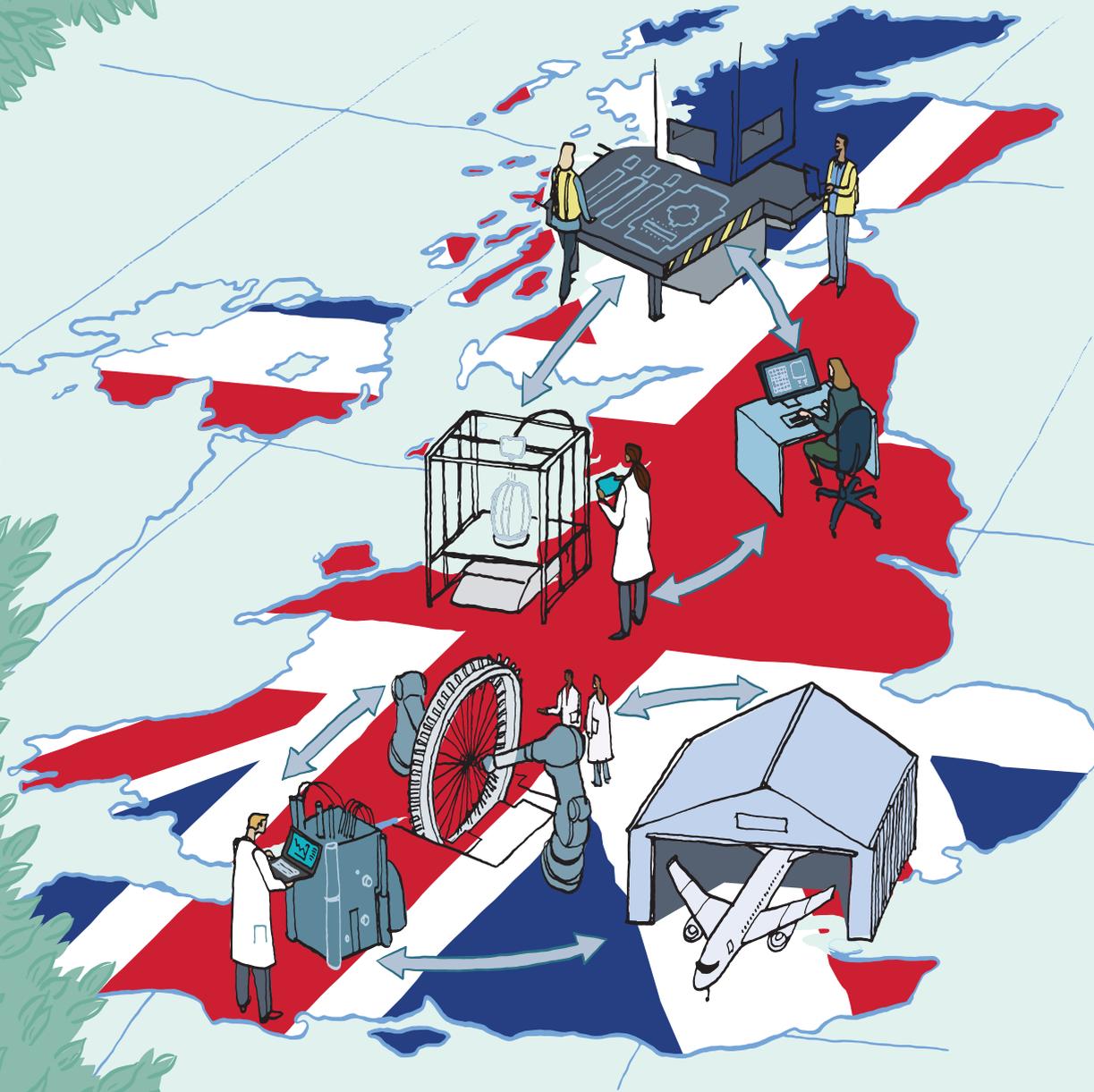


CATAPULT
High Value Manufacturing

High Value Manufacturing Catapult
Annual Review 2020/21

**Manufacturing
A Clean Green
Recovery**



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Our Centres
AMRC: University of Sheffield Advanced Manufacturing Research Centre
CPI: Centre for Process Innovation
MTC: Manufacturing Technology Centre
NCC: National Composites Centre
NMIS-AFRC: Advanced Forming Research Centre (part of the National Manufacturing Institute Scotland)
Nuclear AMRC: Nuclear Advanced Manufacturing Research Centre
WMG: Warwick Manufacturing Group

A decade of manufacturing innovation



Dick Elsy CBE
Chief Executive, HVM Catapult
(2013-2021)

My final report as CEO, before my retirement, gives me the chance to reflect on my last eight and a half years, and the decade since the High Value Manufacturing (HVM) Catapult was founded.

I deferred my retirement last year to focus on the emergency challenge to build intensive care ventilators for the NHS, and also to support our industrial clients as they fought with the consequences of lockdowns and the stagnation of trade. The key mantra for the **HVM Catapult** during this difficult phase was to “keep the torch lit for innovation”. With many companies having to resort to furlough and plant closure, industry focus was very much on the short-term and damage limitation, meaning there was a risk that the many innovation programmes we were working on would fall by the wayside, and that the UK would fall behind. The **HVM Catapult’s** Centres rose to this challenge going to extraordinary lengths to keep our work moving and projects running.

This outcome is reflected by our performance in the year, with a 5% increase in revenues over the prior year as the **HVM Catapult**

became the largest advanced manufacturing research capability in Europe.

The scale of our operations and revenues, however, are only indicators of activity and appetite for our innovation support. The thing that I am most proud over the last 10 years is the impact we have had, especially regionally. Much is said in government circles about “levelling up”; what we have seen in the **HVM Catapult** is *genuine industrial transformation*.

Talking stock of all of this reveals a profound transformation of the UK industrial landscape.

The University of Sheffield **AMRC** and the **Nuclear AMRC** have built on the ashes of former industry and transformed the site of the Orgreave colliery and coking works into an international hub of industrial collaboration, bringing the likes of Rolls-Royce, McLaren and Boeing to Rotherham and Sheffield. With **AMRC Cymru** now open, similar transformation is underway in North Wales.

The **MTC** has moved from a 10-person team in a portacabin to a site of crowded investment, attracting £600m to Ansty Park including Meggitt’s £130m innovation centre.

WMG has continued to grow its global reputation in battery technology, making Coventry a go-to destination for battery investment.

The **AFRC** has grown from a small Centre focused on forming and forging into a Scottish industrial powerhouse, leading the creation of Scotland’s first major advanced manufacturing park and a £100m investment in the new National Manufacturing Institute Scotland (NMIS).

The **NCC** has been our anchor in the South West, building the UK’s sovereign capability in aircraft structures and leading digital innovation.

CPI has had a major impact in North East England, advancing the national capability for advanced vaccine development and contributing significantly to healthcare resilience in the UK.

These are illustrations of exactly the sort of innovation-driven transformation that the UK needs to level itself up and face the big societal challenges that lie ahead of us. From climate change to global competitiveness, the answers lie in innovation which will drive an unprecedented demand for new technologies, products and services.

In parting, I know that the HVM Catapult is at the peak of its fitness to tackle these challenges. My eight and a half years have been extraordinary and I feel that they have been well-spent in the service of UK innovation.

