

High Value Manufacturing Catapult

An overview





The HVM Catapult is the catalyst
for the future growth and success
of manufacturing in the UK.

We help accelerate new
concepts to commercial reality
and thereby create a sustainable
high value manufacturing future
for this country.

Our ultimate aim is to significantly grow
the contribution of the manufacturing
sector to the UK economy.

Bridging the gap to commercial success

The UK has a track record of generating good ideas and innovations. Too often however, we do not turn such inventions into commercial products in the UK, thus allowing others to make the economic gain from our inventions.

The journey of a good idea into a saleable product is illustrated below, using the **Technology Readiness Scale**.

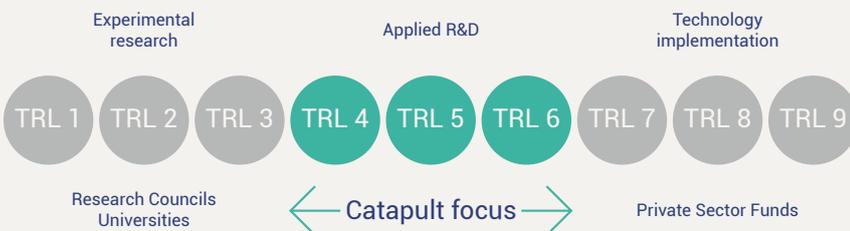
Level 1-3 is the stage from idea to functioning prototype, often taking place in a research institution, university or laboratory.

Level 4-6 is the translational space – moving the prototype to proof of commercial viability. This is where HVM Catapult operates.

The translational activity is the risky, expensive stage, often involving significant investments in equipment and people, without any guarantee of success. It is estimated that 80% of innovations fail in this so-called Valley of Death.

By working with HVM Catapult, our customers reduce that risk significantly because they have access to the facilities and the expertise needed, and can defer the main investment decision until it's been established that the innovation can be scaled up and is realisable on a commercial scale.

At that stage, they enter **level 7-9**, where private investment turns the proven concept into industrial scale manufacturing activity.



Who we work with

Size

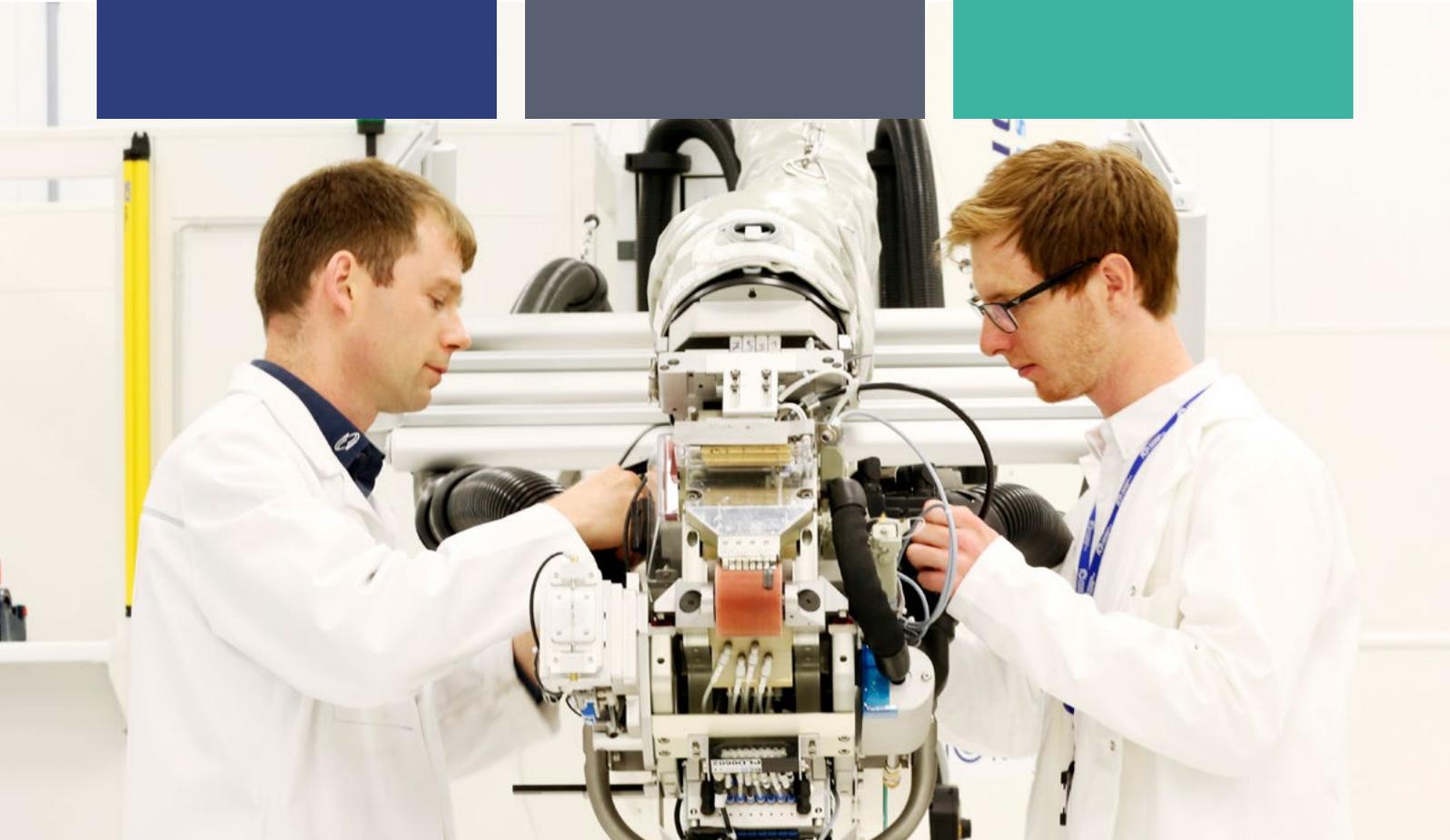
We work with companies of all sizes, from small start-ups to large OEMs.

