaled-up testing and prototyping capabilities to accelerate the validation of sustainable manufacturing technologies and complex component designs

2040

- Low-carbon feedstocks, decarbonised heating systems, energy-efficient tooling and precise digital process controls to reduce emissions and material waste
- Standards to support remanufacturing, enabling an increasing use of high-value, recycled materials
- Combine additive, casting and forming technologies with hybrid tooling to create tailored composite structures and components
- Increased automation and digitalisation to enhance production efficiency, consistency and data-driven decision-making
- Partner with powder suppliers and universities to develop and qualify materials for extreme environments and formability
- Embed modularisation, DFX and dismantling principles into design/data standards and materials processing knowledge base

Subtractive manufacturing

Achieving net-shape geometry through controlled material removal, delivering the strict dimensional precision and surface integrity required for high-performance applications.

Subtractive manufacturing strategies underpin the creation of the UK's most critical, high-integrity infrastructure. By exploiting advancements in autonomous machining, adaptive process control and digital twins, we are cutting waste and energy use to boost precision, productivity and UK capability. These rigid, high-accuracy technologies have diverse applications, spanning from nuclear energy to complex defence systems. The High Value Manufacturing Catapult is pushing the boundaries of what is possible – transforming legacy mechanics into a data-driven science.

Why: Demand drivers

- Addressing the digital deficit in manufacturing process optimisation
- Mitigating supply chain fragility and securing strategic investment
- Overcoming barriers in advanced material development and qualification
- Transitioning to sustainable and circular subtractive manufacturing models
- Scaling industrial infrastructure to support national energy systems.

What: Priority industry capability needs

- Disruptive and non-traditional material removal processes for challenging environments
- Data-centric subtractive frameworks and digital passports for life cycle transparency
- Integration of sustainable principles for circular economy within subtractive manufacturing operations
- Deployment of reconfigurable subtractive systems within connected and responsive future supply chains
- Capability for design for subtractive manufacture, repair and component re-use
- Harmonisation of physical autonomy with human-in-the-loop for robust subtractive operations.

How: Priority innovation requirements

- Establishing a centralised national database to validate properties and accelerate new material introduction
- Developing AI-driven tools to assess manufacturability and verify processes via high-fidelity digital thread simulations
- Engineering technologies to capture, separate and reprocess waste for circular resource recovery
- Prototyping scalable hybrid systems and reconfigurable robotics for large-envelope in-situ machining operations
- Implementing standard data protocols to enable fully optimised and resilient supply chains
- Fostering collaborative innovation ecosystems and upskilling the workforce for human-centric manufacturing.

Key HVM Catapult capabilities in subtractive manufacturing

Flagship subtractive manufacturing capability, AMRC (Rotherham)

Factory of the future has world leading equipment and expertise covering a wide breadth of subtractive processes enabling technology development and routes to implementation across a number of high-value manufacturing sectors. Working across all material systems and conditions of supply from established production routes through to emerging near net shape and additively manufactured approaches. Established foundational experience in subtractive manufacturing science and engineering with a pull through across technology readiness levels.

Large-scale subtractive manufacturing capabilities, AMRC (Rotherham)

Future Energy Factory leverages world-class equipment at scale with the engineering expertise to process oversized, high-value components with precision – optimising complex operations and reducing cost and lead-times.

National Manufacturing Institute Scotland (NMIS), (Renfrew)

Precision subtractive manufacturing of composite materials, addressing tool wear, delamination and process optimisation to support high-rate production for aerospace, energy and transport sectors. Integrated additive and subtractive manufacturing workflows, enabling complex geometries, material efficiency, repair solutions and flexible production.

Laser processing centre of excellence, MTC (Coventry)

The UK's most comprehensive laser subtractive manufacturing and surface engineering capability, enabling cutting, texturing and cleaning applications, scaling applications from laboratory development to industrial deployment.

Connect with us

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Subtractive manufacturing

Further details of the **demand drivers**, **industrial capability needs** and **innovation requirements** are available online. Follow the QR code or click here.

Vision

Leading innovation for subtractive manufacturing processes and technologies by pioneering autonomous precision,digitalisation and circularity, enabling resilient, high-integrity production across the UK's critical supply chains.