The next decade will eclipse that, as the HVM Catapult steps up to play its central role in supporting the innovations which will transform our lives.

Shoulder to shoulder with industry



The last year has been a test for UK manufacturing and the wider global economy. With the appropriate restrictions in place, manufacturing output dipped and some sectors ceased to operate. In this most difficult time, the **HVM Catapult** has shown remarkable resilience, maintaining its focus on innovation and supporting companies to grasp the opportunities presented, despite the odds, and continue to grow.

This success is borne out by the facts. In 2020/21, the **HVM Catapult** supported 5,897 industrial partners, over half of which were small and medium enterprises with growth potential. These businesses showed great strength in challenging times to develop innovative products and services for their chosen markets.

We stood shoulder to shoulder with industry, both large and small, to deliver 13,437 ventilators to the NHS in its time of need, and we led the UK's effort for vaccine scale-up, now hosting the COVID-19 vaccine library which is set to support the fight against new variants. And we were instrumental in establishing a £250m supply chain for personal protective equipment (PPE) in Scotland.

We have also continued to work closely with companies across the UK to adapt to a changing industrial landscape, building new UK-based supply chains, making the UK more attractive to new and existing companies, and helping them to deliver cost-effective solutions to their clients at all times.

This year has shown that the HVM Catapult is resilient, capable and able to deliver for the great challenges we face now and in the future.

2020/21 in numbers

Worked with
5,897
industrial partners

56% (3,322)
were SMEs

4,687
SME engagements

2,234
commercial projects

443
collaborative R&D projects

261
projects with
academic institutions

1,404
engagements with academic
institutions across the globe

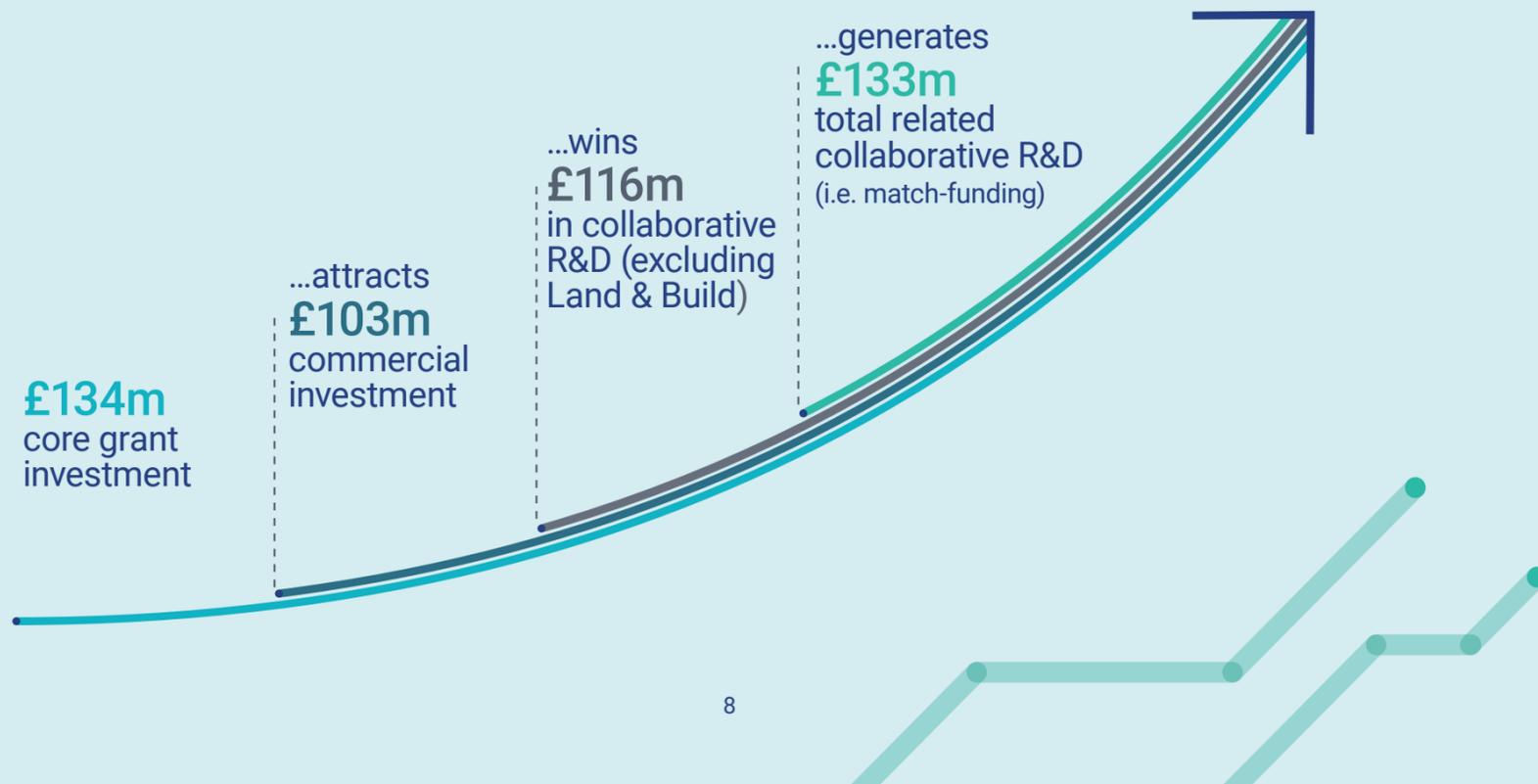
106
original research
publications



Stimulating R&D investment

£486m

industry R&D directly linked to HVM Catapult activity



Introduction: Tackling global challenges

Big questions about social, economic and natural distress demand big answers.

We are faced with damage to fragile habitats and biodiversity, aging populations, increasing global inequalities and, of course, climate change driven by greenhouse gas emissions. Also, how do we respond to UK industrial decline and regional inequalities? How do we retain access to the things that we need during pandemics or supply chain disruptions? How do we make sure that the next generation enjoys a healthier, more prosperous future?

The answers lie, in part, in innovation, and the manufacturing community has a key role to play.

That's where the High Value Manufacturing Catapult comes in.

Working alongside business and government, we are helping to develop and scale-up the new green technologies and processes needed to reach net zero greenhouse emissions by 2050 and

avert climate disaster. We are supporting manufacturers to make the green products of the future with clean energy and sustainable materials that will not leave a scar on landscapes. We are reducing the environmental impact of both industry and households, and showing how businesses up and down the land can use all resources more wisely and how best to handle products at the end of their life.

The work we are doing will help to shape the resilient industries of the future, protecting both the global environment and our home communities.

The opportunity for the UK is huge. By developing UK-based supply chains, we can bring highly skilled work back into the places that need it. By taking a lead in the development of environmentally friendly products, processes and technologies, we can grow UK markets while offering global solutions. By building on industrial clusters around centres of innovation, we can inject new energy into landscapes blighted by

past industrial decline, supporting that energy with action to build the skills needed to harness new technologies effectively.

The transformation we have led around the former Orgreave site in Rotherham is an excellent example of how long-term investment can have real impact. Where the colliery and coking works once dominated the landscape, there are now over 100 thriving companies employing 2,000 highly skilled workers.