Innovation

We work with companies seeking to investigate innovative technologies or scale up new products and processes to prove they have achieved manufacturing readiness.

Value

We work with companies operating in high value manufacturing ie: manufacturing that requires a high level of R&D and has the potential to yield high returns for the UK.



Our offer



We have capability which spans basic raw materials through to high integrity product assembly processes.

We provide companies with access to world-class facilities and skills to scale-up and prove-out high value manufacturing processes.

We develop a network of leading suppliers who contribute to key UK industry supply chains.

We unite industry, government and research in a shared goal to make the UK an attractive place to invest in manufacturing.

7 centres



Through our 7 centres we have capabilities and competences which span basic raw materials through to high integrity product assembly processes.



Shaping the future, forging partnerships



Focused on developing metal forming and forging technologies to support the design and advanced manufacture of products.

- > High integrity forging and thermal processing
- > Materials evolution, component resilience and residual stress
- > Near net shape design and make
- > Sheet processing technology
- > Digitalisation, technology planning of process and supply chains

Advanced Forming Research Centre

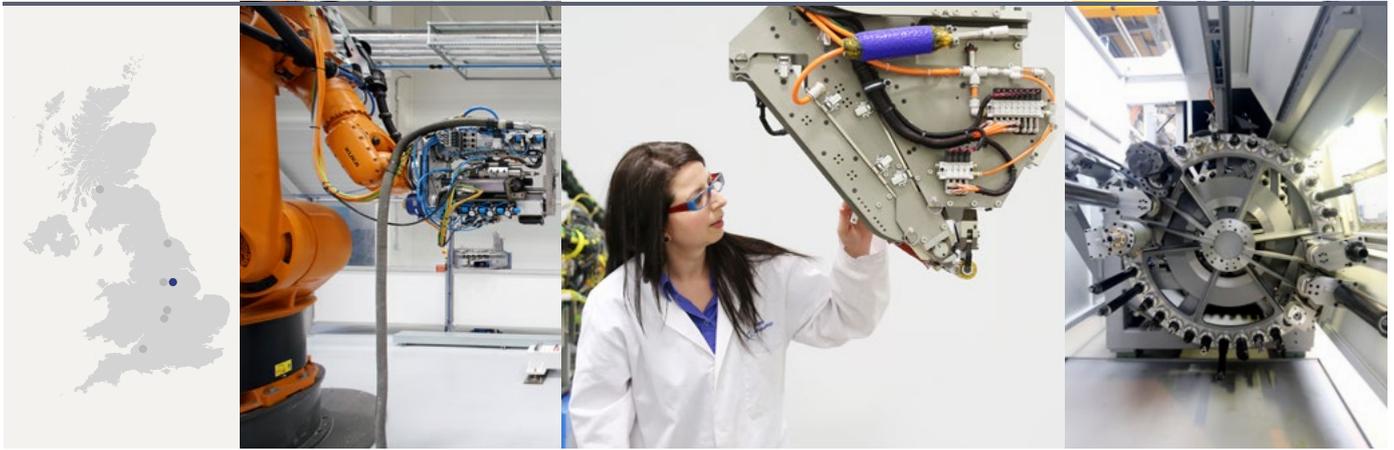
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At the cutting edge of collaborative research



Advanced Manufacturing Research Centre

World-class centre for collaborative research focused on advanced machining and materials for aerospace and other high value manufacturing sectors.

- > Additive Manufacturing
- > Automation
- > Castings
- > Composite Manufacturing
- > Design and Prototyping
- > Digitally Assisted assembly
- > Manufacturing Informatics
- > Machining
- > Manufacturing Intelligence
- > Medical
- > Metrology
- > Microscopy
- > Robotics
- > Structural Testing
- > Virtual Reality

Advanced Manufacturing Research Centre – AMRC with Boeing

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From innovation to commercialisation