2026 | 2030 | 2035 | 2040

Addressing the digital deficit in manufacturing process optimisation

Development of educational frameworks for next-generation subtractive manufacturing engineers and machinists

Data-centric subtractive frameworks and digital passports for life cycle transparency

Harmonisation of physical autonomy with human-in-the-loop for robust subtractive operations

Embedding sustainable subtractive principles and energy efficient machine tools for circular operations

Mitigating supply chain fragility and securing strategic investment

Deployment of reconfigurable subtractive systems within connected and responsive future supply chains

Realisation of zero-defect subtractive processes and precision finishing of complex near net shape routes

Advanced subtractive processing capabilities for next-generation materials and future complex components

Capability for design for subtractive manufacture, repair and component re-use

Implementation of digital autonomy and digital twins for intelligent process planning

Overcoming barriers in advanced material development and qualification

Disruptive and non-traditional material removal processes for challenging environments

Deploying embedded 3D metrology and sensors to drive real-time adaptive control for zero-defect production

Implementing standard data protocols to enable secure sharing and performance benchmarking across supply chains

Defining robust subtractive strategies and tooling parameters for novel alloys and difficult-to-process materials

Establishing a centralised national database to validate properties and accelerate new material introduction

Transitioning to sustainable and circular subtractive manufacturing models

Developing AI-driven tools to assess manufacturability and verify processes via high-fidelity digital thread simulations

Designing application-oriented training programmes to upskill the workforce in human-centric automation and digital skills

Creating modelling toolkits that prioritise energy efficiency and carbon reduction in process parameter selection

Prototyping scalable hybrid systems and reconfigurable robotics for large-envelope in-situ machining operations

Formalising partnerships between research centres and industry to facilitate knowledge exchange and de-risk R&D

Scaling industrial infrastructure to support national energy systems

Engineering technologies to capture, separate and reprocess waste for circular resource recovery

Key

Demand drivers
Why change is needed.

Industry capability needs
What capabilities industry needs to respond to these changes.

Innovation requirements
How capabilities must develop.

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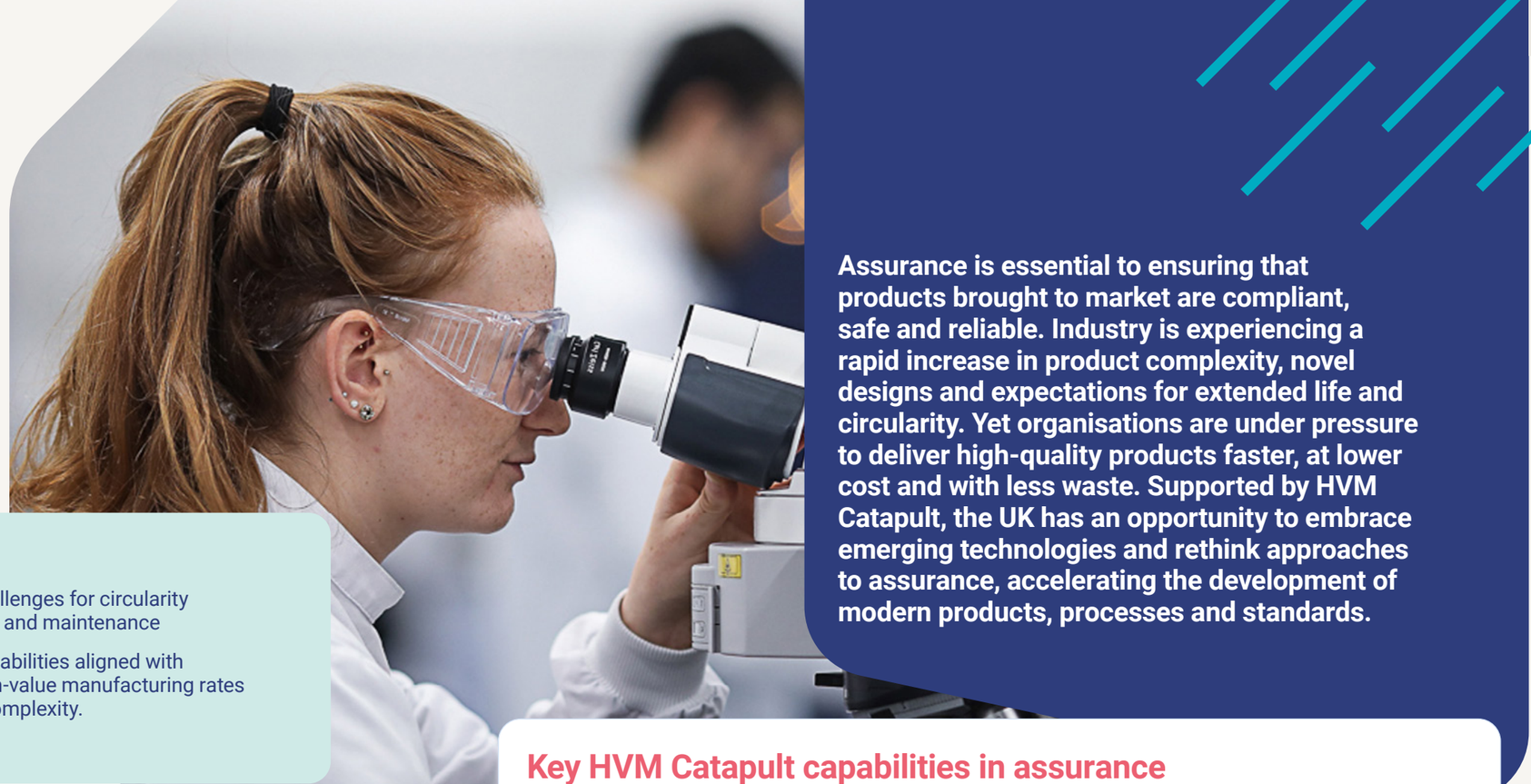
Assurance