Transition to a new, more sustainable global economy will not be easy. In this report you will see that we are working on many global and national challenges, using innovation to provide important answers.

The HVM Catapult is ready to bring its skill and expertise to bear on global challenges for a better future for all.



Our offer

What we do

Working through seven world-class centres of industrial innovation, the HVM Catapult bridges the gap between business and academia.

We enable companies to turn great ideas into commercial realities by providing access to world-class research, development facilities and expertise that would otherwise be out of reach for many businesses in the UK.

We pride ourselves on helping businesses to transform the products they sell, the way they make them and the skills of their workforce to remain competitive in a global marketplace.

For industry

We offer companies of all sizes access to world-class facilities and expertise to scale-up and prove-out manufacturing technologies, using our insight to help them solve their business challenges and upskill their workforce.

For academics

We offer a central meeting point between academics and businesses, delivering key insights into industry demand and technology gaps which stimulate new research in areas for potential UK growth.

For Governments

We offer a trusted partnership in manufacturing innovation, which drives inward investment towards historically neglected communities to build the UK production capacity needed to tackle industrial challenges and secure UK leadership in global markets.

Our vision

For the UK to have a world-leading, agile, innovation-led manufacturing sector, making a growing contribution to the UK economy, society and environment.

Our mission

To enable companies to improve their competitiveness through accelerating innovation:

- Bridging the gap between UK research and industry, translating research into innovative products, and services
- Convening our extensive network to develop and deliver solutions including new technologies, processes, workforce development and broader business support
- Supporting and informing government in shaping and implementing industrial policy, such as its Innovation Strategy and plan to Build Back Better.

Our technology areas



Additive manufacturing



Assurance



Automation



Biotech & biologics



Composites



Digital technologies



Electronics



High value design



Joining



Near net shape manufacturing



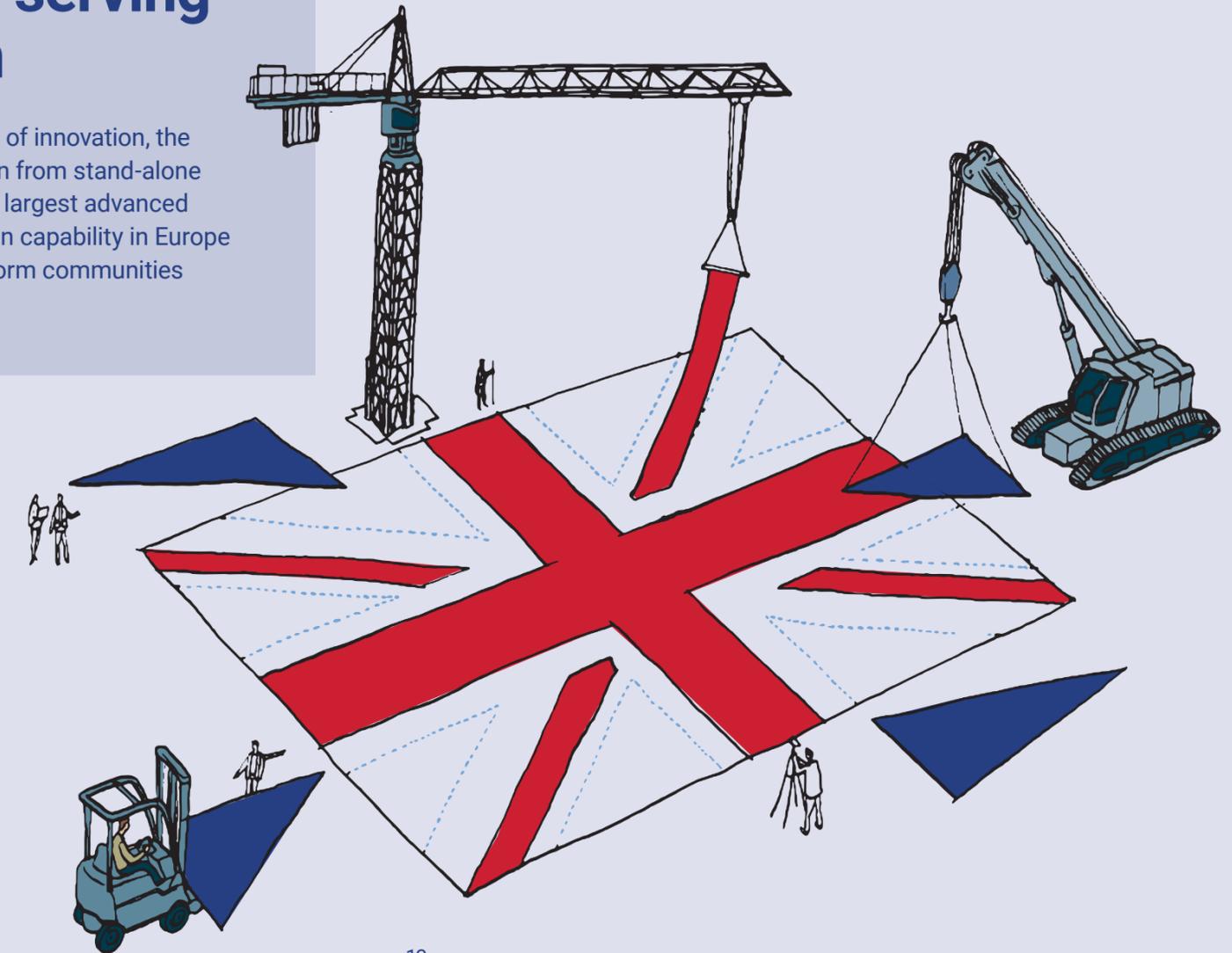
New materials



Subtractive manufacturing

Ten years serving the nation

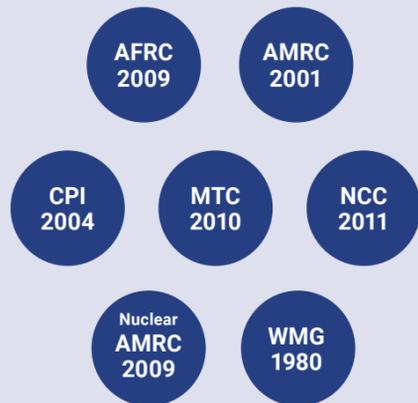
Built from seven centres of innovation, the HVM Catapult has grown from stand-alone local operations into the largest advanced manufacturing innovation capability in Europe with the power to transform communities across the UK.



Our history

Our seven centres of industrial innovation were brought together in 2011 by Innovate UK, the UK's innovation agency, to accelerate the commercialisation of innovative new products and processes.

Over our decade of work, we have helped more and more businesses each year to grasp the opportunity of innovation and grow.



2018

MTC, and partners launch the Construction Innovation Hub to drive the transformation of the construction sector.

2017

Scottish First Minister announces new National Manufacturing Institute Scotland (NMIS), starting the expansion of the AFRC

2015

The MTC's Advanced Manufacturing Training Centre opens

The National Centre for Additive Manufacturing is established at the MTC

2014

WMG's Energy Innovation Centre opens.

2013

The AMRC Training Centre welcomes its first cohort of 150 apprentices

2011

HVM Catapult founded to combine strengths of seven centres of innovation across the UK.

2019

AMRC Cymru opens in Broughton, North Wales.