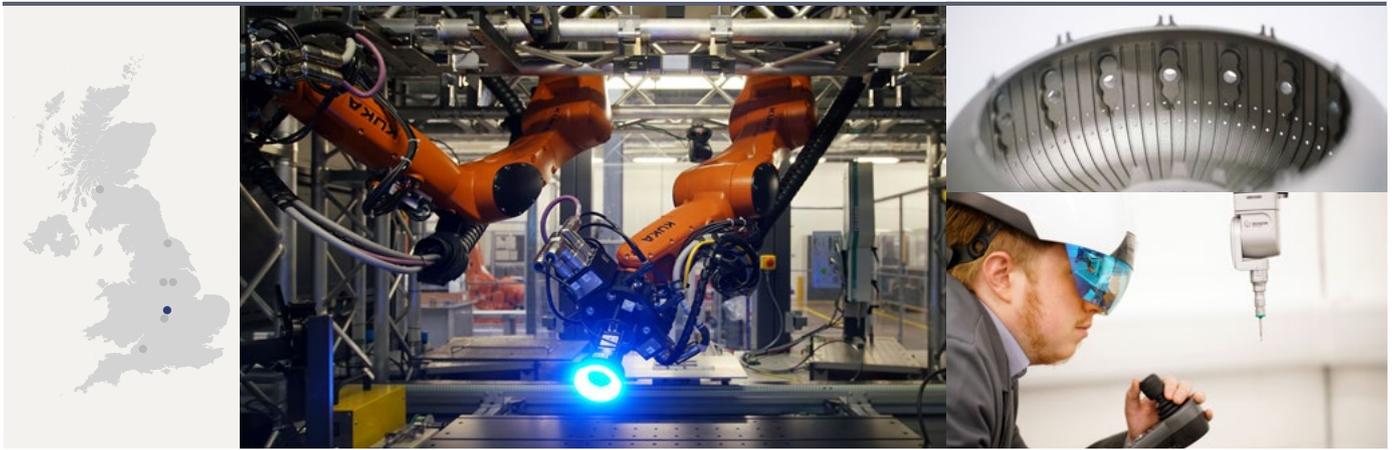
Helping companies to develop, prove and commercialise the next generation of products, processes and services. Enabling ideas, research and knowledge to be translated into commercial business propositions by providing the facilities and technical expertise to help companies overcome their innovation challenges.

- > Printable Electronics
- > Formulation
- > Industrial Biotechnology
- > Biopharmaceuticals
- > Graphene

Centre for Process Innovation

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Challenging the boundaries of manufacturing



Inspiring great British manufacturing, on the global stage.

- > Additive Manufacturing
- > High Integrity Fabrication
- > Non Conventional Machining
- > Advanced Tooling and Fixturing
- > Electronics Manufacturing
- > Robotics and Autonomous Systems
- > Special Purpose Machines
- > Manufacturing Simulation
- > Manufacturing Informatics
- > Metrology and NDT

Manufacturing Technology Centre

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Innovation Accelerated. People Developed. Solutions Delivered



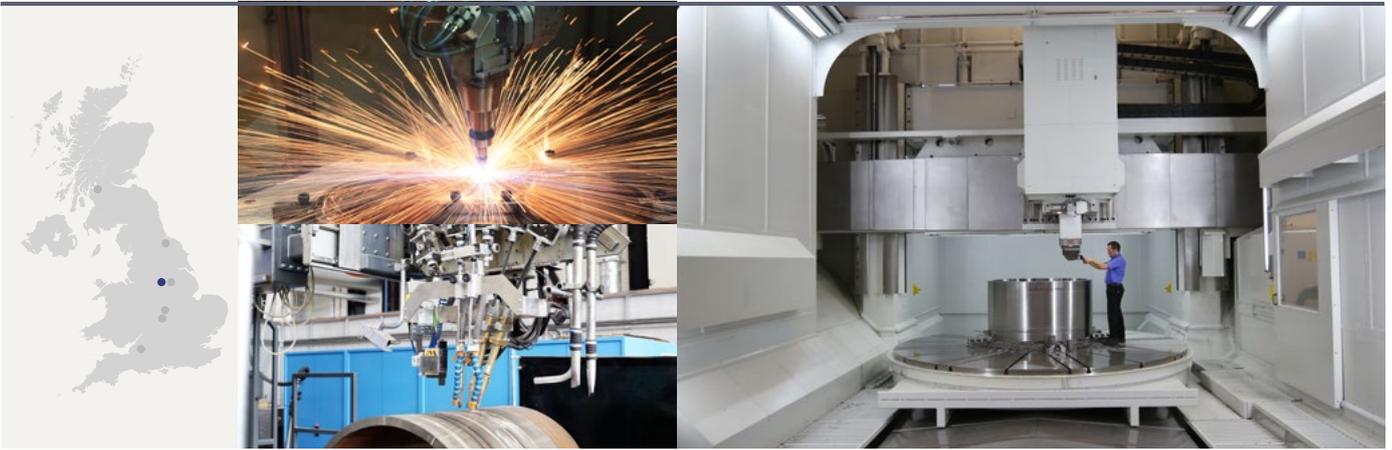
Providing solutions for the design, manufacture and application of thermoplastic & thermoset composites and multi-materials, in an open-access centre, focusing on research, technology development, transferring knowledge and people development:

- > Design, analysis and simulation of advanced composites applications
- > Product and process development and optimisation
- > Materials through intermediates and preforming to end product
- > Extensive range of deposition and curing technologies
- > Application of digital technology to composites manufacturing
- > Prototyping and validation
- > Manufacturing, inspection and testing
- > Collaborative and confidential working environments

The National Composites Centre

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[@NCCUKComms](https://twitter.com/NCCUKComms)
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Helping UK manufacturers win work in civil nuclear



NUCLEAR AMRC

Working with UK companies of all sizes to enhance their manufacturing capabilities for nuclear and other innovative energy sectors.