Processes, practices and technologies used to provide confidence that new and existing manufactured products or systems will meet design requirements, standards, regulations and codes through inspection, measurement and test.



Assurance is essential to ensuring that products brought to market are compliant, safe and reliable. Industry is experiencing a rapid increase in product complexity, novel designs and expectations for extended life and circularity. Yet organisations are under pressure to deliver high-quality products faster, at lower cost and with less waste. Supported by HVM Catapult, the UK has an opportunity to embrace emerging technologies and rethink approaches to assurance, accelerating the development of modern products, processes and standards.

Why: Demand drivers

- Assurance barriers to adoption of advanced and flexible manufacturing technologies
- Integrated digital manufacturing and assurance data traceability
- Advancing assurance certification and regulatory pathways
- Assurance challenges for circularity remanufacture and maintenance
- Assurance capabilities aligned with increasing high-value manufacturing rates and product complexity.

What: Priority industry capability needs

- Accepted methods and frameworks to ensure single source of truth for assurance data
- Encourage adoption of secure digital sharing of assurance data among supply chains
- Acceptance of in-process practices as definitive and credible sources of inspection and measurement
- Advanced use of data and simulation across quality and certification activities
- Simplified approaches, software and AI to address assurance challenges.

How: Priority innovation requirements

- Cost/benefit/risk analysis framework for investment in inspection, measurement and test activity
- Automating credible digital traceability of quality and certification data
- AI developed towards accelerated certification pathways, automated decision making, inspection, measurement and test
- Process certification by analysis, reducing physical testing through analysis and in-process techniques
- Assurance for maintenance, repair and overhaul/remanufacture, repurpose, reuse and recycle.

Key HVM Catapult capabilities in assurance

Infrastructure NDT, MTC (Coventry)

Using advanced vehicle mounted ground penetrating radar paired with commercial software and bespoke analysis to provide visualisation and insight into bridge structures and potential defects without the need for a full conventional intrusive bridge deck examination.

National research facility for lab-based XCT, WMG (Coventry)

Advancing scanning technologies, such as high-resolution laser scanning and microfocus CT, to enable 3D characterisation of internal and external structures in support of a wide range of small to large-scale applications.

Automated inspection, Validation and NDT, NCC (Bristol)

As demonstrated in the Airbus Wing of Tomorrow programme. Provides advanced automated inspection solutions, including robotic ultrasonic testing and in-process monitoring, to ensure quality assurance and certification readiness for composite and hybrid structures.

Automated in-process monitoring, AMRC (Sheffield)

Advanced in-process monitoring capabilities to enable autonomous systems, focusing on: non-intrusive sensors, high-speed connectivity, computational intelligence, process certification and real-time adaptive control.

Product process regulatory compliance, CPI (Renfrew, Darlington, Sedgefield, Wilton)

Expertise in compliance across GMP, ISO13485 and FSSC 22000 (pharmaceutical, medical device and food/feed), including critical quality attribute (CQA) and critical process parameter (CPP) development and analysis.

Residual stress measurement and strain mapping, NMIS (Renfrew)

Advanced residual stress measurement and strain mapping capabilities using diffraction-based techniques, mechanical methods and digital image correlation to evaluate forming processes, validate simulations and optimise structural performance and component integrity.

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Assurance

Further details of the **demand drivers**, **industrial capability needs** and **innovation requirements** are available online. Follow the QR code or click here.

Vision

Secure the UK as a competitive provider of safe, reliable high-value manufactured products by championing best practice and redefining traditional approaches to measurement, inspection, testing and certification. Ensure assurance is recognised as a strategic value-add activity.