Nuclear AMRC Midlands opens in Derby

MTC Liverpool opens

The Lightweight Manufacturing Centre, AFRC's sister facility in NMIS opens

2020

The NCC opened the latest phase of the most advanced composite manufacturing facility in the world.

HVM Catapult leads effort to deliver over 13,000 ventilators to the NHS in response to COVID-19

2021

CPI is tasked by the UK Government to develop vaccine library in fight against new COVID-19 variants.

UK Battery Industrialisation Centre, founded by WMG, is officially opened by the Prime Minister.

Ten years serving the nation

A decade of growth

Over the last decade, we have worked with

21,734
companies*

of which 11,840 (54%) were SMEs*

We have worked on a total of

9,257

commercial and collaborative R&D projects*

And we have engaged with SMEs another

28,484
times*

We now work with more than

5 times as many SMEs

per year than in 2012/13.

We have grown from 493 experts in advanced manufacturing innovation (as FTEs) in 2012/13 to

3,112
this year

In 2011, we were supporting advanced manufacturing at 7 sites across the UK. Today, we reach out from

17 locations* across Great Britain.

Our cutting-edge facilities have grown by

3.5 times to **£828m** of assets in the last ten years

giving more and more companies the access to the specialist equipment they need for innovation.

*These cumulative figures have been reduced by the average rate of YOY project overlap 2018-2020 and may be conservative.

Moving work back to the UK

With increasing disruption on the global stage, the SME Albert Jagger Engineering realised that returning productive capacity to the UK from China would be crucial for supply chain resilience.

Approaching our experts at the MTC to help, they sought to secure their supply chain and save their UK facilities from closure by reshoring the manufacture of one of their signature industrial hardware product ranges.

Using user-friendly visualisation tools and world-leading expertise in manufacturing optimisation, the MTC team showed Albert Jagger what was possible to achieve their aims. Their virtual reality environment enabled the live mapping of the shop floor in a risk-free way, before any significant capital investment.

With the most efficient plan in place, the company was able to save and transform its Bloxwich engineering facility, expanding their workforce. Albert Jagger is now in a position to manufacture their product range in-house for up to 50% less than the outsourced operation in China, achieving an incredible profit increase of over 60% and 600% improvement in customer satisfaction.

A great example of where British manufacturing is best.

600%
improvement in
customer satisfaction



Building success from the ashes of industry

Sitting proudly on the site of the former Orgreave colliery and coking works, the AMRC is a powerful symbol for what is possible in areas scarred by lost industry and limited opportunity.

It has spurred regeneration with the development of a 150-acre Advanced Manufacturing Park in Rotherham, transforming a once bleak landmark of industrial confrontation into a haven of industrial collaboration and innovation.

Where the coking works once dominated the landscape, there are now over 100 thriving companies employing 2,000 highly skilled workers.

The research and innovation excellence of the AMRC and its sister Centre, the Nuclear AMRC, has been the key magnet all of them including some of the world's biggest manufacturers: Rolls-Royce setting up on the site in 2015, Boeing Sheffield and McLaren in 2018, and UKAEA in 2020. And with the skills pipeline the AMRC Training Centre adds to this winning recipe, it's no wonder they've stayed. This is the power that the HVM Catapult can have: transforming landscapes, developing talent and changing communities for the better.

**Working with the AMRC,
we can achieve things we
couldn't achieve on our own**

Neil Mantle, Director of Manufacturing, Rolls-Royce



1984



2003



Today

Aerospace lifting off in Scotland

For over a decade the **NMIS-AFRC** has been working with leading names in aerospace to increase productivity, turn research ideas into a commercial reality and solve all manner of production challenges.

For two companies in particular, this work has had significant impact.

Aerospace giant, Boeing, one of the founding members of the **AFRC**, has hired a team to work on an £11.8 million research and development programme with the centre's leading forming and forging technologists, which will be housed in a newly refurbished facility nearby.

The programme is demonstrating innovative manufacturing processes

and technologies related to metallic components, building upon research previously conducted at the **AFRC**. Through these technologies and building capability in others, the team will be investigating reducing material wastage, possibilities to improve safety, productivity and environmental impact.

Elsewhere in Scotland...

In 2017, the aerospace structures manufacturer Spirit AeroSystems identified a need to double its productivity over 10 years to meet market demand. Realising the scale of this challenge, the company approached the **NMIS-AFRC** for help. Working in close partnership with Spirit, the **NMIS-AFRC** team

developed an automated combined non-destructive testing and metrology inspection facility that delivered a significant reduction in part inspection time – a key achievement in its overall productivity requirement.

The technology created at this facility is currently being transferred to Spirit's new research facility, the Aerospace Innovation Centre in Prestwick, Scotland, where the cell is being scaled up to allow combined inspection of aerospace parts up to 20m in length. As a pre-production facility, it will be used for inspecting new demonstrator parts that Spirit will manufacture during future research projects for the next generation of airplanes.

Enabling Jaguar Land Rover's successful transition to electric vehicles

Driven by the need for environmentally sustainable transport, the international automotive market is experiencing unprecedented levels of change. As a centre for excellence in battery technology, **WMG's insights are crucial to the industry, allowing companies to accelerate the decarbonisation of their production vehicles.**

Working as a co-located team since 2011, **WMG** has conducted collaborative research with Jaguar Land Rover to define the performance, safety and degradation properties of lithium-ion batteries, through a comprehensive programme of experimentation and modelling.

WMG's research insights into the functionality of lithium-ion batteries has underpinned the battery development for the company's first electric vehicle (the Jaguar I-PACE) and has been vital to the company's swift transition from a manufacturer of vehicles reliant on fossil fuels to one at the forefront of electric vehicle (EV) production.

WMG's researchers applied their modelling and battery management systems knowhow to help develop a power balancing algorithm that allowed optimal performance of the cells. A vital piece of knowledge in the development of the I-PACE.



De-risking Rolls-Royce £100m investment in North East England

Ground-breaking manufacturing techniques developed by the AMRC helped Rolls-Royce halve the production time of its aero-engine discs, a vital component of its Trent engines which are exported globally.

The materials used to make the discs are difficult to machine and require complex manufacturing processes. AMRC engineers used simulation tools to guide the fixture design and machining of the disc, improving the fabrication process.

As a result of the AMRC's work, Rolls-Royce invested £100m in fan disc production at its plant in North East England, securing 300 high value-added jobs. Rolls-Royce now has the capacity to manufacture 2,500 fan and turbine discs a year, which feature in a range of Trent aero engines for some of the world's most advanced passenger jets.



Image credit: Rolls-Royce

Shaping a healthier society

At a time when the health of the nation has come into sharp focus, the HVM Catapult is working to develop new technologies that can help to keep us healthier, live longer and have a better quality of life.



Tackling COVID-19

The COVID-19 pandemic has been a time of acute suffering, but it has also been a time of unique solidarity between countries, organisations and businesses. The **HVM Catapult** has played a leading role in the UK manufacturing community's response to the virus.



Leading the Ventilator Challenge

On the 16th of March 2020, the Government asked UK industry to support the NHS in its fight against COVID-19.

The VentilatorChallengeUK (VCUK) Consortium, led by the **HVM Catapult's** outgoing CEO Dick Elsy and made up of more than 33 businesses from the aerospace, automotive and medical sectors, came together at speed to build medical ventilators.