- > Intelligent machining
- > Modularisation
- > Laser welding & cladding
- > Mechanised arc welding & cladding
- > Ultra thick section joining
- > Large-volume metrology
- > Metal powder manufacturing
- > Bulk additive manufacturing
- > Surface integrity
- > Visualisation

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Addressing the global challenge of low carbon mobility



One of the world's leading research and education groups. Working with businesses of all sizes to overcome the challenges associated with low carbon mobility.

- > Connected and autonomous systems
- > Efficient use of materials
- > Energy innovation
- > Advanced propulsion systems

WMG

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Key technology capabilities

Through our seven centres we offer technology innovation and scale-up capabilities across the spectrum of process and discrete manufacturing industries.

These technologies are available:

1

At an industrial scale on an open-access basis so companies of all sizes can develop their processes, products and services, on state of the art equipment.

2

To allow companies to test alternative approaches to innovation so they can lower risk without incurring significant capital costs.

3

So academia and university spin-outs can scale-up their research in a way that prepares them for commercial markets.

4

Along with extensive experience available through the highly skilled technology development teams in the centres.



Advanced Assembly

Assembly is the general term for applications that assemble and inspect the fundamental parts to form a final product or sub-component. Industry is increasingly seeking to automate complex manual assembly tasks in order to improve manufacturing flexibility, speed and quality, while also reducing costs.



Automation

Automation is the use of various control systems for operating equipment such as machinery, processes in factories, and other applications with minimal or reduced human intervention. Some processes have been completely automated.



Biologics

Biologics are preparations, such as a drug, a vaccine, or an antitoxin, that are synthesized from living organisms or their products and used as a diagnostic, preventive, or therapeutic agent.



Biotechnology

Biotechnology uses microorganisms, such as bacteria or yeasts, or biological substances, such as enzymes, to perform specific industrial or manufacturing processes. Biorefining is the sustainable processing of biomass into a spectrum of bio-based products and bioenergy (biofuels, power and/or heat).



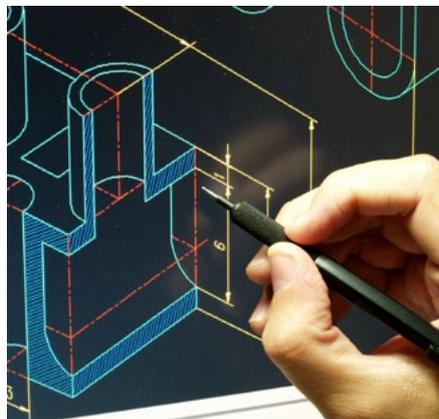
Casting

Casting involves liquid material being poured into a hollow mould, and being left to solidify. Casting innovation through computer process modelling of molten metal flow and solidification, design for casting and new casting processes and materials, improves product performance and reduces cost.



Composites

Composite materials are materials made from two or more constituent materials with significantly different physical or chemical properties, that when combined, produce a material with characteristics different from the individual components.



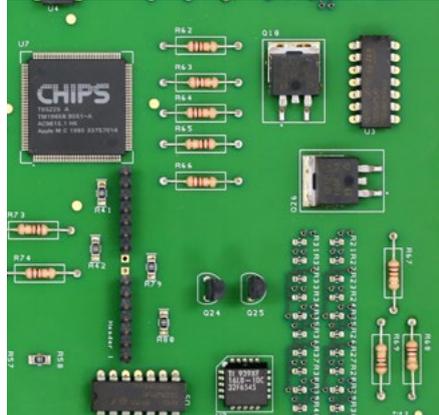
Design

Design for manufacture is a term used to describe the process of designing products/ parts/components in a way that optimises all the manufacturing functions (fabrication, assembly, test) as well as ensuring that design supports the optimisation of cost, quality and regulatory compliance.



Digital Manufacturing

Advanced manufacturing is a highly knowledge intensive sector where advances in IT systems have a huge role to play in improving manufacturing intelligence; capturing, sharing and managing big data; supporting collaboration; increasing efficiency; speeding up innovation; and enabling new business models and technologies.



Electronics

Electronics deals with electrical circuits that involve active electrical components such as vacuum tubes, transistors, diodes and integrated circuits, and associated passive electrical components and interconnection technologies.



Flexible Manufacturing

A method for producing goods that is readily adaptable to changes in the product being manufactured, in which machines are able to manufacture parts and with the ability to handle varying levels of production.



Formulations

Formulations refer to the putting together of components in appropriate relationships or structures, according to a formula. Formulations are commercially produced for drugs, coatings, dyes, alloys, cleaning agents, foods, lubricants, fuels, and many others.