Key

- **Demand drivers** — Why change is needed.
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2026

- Barriers to adoption of advanced and flexible manufacturing technologies
- Integrated digital manufacturing and assurance data traceability
- Advancing assurance certification and regulatory pathways
- Challenges for circularity remanufacture and maintenance
- Assurance capabilities aligned with increasing high-value manufacturing rates and product complexity

2030

- Establish test beds to develop, integrate and validate novel inspection, measurement and test techniques and processes
- Developed best practice for sharing and cyber security of certification and quality data
- Adoption of developed new product and process assurance standards
- Integrated frameworks and maturity grids for assessment and adoption of assurance processes
- Demonstration of data driven quality/fault prognosis, decision making and control
- Establish test facilities supporting the testing of emerging products and applications
- Coordinated sectorial collaboration to engage regulators and drive regulatory advancement and development of new standards
- Cross-sector transferable inspection, measurement and certification best practice
- Acceptance of in-process practices as definitive and credible sources of inspection and measurement
- Assurance skills pathways for technicians and certified professionals across all inspection, measurement and test activities
- Demonstrated integration of assurance requirements within MBD models
- Cost/benefit/risk analysis framework for investment in inspection, measurement and test activity

2035

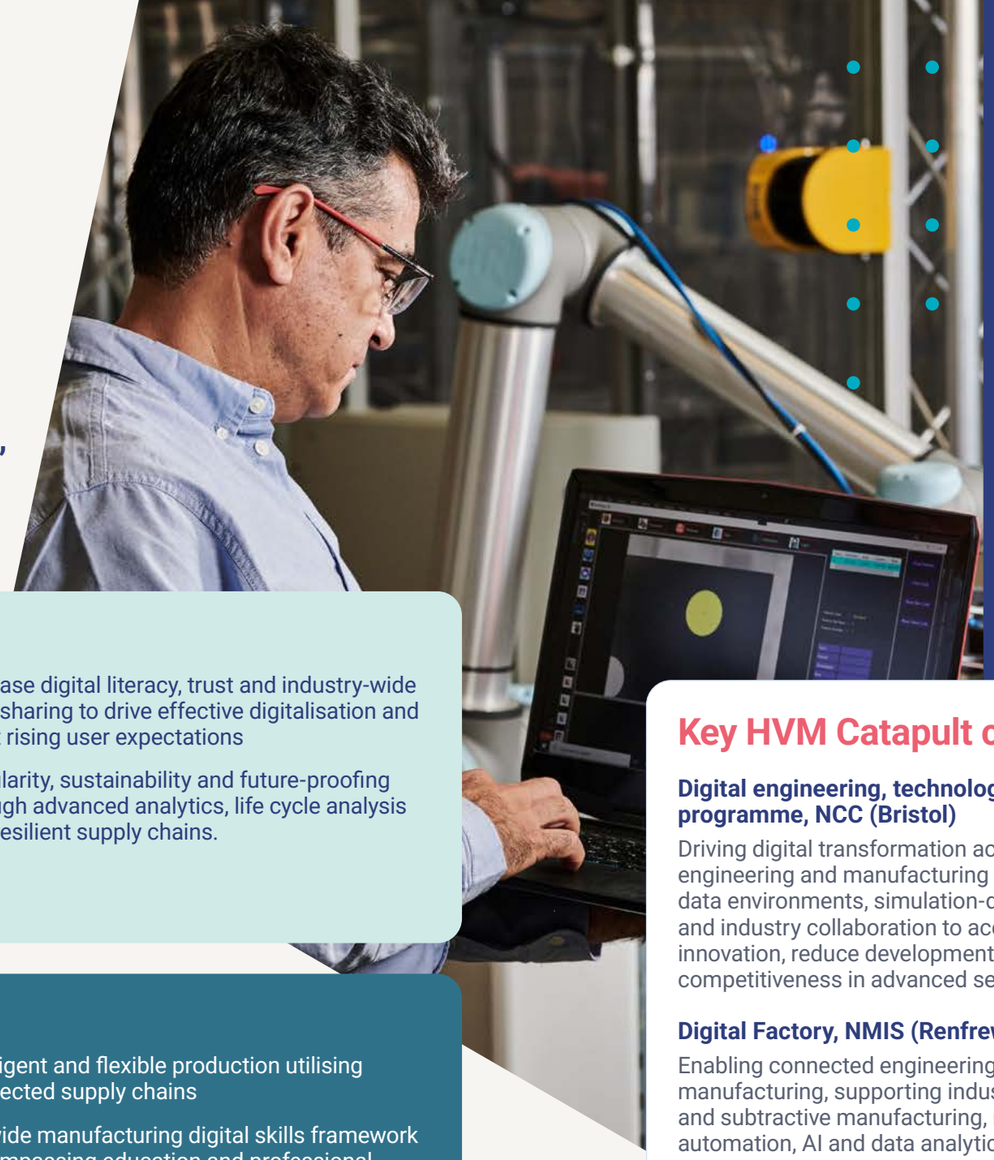
- Accepted methods and frameworks to ensure single source of truth for assurance data
- Advanced use of data and simulation across quality and certification activities
- Simplified approaches, software and AI to address assurance challenges
- Develop adaptive and dynamic inspection planning based on results and in-process measurement
- Demonstrate credible consistency in detection of vision recognition systems