The Consortium worked with great determination and energy to deliver

critical Penlon ESO 2 and Smiths paraPAC™ plus ventilators to the NHS throughout the crisis. In a matter of weeks, VCUK established, from scratch, seven new large-scale manufacturing facilities; set-up new parallel supply chains; acquired some 42 million parts and electronic components from 22 countries; achieved full MHRA approval for the Penlon ESO 2 device in just three weeks; and recruited and trained a 3,500 front-line assembly team in a new age of social distancing. The Consortium delivered an incredible 13,437 ventilators in just 12 weeks.

Vaccine taskforce

The UK's vaccine programme has been vital in combatting COVID-19.

In April 2020, **CPI** joined the UK Government's Vaccine Taskforce to support the manufacture and formulation of novel mRNA vaccine candidates in the fight against the virus. Using its facility in Darlington, **CPI** played a key role in the development, scale-up, manufacture and supply of the vaccine being developed at Imperial College London. Following on from this work, **CPI** received a further investment of £5m from the UK Government to establish a 'library' of mRNA vaccines. The library will help in the fight against new COVID-19 variants and ensure that new vaccines can be rapidly scaled-up and manufactured for clinical trials. This work is helping to protect people and the economy in the longer term.

A new £250m PPE supply chain

As part of a Scottish Government-led working group set up to help ensure critical NHS supply chains remained resilient, the **NMIS-AFRC** team addressed more than 700 enquiries linked to the provision of ventilators, intensive care equipment, PPE, hand sanitiser and testing; spoke to more than 400 companies, organisations and individuals who offered support and ensured 210 viable opportunities were escalated to NHS Procurement and Scottish Government teams. All within little more than eight weeks.

From a position of manufacturing next to zero PPE and being almost fully reliant on imports pre-pandemic, over 90% of the PPE sourced by NHS National Services Scotland is now manufactured within Scotland. This supply chain is thought to be worth over £250m.

- The **MTC** has developed and produced an innovative new PPE shield to protect NHS workers during aerosol generating procedures like mechanical ventilation.
- **CPI** and **WMG** supported the UK manufacturing scale-up of a US-developed COVID-19 test.
- Both **AMRC Cymru** in Wales and **NMIS** in Scotland have been crucial to developing both nations' guidelines for returning to COVID-secure on-site manufacturing.
- **WMG** helped the SME Ramfoam to become the UK's largest supplier of critical PPE in less than five weeks.
- **NMIS-AFRC** supported SME Breathe Easy to scale their production of a lip-reading friendly face mask, helping social inclusivity for the hard of hearing during the pandemic.
- The Mercedes F1 teams have produced 10,000 CPAP devices within 10 days with the help of the 24 hour a day work of the **AMRC** and **MTC's** Autonomous Guided Vehicles.

Keeping us healthy

It's not only the immediate response to a crisis that matters; the agility to adapt to subsequent changes is also important. We have been helping a wide range of sectors do just that, and also supporting the development of innovations that will help in any future pandemic.

Helping construction reopen safely

Social distancing is key to reopening sections of the economy that have needed to close during the COVID-19 pandemic.

Due to the group nature of the work, social distancing has particularly hit the UK construction sector, meaning many sites have been unable to operate normally. At the start of the pandemic the sector suffered a 35% decrease in new work, with the largest contributor to that decrease being the private housing sector. Mitigating further work stoppages is crucial for the UK economy.

That's why, as part of the Construction Innovation Hub, the MTC has investigated different wearable technologies that could be deployed within construction and elsewhere to help with social distancing.. By using 'right first-time' technologies, businesses will be able to reopen in a safe environment whilst ensuring the safety of their workers. These new solutions facilitate social distancing and should allow improved Health & Safety going forward, protecting lives both during and after the pandemic.

Anti-microbial poles for public transport could help in future pandemics

Since the beginning of the COVID-19 pandemic many people have been hesitant about taking public transport. In part, this is due to the potential risk of picking up germs from areas travellers must use, such as the grab-poles on trains, buses and trams.

Project AMICABLE is working to make public transport safer and, vitally, feel safer

for travellers. Researchers from WMG and other industrial partners have come together to design and produce anti-microbial grab-poles - a step-change in hygiene for public transport.

The lightweight composite poles can be used in a wide range of public transport applications, such as bus, tram and rail, with the ability to retrofit them to existing

vehicles. This means that the transmission of infections like COVID-19 can be reduced on both new vehicles and old vehicles alike. An added bonus is that the poles are a fraction of the weight of their steel counterparts, meaning that fuel usage can be reduced and public transport can move even further towards net zero.



Building a green recovery

Tackling climate change is a global and national priority. If we fail to address it, the effects will have far-reaching consequences for all of us.

As we respond to both the causes and effects to secure a sustainable environment and society, there is real potential for the UK to seize valuable economic benefits, maximising the wealth generated by green technologies. The HVM Catapult is working with businesses across the UK to enable product and process developments that support their success while leading the way to a net zero world.

Green energy

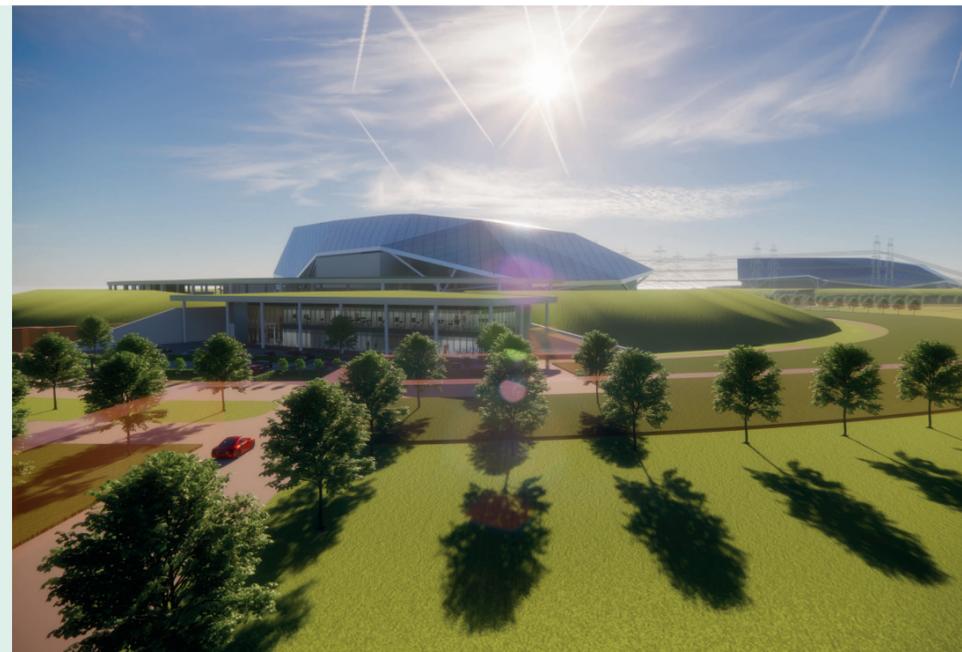
Green energy is the foundation of net zero, powering our lives and the economy while protecting the environment. We are driving emissions down by helping the country embrace nuclear, hydrogen and renewable energy.