High Temperature Processing

Forming of metallic components by use of carefully controlled combinations of temperature and pressure to effect viscoelastic flow and/or plastic deformation.



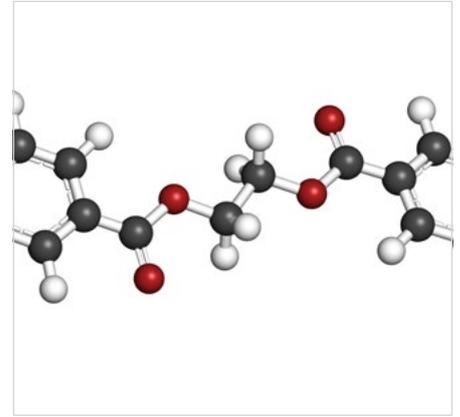
Joining

Joining technology is fundamental to engineering and manufacturing. Without the ability to make strong and durable connections between materials it would not be possible to produce the many different items upon which industry rely, and we all rely on in our everyday lives.



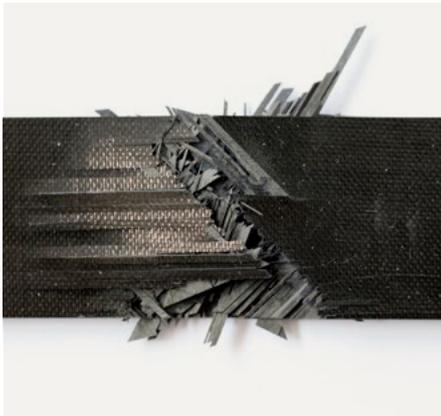
Machining

Machining is any of various processes in which a piece of raw material is cut into a desired final shape and size by a controlled material-removal process.



Manufacturing with Polymers

Polymeric materials are created via polymerisation of many small molecules. Their consequently large molecular mass relative to small molecule compounds produces unique physical properties, including toughness, viscoelasticity, and a tendency to form glasses and semicrystalline structures rather than crystals.



Materials Characterisation

Characterisation and testing of materials refers to the broad and general process by which a material's structure and properties are probed, measured and tested.



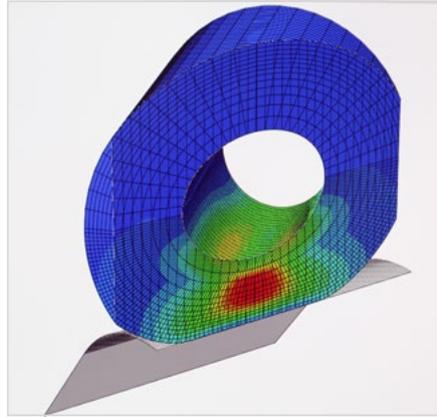
Metal Forming and Forging

Forging is a manufacturing process involving the shaping of metal using localized compressive forces. Forging is often classified according to the temperature at which it is performed: "cold", "warm", or "hot" forging.



Metrology

Metrology (the science of measurement) provides critical quality assurance for manufacturing processes.



Modelling and Simulation

Modelling and simulation is getting information about how something will behave without actually testing it in real life. Models, including emulators, prototypes and simulators, either statically or over time, are used to develop data to inform managerial or technical decisions.



Netshape and Additive Manufacturing

Additive manufacturing (AM) (or 3D printing) uses primarily additive processes, in which successive layers of material are laid down under computer control. This results in objects that can be of almost any shape or geometry, and are produced from a 3D model or other relevant data source, with little or no waste.



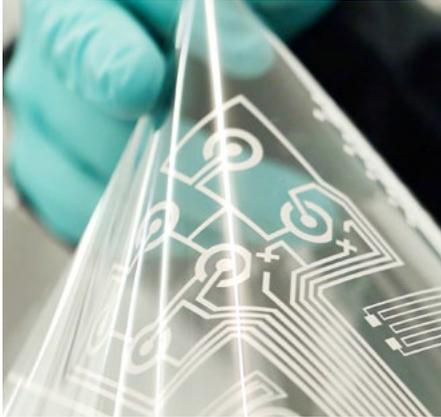
Powder Technology

Many of the emerging production methods that produce net shape components (components close to final geometry without the need for extensive machining) begin with powdered metals. The powder metallurgy industry has witnessed a steady expansion since the 1980s and continues to reinvent itself, introducing new materials, products and services.



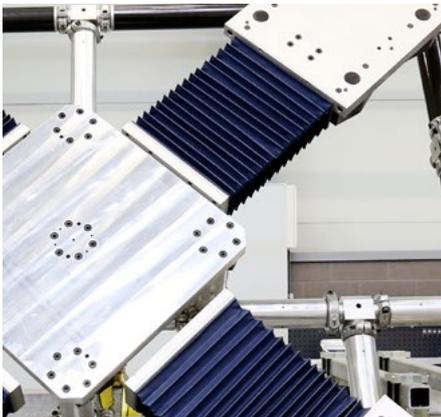
Power and Energy Storage

Environmental legislation is creating a significant demand for electrochemical storage solutions for both static (grid balancing and storage of renewable energy) and mobile application (low carbon vehicles).