2040

- Encourage adoption of secure digital sharing of assurance data among supply chains
- Process certification by analysis, reducing physical testing through analysis and in-process techniques
- Develop DoE programme to validate accuracy of in-process detection methods
- Demonstrated secure external access and sharing of assurance data across external supply chain partners
- Automating credible digital traceability of quality and certification data
- Establish secure comms traceable assurance data throughout the full model-based engineering (MBE) workflow
- AI developed towards accelerated certification pathways, automated decision making, inspection, measurement and test
- Assurance for maintenance, repair and overhaul/remanufacture, repurpose, reuse and recycle

Digital manufacturing

The application and development of connected data, automation, digital twins and cyber-physical systems to plan, control and optimise production processes, improving efficiency, quality, agility and real-time operational performance within factories and supply chains.



HVM Catapult's digital manufacturing vision and roadmaps chart a path to a connected, data-driven ecosystem where interoperability, AI and digital twins drive agility, resilience and sustainability. Our centres are already delivering collaborative, human-centric solutions, from federated factories to digital threads, that empower the workforce and accelerate innovation. Our ambition is to make the UK the global benchmark for high-value, digitally enabled manufacturing.

Why: Demand drivers

- Advanced, data-driven and digitalised manufacturing to improve productivity and competitiveness
- Address knowledge capture and retention challenges through digital technologies
- Robust data governance and management frameworks ensure secure, decentralised and effective use of manufacturing data
- Increase digital literacy, trust and industry-wide data sharing to drive effective digitalisation and meet rising user expectations
- Circularity, sustainability and future-proofing through advanced analytics, life cycle analysis and resilient supply chains.

What: Priority industry capability needs

- Agile, connected manufacturing through interoperable reference architectures, digital threads and distributed supply chains
- Integrated process optimisation linking automation, digital twins and connected enterprise systems
- AI insights that are trustworthy, validated, ethical and transparent
- Intelligent and flexible production utilising connected supply chains
- UK-wide manufacturing digital skills framework encompassing education and professional development
- Manufacturing scalability of quantum technologies, i.e. sensing, computing, timing and cryptography.

How: Priority innovation requirements

- Development of ontologies, interoperable frameworks, digital passports and collaborative platforms to establish robust data and knowledge management
- AI-integrated modelling, simulation and process control using statistical, machine learning and advanced analytics methods for manufacturing effectiveness and validation
- Implement and demonstrate validated end-to-end data-sharing platforms, visualisation and digital passports within a governance framework to ensure consistent data models and interoperability
- Demonstrators for interoperable, cyber-secure and governed data management and sharing platforms advocating industry standards.

Key HVM Catapult capabilities in digital manufacturing

Digital engineering, technology and innovation programme, NCC (Bristol)

Driving digital transformation across design, engineering and manufacturing with connected data environments, simulation-driven workflows and industry collaboration to accelerate innovation, reduce development time and enhance competitiveness in advanced sectors.

Digital manufacturing accelerator, MTC (Liverpool)

Advancing intelligent production through industrial digitalisation, robotics and automation, data-driven optimisation and cyber-physical systems to enhance productivity, resilience and high-value manufacturing capability across regional and national supply chains.

Digital Factory, NMIS (Renfrew)

Enabling connected engineering and manufacturing, supporting industry with additive and subtractive manufacturing, robotics, automation, AI and data analytics to boost productivity, sustainability and innovation.

Factory 2050, AMRC (Sheffield)

Delivers advanced automated assembly, large-volume metrology and digitally assisted assembly using VR, AR and manufacturing intelligence for complex, low-volume, high-value components.

Digital factory hub, AMRC Cymru (Broughton)

Empowering high-value manufacturing through integrated digital infrastructure, cyber-physical systems, real-time data analytics and automation to accelerate smart production, workforce upskilling and industrial adoption across advanced sectors.