Creating jobs in nuclear energy

As we strive towards net zero, the UK needs a low carbon source of power that's reliable when the sun doesn't shine and the wind doesn't blow.

Nuclear is an obvious answer, but lead times are lengthy and the financing challenges for large reactors are formidable. Small modular reactors (SMRs) can dramatically reduce both cost and lead times for nuclear new build, bringing a crucial part of the transition to zero carbon energy online both quickly and cost-effectively.

The **Nuclear AMRC** has demonstrated how advanced manufacturing techniques can reduce capital costs and production time for a new generation of these compact modular nuclear power stations. Working as part of the UK SMR



Consortium, led by Rolls-Royce and comprising nine engineering companies and research institutions, the Centre has focused on key manufacturing technologies which could be deployed in SMR factories across the UK. Its work has included developing an optimised machining strategy, which will reduce the floorspace required within the factories and the capital cost of the facilities, and investigating fixturing, part movement, metrology and cleaning technologies to reduce production times while ensuring quality.

The UK SMR programme is now entering its second phase, supported by up to £215 million from the Industrial Strategy Challenge Fund plus up to £300 million of private investment. As well as delivering a key source of low carbon energy the consortium expects to **create around 6,000 jobs by 2025, and 40,000 by 2035.**

End-to-end hydrogen – supporting critical infrastructure

Hydrogen is a powerful fuel source that has the potential to revolutionise a number of sectors, including transport.

With almost zero carbon emissions and a high energy density, this abundant gas promises to be a key element of delivering net zero whilst satisfying the increasing national need for energy. Led by the **Catapult Network** (including HVM Catapult) and other top technology centres, the Hydrogen Innovation Initiative will help to create a new connected innovation ecosystem for accelerating the hydrogen economy and anchoring value in the UK.

The initiative includes a virtual innovation centre which will focus on strategic technologies and cross-sectorial innovation priorities. It will be a crucial driver of the end-to-end UK Hydrogen Innovation roadmap, directly addressing the challenges faced by a traditional 'sector-focused' approach. With industrial knowhow and academic excellence, the market opportunities of a hydrogen economy are within the UK's grasp. The Hydrogen Innovation Initiative will make sure that the UK seizes those opportunities as we race to net zero.





Environmentally friendly solution for wind turbine installation

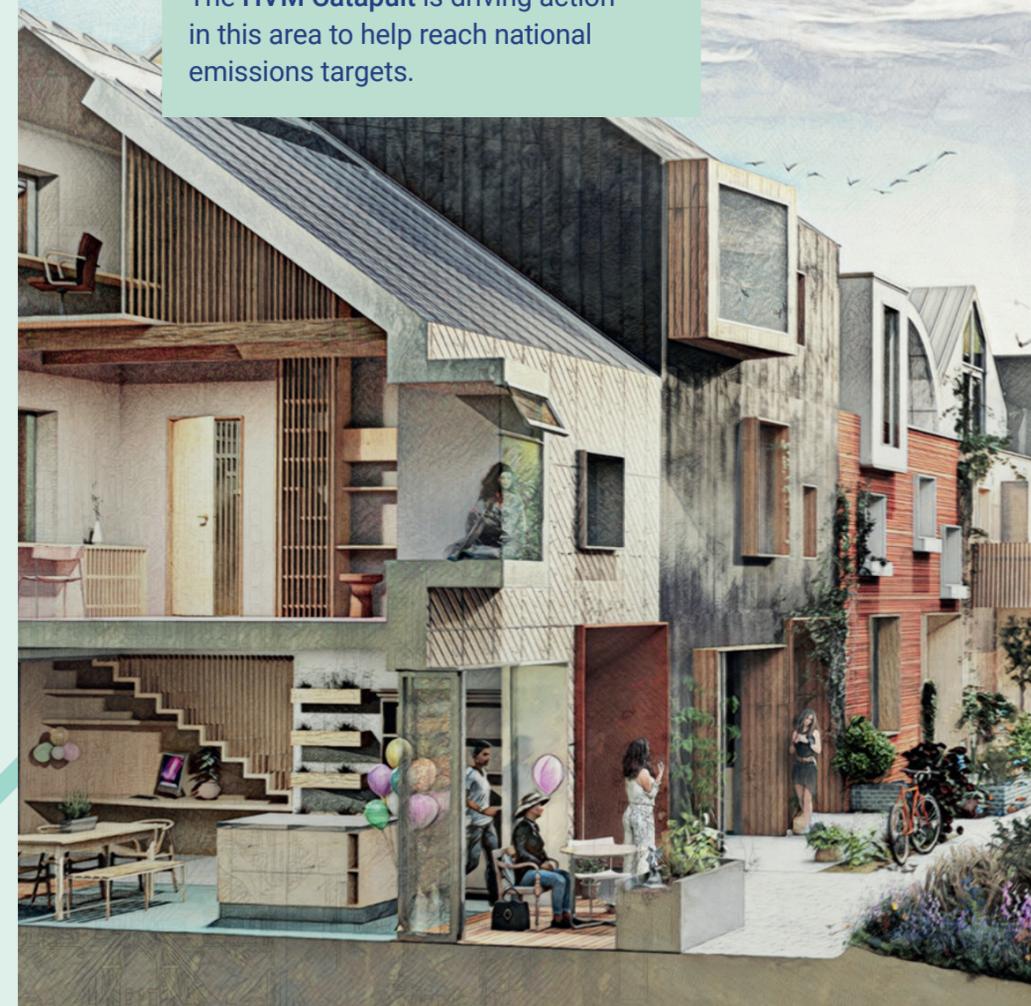
Offshore wind energy has become a vital part of the UK's energy mix, helping with the transition to net zero emissions across the economy.

However, wind turbine installation is costly and adversely impacts the marine environment of the site, discouraging new investment. But it needn't be that way. An inventive renewables SME Cedeco worked with our **NCC** team to establish whether one element of the turbine could be made more environmentally friendly at a cost-effective price point.

With funding from the Offshore Wind Growth Partnership, the **NCC** worked with Cedeco to develop an early-stage concept for a composite gripper, which would hold an offshore wind turbine leg in place without so much need for environmentally invasive reinforcement. Through modelling and detailed assessment, **NCC's** experts established that the composite grippers could slash the cost of that part and cut the installation time of a turbine farm by up to 50 days, whilst also reducing the environmental impact of the turbine installation by up to 40%. This would help to make investment in offshore wind even more attractive, moving the UK further towards its net zero target.

Green buildings

An estimated 20% of all the UK's greenhouse gas emissions come from heating the places we live and work. The **HVM Catapult** is driving action in this area to help reach national emissions targets.



Smart, sustainable homes for the future

An estimated 345,000 homes need to be built in the UK each year to meet demand. To reach the government's target of net zero by 2050, each of them will need to have impeccable green credentials.

Achieving this requires examining radical solutions. Developed with support of the AMRC, HLM Architects' 'Forever Home' platform is designed for manufacturing, assembly and disassembly, allowing a next generation of fully flexible and easily upgradeable modular homes. This means not only that more sustainable materials than high-emission cement could be used in the first instance, but that homes could potentially be upgraded over time as more net zero standards and materials become available.