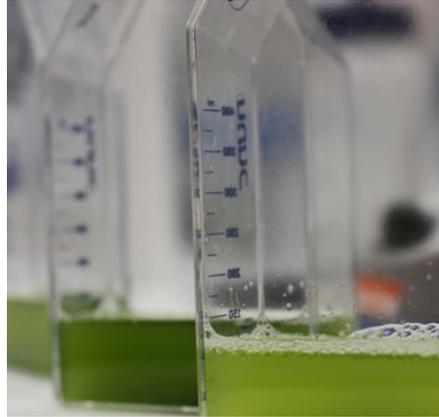
Printable Electronics

Printable electronics refers to the methods used to create electrical devices on various substrates including thin film, textiles and paper. Development of printable electronics technology provides benefits for end-users across sectors and has the potential to enable products to be lower cost, lighter in weight, and to provide more integrated functionality and lower energy consumption both in manufacture and use.



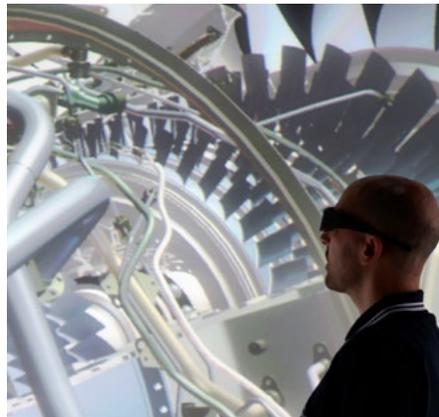
Tooling and Fixtures

Tooling refers to working or specialist manufacturing aids which are usually limited in use to a specific production line or the performance of a specific contract or job. Fixtures are work holdings, used to securely position, hold and support the work to maintain conformity.



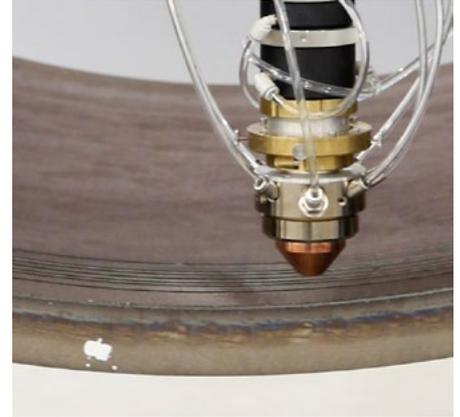
Resource Efficient and Sustainable Manufacturing

The efficient use of resources in manufacturing processes coupled with low carbon and low energy manufacturing processes is a major target across the whole of the manufacturing industry.



Visualisation and Virtual Reality

Virtual reality refers to a set of techniques in which one interacts with a synthetic ("virtual") environment that exists solely in the computer. A variant of virtual reality is often called "Visualisation". This involves presentation of 3D structures (such as anatomy or molecular structure) in ways that maximize learning.



Surface Engineering

Surface engineering refers to a wide range of technologies designed to modify the surface properties of metallic and non-metallic components for decorative and/or functional purposes. Examples include improving corrosion and wear resistance to extend component life; making items more visually attractive; and giving special properties such as lubricity enhancement, non-stick surfaces, etc.

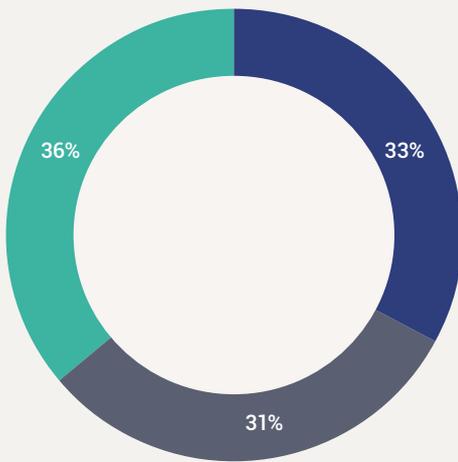
Achievements and impact

The HVM Catapult receives core funding from government through Innovate UK. This core funding must be matched with competitively won collaborative R&D funding, and with industry income. This so-called 1/3 1/3 1/3 model is crucial to the success of the Catapult. To date, after merely four years of operation, the demand for our services and the income we receive from business has far exceeded the 33% target.

In 2015, WECD undertook an economic impact evaluation of HVM Catapult. Key findings from the study, which can be downloaded from hvm.catapult.org.uk, are below:

£15 net benefits to the UK economy from every → £1 core public funding received

Source: WECD Economic Impact Evaluation study



■ Core public funding ■ Competitively won CR&D ■ Commercial income

Total value of our assets

£617m

↑ Up 10% from 2015-16

Number of employees

2,114

Size of order book

£205m

→ Of which £137m is collaborative R&D

Number of private sector projects

1,730

Private sector clients

3,387

→ Over 40% of whom (1,383) are SMEs

Investment in large capital projects:

£52m

Source: HVM Catapult Annual Review 2016-17

Success stories

Flexible inspection automation cell shortens cycle-time

AFRC and partners, including *KUKA Robotics UK*, produced a full-size, flexible inspection automation cell for *Spirit Aerosystems* to help meet the growing demand for highly accurate measurements at reduced timescales. The project has delivered significantly reduced cycle time in the complex geometry inspection of the large-wing systems that Spirit manufacture.