Digital manufacturing test bench, WMG (Coventry)

With human-in-the-loop tool development for tool and operator tracking, enhanced by AR/VR. Advanced factory and process planning and optimisation enabled through 3D modelling and scalable visualisation, with the integration of discrete event simulation and digital twin technologies, supported by the use of structured data for AI across the automation life cycle, alongside vendor-agnostic control code generation.

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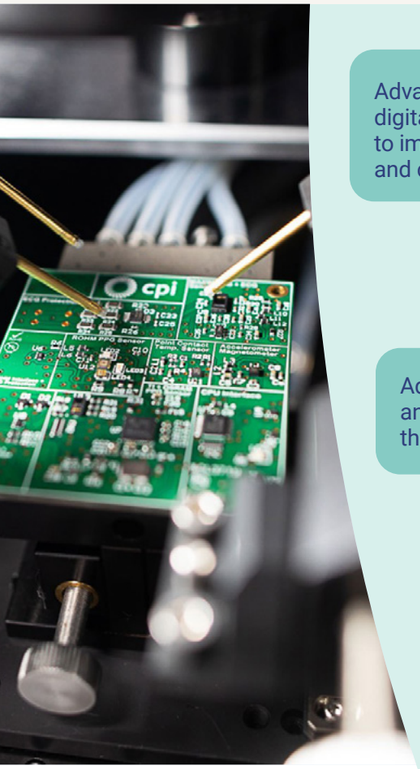
Digital manufacturing

Further details of the **demand drivers**, **industrial capability needs** and **innovation requirements** are available online. Follow the QR code or click here.

Vision

By driving widespread adoption of digital manufacturing across UK industry, we can unlock transformative gains in productivity, efficiency and global competitiveness. These advancements will not only strengthen supply chains and sustainability but also create high-quality jobs, elevate skills and deliver long-term prosperity for the nation.



Key

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Why change is needed.

Industry capability needs
What capabilities industry needs to respond to these changes.

Innovation requirements
How capabilities must develop.

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2026

- Advanced, data-driven and digitalised manufacturing to improve productivity and competitiveness
- Address knowledge capture and retention challenges through digital technologies
- Robust data governance and management frameworks ensure secure, decentralised and effective use of manufacturing data
- Increase digital literacy, trust and industry-wide data sharing to drive effective digitalisation and meet rising user expectations
- Circularity, sustainability and future-proofing through advanced analytics, life cycle analysis and resilient supply chains

2030

- Advanced simulation for manufacturing optimisation, uncertainty quantification and process qualification to reduce costly trials and accelerate innovation
- Intelligent and flexible production utilising connected supply chains
- Unified digital demonstrators, automation, sensors and robotics for efficient, traceable and sustainable manufacturing adoption
- Digital platforms for knowledge capture, traceability and skills frameworks supporting assurance and lifelong engineering development
- Sustainable design and digitalisation to minimise waste and maximise resource recovery
- Demonstrate operational cyber security monitoring and resilience of digitally connected assets
- Development of ontologies, interoperable frameworks, digital passports and collaborative platforms to establish robust data and knowledge management
- Manufacturing scalability of quantum technologies, i.e. sensing, computing, timing and cryptography
- Validated AI models enabling optimisation, transparency and advanced analytics for manufacturing
- AI-integrated modelling, simulation and process control using statistical, machine learning and advanced analytics methods for manufacturing effectiveness and validation
- Demonstrators for interoperable, cyber-secure and governed data management and sharing platforms advocating industry standards
- AI-powered personalisation, generative models and automation for enhanced manufacturing efficiency and learning

2035

- Integrated process optimisation linking automation, digital twins and connected enterprise systems
- AI insights that are trustworthy, validated, ethical and transparent
- UK-wide manufacturing digital skills framework encompassing education and professional development
- Agile, connected manufacturing through interoperable reference architectures, digital threads and distributed supply chains
- Autonomous and remotely operated systems to support predictive maintenance and real-time monitoring for extending component life

2040

Robotics and automation

The use of robotics, machines and control systems to perform previously manual tasks, improving productivity, quality and safety.

The future competitiveness of UK manufacturing will be shaped by the targeted deployment of robotics and automation to raise productivity and enable rapid scale-up of manufacturing capability. Scalable, flexible and reconfigurable automation will support high-rate assembly in high-mix, low-volume production, reducing unit costs and accelerating industrialisation. Automation will also underpin recovery, repair and remanufacture of critical components, extending high-value assets life. Robotics-enabled virtualisation and advanced design methods will improve resource efficiency, strengthening manufacturing performance and operational resilience.