A finalist for the RIBA Home of 2030 Design award, the platform aims to help solve the housing crisis whilst also tackling the capacity and compatibility issues that other offsite construction methods suffer from. The goal is a universal design standard that would enable any modern methods of construction system to deliver the same high-quality, sustainable and affordable homes with interchangeable parts. Now introduced to Homes England, this platform could set the new standard for sustainable homes in the UK.

Seismic II takes schools to the next level

Large public works, like schools and hospitals, are increasingly benefitting from the faster delivery of modern methods of construction, such as modular building.

The catch is that there are many platforms for modular structures that can prove incompatible, leading to potential waste and increased cost. The £6m Seismic II project, funded by UKRI's Industrial Strategy Challenge Fund, aims to change this by creating a collection of standardised, reconfigurable components and aligning platform interface standards.

As part of the consortium, the **NCC** is investigating the benefits of composites in modular construction, taking advantage of the increased uptake in manufacturing to build stronger, more durable structures. These components will reduce waste, cost and carbon dioxide emissions whilst further increasing the speed of construction. Working closely with **MTC's** Construction Innovation Hub, the project is set to create a new benchmark for construction in the UK, reducing building emissions and improving construction productivity while driving down costs.



Green transport

Transport is the single biggest source of UK territorial carbon emissions. We are helping to change this by both cutting emissions from conventional vehicles and driving net zero transport solutions forwards.



Lightweighting the iconic Ford Transit

The bestselling van of all-time, Ford's iconic Transit, has been put on a diet by an award-winning project involving the HVM Catapult's NCC team.

Alongside Gestamp and the University of Nottingham, the **NCC** helped Ford to shed an impressive 40% of the weight from crucial production parts in the Transit's suspension system whilst maintaining an affordable price point. With over 30kgs saved from every production vehicle in this area alone, the next Ford Transit will be a lighter, more fuel-efficient van with lower emissions.

The approach is not limited to the Transit alone. The Composite Hybrid Automotive Suspension System Innovative Structures (CHASSIS) project was developed to be a multi-material solution to provide affordable weight savings for mass production of any vehicle. Alongside other innovations, lightweighting is key to achieving net zero carbon emissions in transport.

Key role in Driving the Electric Revolution

The UK is planning to reach net zero carbon emissions by 2050, with 78% of the reduction in carbon emissions planned for 2035. Such an ambitious target calls for radical restructuring of all forms of transport.

Electrification is a key part of the solution. As an important national asset in transport electrification, **WMG** is now playing a key co-ordinating role in UKRI's 'Driving the Electric Revolution (DER)' Industrial Strategy Challenge Fund programme. The programme's Industrialisation Centre scheme will establish clusters of innovation across the UK to support the transition to lower carbon travel.

As part of their new role, **WMG** has been selected to lead the Midlands region DER Industrialisation Centre, one of four across the country. These centres will co-ordinate and build on the UK's national capability in power electronics, machines and drives to deliver long-term sustainable growth on the road to net zero. **WMG** is also due to open a new Winding Centre of Excellence led by Dr David Simkin, which will help UK supply chains to manufacture more efficient electric machines.



Green production

Manufacturing is central to every aspect of modern life: our homes, our transport, our clothes, our food and much more. The **HVM Catapult** is leading the effort to measure emissions resulting from the production of these products throughout sectors and supply chains to strengthen the UK's contribution to reaching net zero across the world.

Net zero manufacturing

Around a quarter of all global greenhouse gas emissions come from industry. This means that significant action is needed here to reach net zero and avert a climate catastrophe. The **Catapult Network** is leading the way, identifying key areas for emission reduction in transport, industrial processes, and energy generation and usage.

As the lead on industrial processes, the **HVM Catapult** has identified the key areas that should be of global focus: net zero design and make; and tracking emissions throughout manufacturing supply chains.

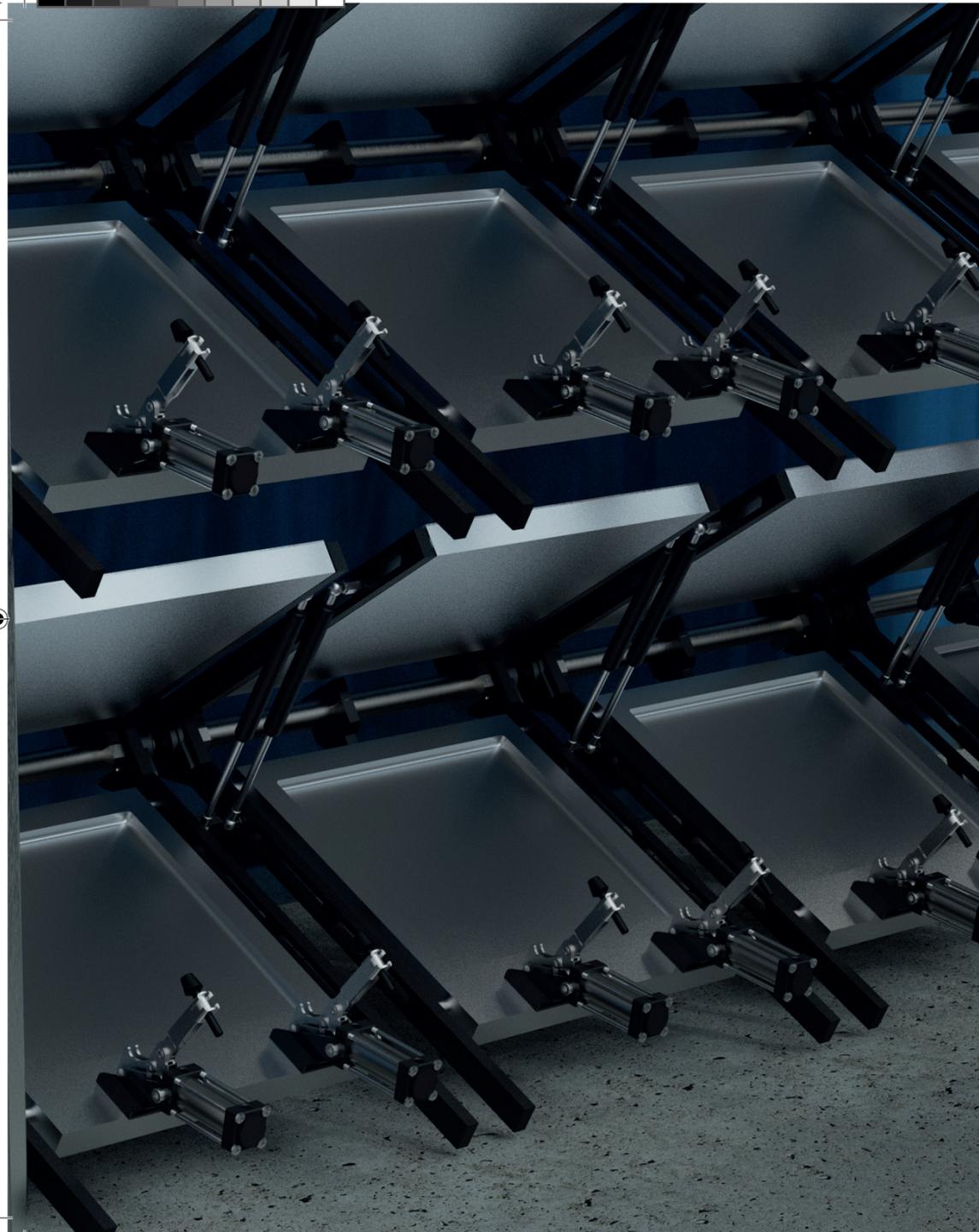
Working with the universities of Cranfield, Lancaster, Leeds and engineering consultancy Ricardo, we have found that the bulk of these manufacturing emissions are located in the materials processing stages of production, where raw materials are transformed for end use. This often takes place outside of the UK, showing the need for carbon accounting standards across global supply chains. This carbon accounting would show the true impact of market forces on emissions, creating an environmental for better emission reduction across sectors.