For a 6m² part, overall inspection time has been reduced from 2.4 hours to around 50 minutes; a reduction of 65%. This step change will underpin the productivity of *Spirit* as it responds to industry demand, which is expected to double to 100 wing sets per month.

Largest ever 3D printed aero engine component

The MTC worked with *Rolls-Royce* on the additive manufacture of a flight test front-bearing housing, resulting in a 30% improvement in lead time for first part to stores for the engine development programme. Working in conjunction with *Rolls-Royce* and *Arcam*, the MTC developed processes from powder inspection and characterisation to component manufacture and post-process non-destructive testing of the additive layer manufactured components. As a result of this work, hundreds of aerospace quality components were manufactured under full *Rolls-Royce* control, with tens of thousands of equipment run-hours allowing for extensive data capture.

This resulted in the electron beam additive-manufactured components being incorporated into ground and flying test-bed XWB-97 engines.

Increasing the scale and speed of commercialisation

With the support of the AMRC, Yorkshire-based SME *Technicut* developed a cutting tool that speeds up the cutting of tough alloys such as titanium, with machine time on an engine component reduced from two minutes 52 seconds to five seconds. The AMRC then brought in tool-holder specialist *Nikken* and they collaboratively developed a system which maximises the capacity of the cutting tool and reduced cycle time for one part from 36 hours to 11 hours, with only six milling tools doing the work previously done by more than 30 tools.

As a result, Japanese-based *Nikken* built a new European R&D centre in Sheffield and the tool is now manufactured in the UK and has since been adopted by machining workshops around the world. The *Technicut* tool was also one of the key innovations adopted by the combined team of AMRC and *Rolls-Royce* as they sought to reduce the time involved in machining Trent 900 fan discs, which had become uneconomic to manufacture in the UK. As a result, machine time was halved and productivity on engine discs doubled.

Needle free 'breathalyser' for daily diabetes testing

Applied Nanodetectors Ltd worked with CPI on developing a simple breathalyser test for daily monitoring of glucose levels in diabetics. A non-invasive handheld breath test device has the potential to replace the 'prick test' methods used today and would significantly improve patient monitoring and self-management.

The collaboration is part of an Innovate UK project – 'Plasense' – which developed a low-cost and scalable method for printing sensors onto flexible plastic substrates. Further work will look at upscaling the sensor and integrating it into a point-of-care diagnostic device. The project is a key breakthrough for the monitoring of glycemic levels and the technology will revolutionise the way in which we monitor glucose.



Working with CPI has helped to accelerate the sensor development cycle and utilise plastic electronics technologies to obtain the most cost-effective manufacturing solution.

**Dr Victor Higgs, Managing Director,
Applied Nanodetectors Ltd**

Success stories

Helping UK manufacturing companies compete in nuclear

Over 600 companies have undertaken the Nuclear AMRC's Fit for Nuclear (F4N) supplier development initiative (a unique service to help UK manufacturing companies get ready to bid for work in the civil nuclear supply chain), with 100 having completed the programme and half already experiencing significant business benefits. The larger scale Civil Nuclear Sharing in Growth (CNSIG) programme (an intensive business support programme to help manufacturers compete for work in the civil nuclear industry) has seen 10 key nuclear suppliers undertake a four-year programme led by the Nuclear AMRC. After three years, the companies have won £410m of new contracts, created or sustained 4,900 jobs and committed £45m of additional private sector funding.

Through the CNSIG programme, the Nuclear AMRC is developing new methods of manufacture to support the suppliers of the current 3m³ Intermediate Level Waste (ILW) containers to Sellafield Ltd. This programme includes developing new machining methods aimed at increasing the security of supply and cost effectiveness for Sellafield Ltd to support their high priority decommissioning programmes over the next decade or so. With an eventual requirement of over 100,000 ILW containers over the next 120 years, Sellafield has also engaged the Nuclear AMRC in a longer-term programme to develop alternative designs of waste containers with the objective of reducing the unit cost by 50%.

Dymag reinvents the wheel

Pioneering Wiltshire-based wheel manufacturer *Dymag* worked with the NCC to support their composites technology. Their latest wheels are made in one-third of the original cycle-time and at a reduced cost. The improvement in productivity and unit cost supports *Dymag's* aspiration to increase OEM market reach. The wheels are typically 40% lighter than standard cast aluminium wheels and 25% lighter than equivalent forged aluminium wheels, when tested to the same OEM standards. The team applied design and simulation tools to produce a solution with light weight composites material as an alternative to heavier metal wheels.

Application of manufacturing process knowledge at the product design stage has ensured improved repeatability and efficiency. The NCC has provided high standards of product and process prototype development, test and analysis support, and iteration which has led to further work with *Dymag* to help with refining design and increasing the rate of manufacturing output.