Why: Demand drivers

- Automation enhancing manufacturing productivity and scale-up
- Mass customisation manufacturing through scalable, flexible and reconfigurable automation solutions
- Assembly / disassembly of high-mix, low-volume products and recovery or remanufacture of critical components and materials
- Maximise the value from the compliant use of data, digital threads and digital product passports
- Resource and energy efficient manufacturing through advanced design, virtualisation and innovative materials.

What: Priority industry capability needs

- Agile, intelligent, AI-powered automation systems, including autonomous systems supported by humanoid robotics for variable, customisable, reconfigurable and flexible production, with integrated quality control and safe operation in human-centric manufacturing environments
- Data-driven manufacturing using digital twins, real-time verification and cloud platforms for smart decision making
- User-friendly, plug-and-play systems with AI-enabled robotics to lower adoption barriers
- Targeted training programmes that upskill workers to operate, maintain and optimise advanced robotic automation technologies effectively
- Robotics systems capable of learning and adjusting operations autonomously in response to changing production conditions.

How: Priority innovation requirements

- Modular digital platforms for data, AI, digital twins and design components
- Sensor-integrated automation for process control, defect detection and quality
- AI embedded in robot controller systems for faster processors, smart network of sensors and application-driven sensing response
- Flexible automation, mobile robots and dexterous grippers
- Develop AI-enabled embodied autonomy for advanced manufacturing to enable autonomous and humanoid robotic systems to operate reliably in dynamic production environments.

Key HVM Catapult capabilities in robotics and automation

Advanced autonomous systems, AMRC (Sheffield)

Delivers deployment-ready autonomous and robotic platforms capable of high-precision operation at full industrial scale and production rates, integrating advanced sensing, AI-driven control and real-time data feedback to ensure repeatability, productivity and quality assurance.

Automation and robotics accelerator programme, MTC (Coventry)

Supports SMEs and industry with rapid feasibility studies, system design, simulation and pilot-scale demonstration to accelerate the adoption of robotics and automation technologies with reduced technical and financial risk.

Digital factory hub, HVM Catapult Baglan (Port Talbot)

Showcases digitally connected automation, smart production lines and cyber-physical systems, enabling manufacturers to trial Industry 4.0 technologies and develop integrated, data-driven factory solutions.

Digital Process Manufacturing Centre (DPMC), NMIS and CPI, Renfrew

Delivers digitally enabled automation solutions integrating robotics, advanced process control, data platforms and virtual commissioning to optimise complex manufacturing workflows and support scalable, flexible production.

Innovate UK robotics proving ground, MTC, (Coventry)

Provides industrial-scale validation of robotic and autonomous systems in representative environments, enabling de-risked deployment, performance benchmarking, interoperability testing and accelerated commercial adoption across manufacturing sectors.

High-rate manufacturing testbeds, NCC (Bristol)

Open-access facility for industry to test, iterate and validate automated, high-rate processes for fundamental and novel materials manufacturing. Supporting digital infrastructure and IoT platform integrates adaptive manufacturing and verification technologies.

Digital automation lab, WMG (Coventry)

Supporting future factory development through advanced robotics and automation research, including tetrapod systems, AI-driven robotics, and sensing and perception solution development, while de-risking deployment via proof-of-concept laboratory build and testing. Also facilitating skills development through PLC and automation training suitcases, enabling practical engagement with industrial control systems.

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Robotics and automation

Further details of the **demand drivers**, **industrial capability needs** and **innovation requirements** are available online. Follow the QR code or click here.

Vision

Agile, intelligent, AI-powered automation systems, including autonomous systems supported by humanoid robotics for variable, customisable, reconfigurable and flexible production, with integrated quality control and safe operation in human-centric manufacturing environments.

Key

Demand drivers
Why change is needed.

Industry capability needs
What capabilities industry needs to respond to these changes.

Innovation requirements
How capabilities must develop.

Priority industry capability needs
The most critical capability gaps identified through industry consultation that must be addressed first to deliver impact.

2026

- Maximise the value from the compliant use of data, digital threads and digital product passports
- Automation enhancing manufacturing productivity and scale-up
- Assembly / disassembly of high-mix, low-volume products and recovery or remanufacture of critical components and materials
- Resource and energy efficient manufacturing through advanced design, virtualisation and innovative materials
- Mass customisation manufacturing through scalable, flexible and reconfigurable automation solutions

2030

- Safe, adaptive human-robot work environments where cobots assist operators, boosting productivity and flexibility on the shop floor
- Agile, intelligent, AI-powered automation systems for diverse and custom production with integrated quality control
- Data-driven manufacturing using digital twins, real-time verification and cloud platforms for smart decision making
- User-friendly, plug-and-play systems with AI-enabled robotics to lower adoption barriers
- Intelligent and adaptable automation and robotics solutions for sorting, segregation, disassembly and remanufacturing
- Widespread adoption of automation, with responsive UK-based supply chain with global recognition
- Sensor-integrated automation for process control, defect detection and quality
- Targeted training programmes that upskill workers to operate, maintain and optimise advanced robotic automation technologies effectively
- Robotic systems capable of independent decision making, adapting dynamically to complex manufacturing environments without human intervention
- Accessible training and low-code tools for automation adoption and development

2035

- AI embedded in robot controller systems for faster processors, smart network of sensors and application-driven sensing response
- A capable, UK-based automation supply chain
- Modular, adaptable robotic hardware platforms that can be rapidly reconfigured to suit changing production requirements
- Innovative financial and operational frameworks to support sustainable investment and scaling of robotic automation technologies
- Develop AI-enabled embodied autonomy for advanced manufacturing to enable autonomous and humanoid robotic systems to operate reliably in dynamic production environments
- Intuitive, accessible human-machine interfaces that simplify robot programming, monitoring and interaction for diverse users
- Physical process optimised by product performance through life via data
- Flexible automation, mobile robots and dexterous grippers
- AI algorithms to assist operators and robots with predictive maintenance, quality control, and process optimisation
- Modular digital platforms for data, AI, digital twins and design components

2040

Next steps

Technology capability roadmaps being developed in 2026

Advanced materials

Engineered substances with enhanced, novel properties that outperform traditional materials in strength, conductivity or durability. Developed through advanced manufacturing and nanotechnology, they are critical for high-tech applications in industries like aerospace, healthcare, energy and electronics.

Resilient supply chains rely on having the right advanced materials for their products and processes. If we can anchor these in the UK, then we can drive sustainable and scalable industrial transformation.

Strategic focus area: Advanced materials are central to economic growth, resilience and sustainability for UK manufacturing

Credible intelligence: Supporting UK Government with focused knowledge and expertise in advanced manufacturing across multiple stages of the materials value chain

Commercialisation and scaling: Bridging the gap from lab to industrial scale to capture intellectual property and economic value

Focus on process efficiency: Utilising materials to enhance industrial energy efficiency, reduce resource waste and promote circularity and value retention.

Capability highlight: National Formulation Centre, CPI (Wilton and Sedgefield)

A state-of-the-art facility helping companies to commercialise their next-generation formulated products. Specialising in the chemistry, formulation and scale of precursors, including polymerisation processes, advanced resin formulation, and the development and application of sizing agents.

Digital engineering

Leveraging digital technologies to evolve and transform traditional engineering practices to enhance the structure and management of product development and operational lifecycles. Focusing on model-based and data-driven approaches to integrating design, simulation, verification and life cycle management to connect disciplines, enable traceability and optimise decision making across the entire product and system value chain.

As system complexity increases and technologies evolve rapidly, digitalisation is reshaping what effective engineering design requires. Embracing these tools enables faster innovation, strengthens UK supply chains, boosts competitiveness and supports a highly skilled workforce.

Collaboration and coordination: Model-based engineering, digital design tools, simulation, verification, and lifecycle management

De-risking industrial innovation: Accelerating adoption of digital engineering practices to shorten development cycles, reduce risk and support efficient industrial scale-up

Circularity and supply chain resilience: Applying digital methods to improve resource efficiency, optimise system performance, reduce waste and enable more sustainable end-to-end life cycle management.

Capability highlight: Isambard-AI, NCC (Bristol)

Built by the University of Bristol and hosted by NCC, Isambard-AI is the UK's fastest and most powerful AI supercomputer. It facilitates research into using AI and machine learning for accelerated design, simulation, and optimisation for materials and manufacturing.

An evolving strategic asset

Publication of our technology strategy is an important milestone, not the end point.

We publish the technology capability roadmaps acknowledging that they are a moment in time.

As we implement the technology strategy, we will continue to collaborate and consult with our partners so that it becomes an evolving strategic asset, subject to periodic review, that continuously clarifies our priorities as a network of innovation centres.

The strategy is the beginning of a long-term, system-level partnership, alongside our work supporting supply chains and foresighting future skills needs, in partnerships with Innovate UK, research councils, academia, industry and government.

Your continued feedback and engagement is essential as we help deliver the ambition of the modern industrial strategy.

CATAPULT
High Value Manufacturing

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