We worked very closely with the NCC in developing our new and patented Boxstrom carbon rim. We are absolutely delighted at the way the market (OEM's and aftermarket) is responding to the Boxstrom. Thanks to our design and development work in partnership with the NCC the Boxstrom offers a wide range of performance features that make it our lightest, stiffest and strongest carbon composite wheel yet.

Chris Shelley, CEO, Dymag

Remote Laser Welding Navigator: outstanding research with industrial relevance

The Remote Laser Welding (RLW) Navigator was a 3½ year collaborative programme led by WMG with 12 industrial and academic partners including *STADCO*, *Jaguar Land Rover* and *EnginSoft* (a UK SME). The programme developed software solutions to enable the implementation of RLW technology, effectively taking it from new concept to production.

The main barrier for adoption of RLW has been the lack of methodologies for precise and effective planning and simulation of its application, leading to time-consuming (and expensive) trial-and-error procedures. The new solution developed a range of new capabilities and the results from the RLW Navigator programme led to the first ever fully digitally developed RLW process.

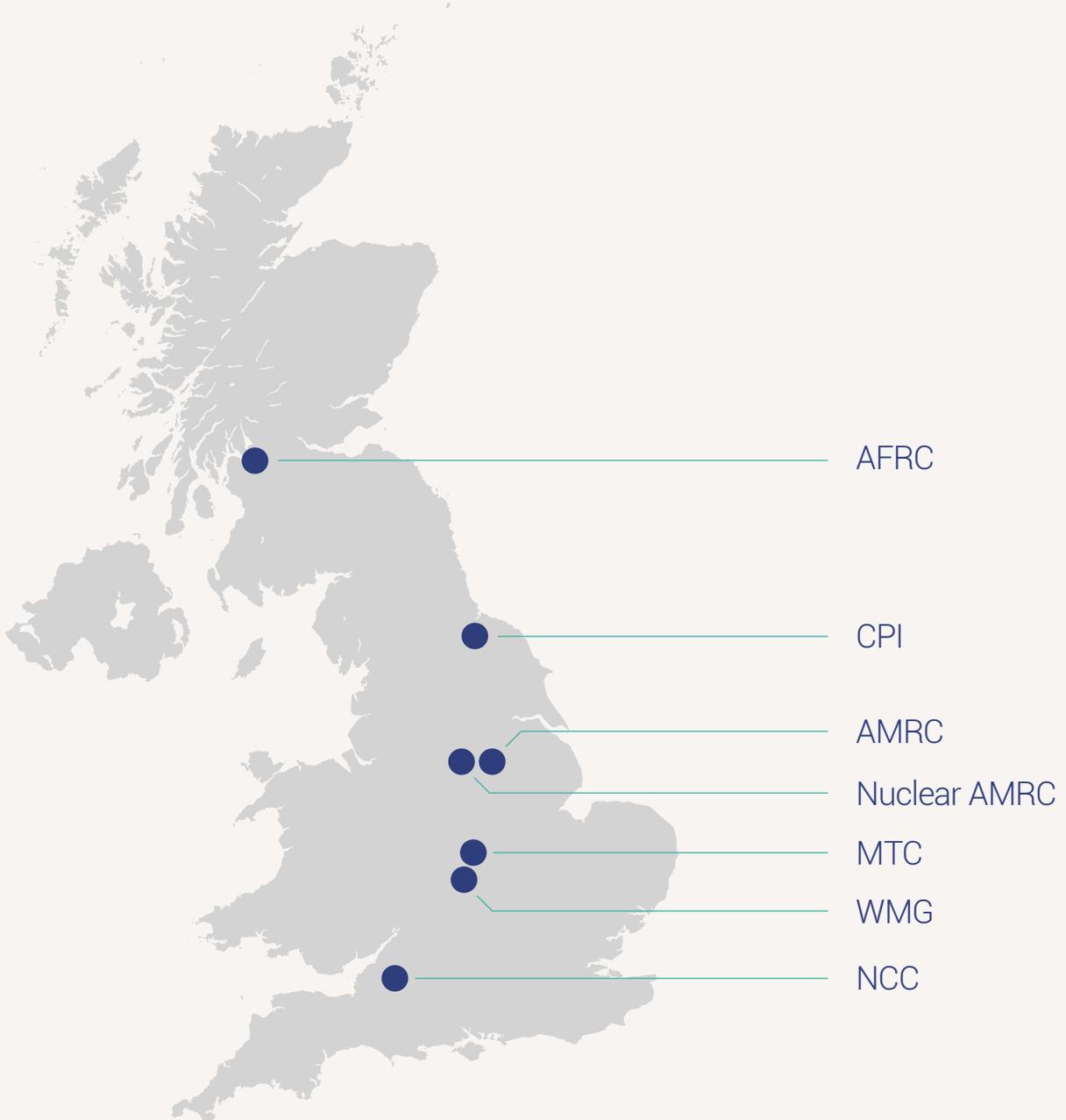
The project has enabled the adoption of RLW leading to greatly improved productivity (up to 5 times faster and with 60% less floor space), reduced costs, enhanced flexibility and reduced weight through RLW optimised design.

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CATAPULT
High Value Manufacturing

We work with
Innovate UK



V2.08.2017