Saving tonnes of carbon in nuclear welding

Welding the thick-walled steel sections of a reactor pressure vessel is an extremely time-consuming task, with each joint taking around ten days to complete and releasing tonnes of carbon.

As part of a four-year collaboration with the US Electric Power Research Institute, the **Nuclear AMRC** has shown that a large electron beam welding chamber can complete these critical welds in just two hours. Not only does this technique drastically cut the time taken for each weld, it also slashes the process cost by over 90% and saves over two tonnes of carbon emissions every time.

Funded by the US Department of Energy, the breakthrough forms part of a broader project with industrial partners on both sides of the Atlantic to reduce the time and cost of making pressure vessels for small modular reactors (SMRs) by around 75%. It is developments like these that help to reduce the production and construction time for SMRs by years, making the transition to net zero faster and more affordable.



Waste slate turned into roof tiles

Using waste from North Wales's industrial past, Carapace Slate's sustainable snap-fit roof tiles take time and cost out of tiling. The company was experiencing increased market demand for their ground-breaking product. but with little capacity to increase manufacture, Carapace approached the MTC to help increase production volumes.

The MTC team modelled the full production process of Carapace's tiles, identifying crucial areas of improvement at each step. By moving to a system of easily interchangeable tooling, they were able to slash downtime for retooling to 10 minutes. Moving to a simple hinge mechanism in the tile system also made each tile cheaper to manufacture and maintain. The final design allowed Carapace to scale their production much more readily, adapting to market demand with a cost-effective process. Taking this into their business, Carapace will be ready to provide a resilient supply into building projects across the UK.

Go with the flow – saving material and time with a forging alternative

Forging may be considered the 'gold standard' of production methods for high pressure and high temperature sectors but it can mean material wastage of up to 80%. Opening up new markets by increasing yield for a metals manufacturing company, the NMIS-AFRC demonstrated an alternative method to forging that reduces waste by up to 40%.

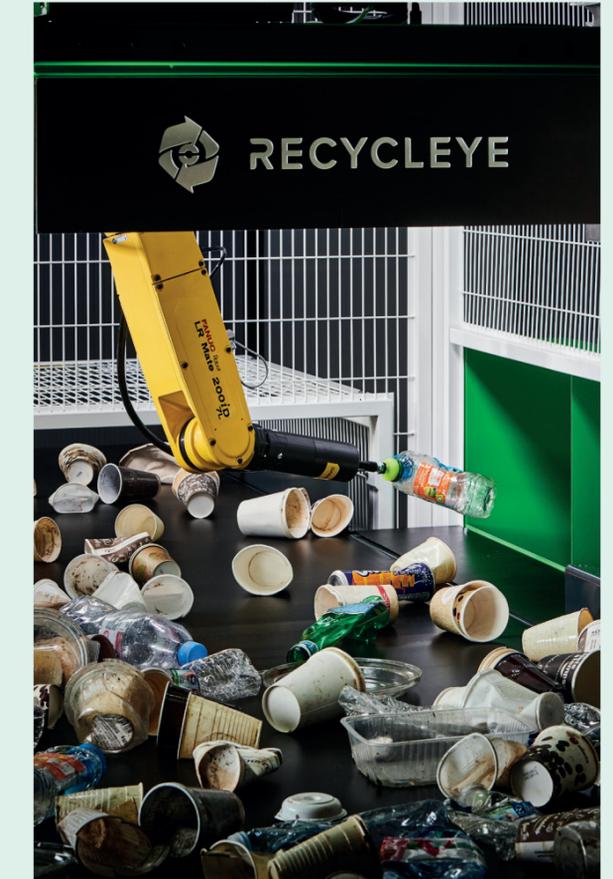
Working with Metaltek International's Scottish arm, Sandusky Limited, the NMIS-AFRC used flow forming to increase a centrifugally cast preform to twice its original length, while also improving its mechanical properties. Demonstrating that the same robust material properties as forging can be achieved, but with less waste, the process can also reduce production time thanks to a more efficient supply chain. A final important benefit: by generating a greater degree of recyclable waste material, the carbon footprint of components is also reduced.

Smart waste management

Two billion tonnes of waste are produced globally each year, of which only 8% is recycled. So, it's no wonder that manual waste sorting is no longer equipped to handle this mountain of refuse.

To help cope with this demand, intelligent waste management start-up Recycleye has developed a robotic waste picker, which the MTC helped them move from concept to commercial product within a year.

The robotic system is powered by Recycleye Vision – a world-leading AI computer vision system which detects all items on waste streams by material, item, and even brand. This allows quick and automated waste picking, identifying more recyclables from waste than manual sorting. The best news is that the system is modular and can be easily retrofitted to existing waste picking lines. The next time you put something in the bin, this innovative MTC-enabled product may well be the system making sure we get another use from your rubbish.



Developing the next generation of sustainable composites

The strength and design flexibility offered by composite materials make them a highly attractive option for many manufacturers.

At the moment, however, 85% of composites are neither reused nor recycled at the end of their life. Instead, the materials end up in landfill, adding to the world's growing refuse problem. The Sustainable Composites Partnership brings together industry, academia and government to transform the scene.

Using CPI's expertise in formulation and materials scale-up alongside NCC's knowhow in composite design and through-life performance, the initiative is accelerating the development of new recycling technologies in the UK and creating new sustainable composites made from bio-based materials including vegetable waste and algae. Working with partners, the initiative is already starting to build a supply chain from raw material suppliers to end-of-life recycling with the ability to deliver the next generation of sustainable composites by 2040.



Developing premium sustainable bio-packaging

Packaging matters in every sector. With over two megatons of plastic packaging waste in the UK each year, a more sustainable alternative is sorely needed.

That's where Oceanium Ltd, a seaweed processing company that purchases sustainably-farmed seaweed from UK sources to create plant-based nutraceuticals, food ingredients and sustainable bio-packaging, comes in.

Working with Oceanium as part of the European Regional Development Fund IMPACT project, CPI helped to develop an initial formulation for their bio-packaging materials which will provide the basis for film and board bio-packaging products, 'Oceanware™', that Oceanium is looking to trial in 2022. This exciting development in sustainable packaging looks likely to make a real difference to plastic usage.

The road to net zero

Reaching net zero greenhouse gas emissions by 2050, and hitting 78% reduction from 1990 levels by 2035, is a challenge requiring co-ordinated effort across the UK.

No one solution will be enough.

We must remove all carbon from our energy system – moving to zero carbon energy from nuclear and renewable sources.

We must move to new methods of transport, some utilising the clean electricity we will generate, and some built around brand-new fuels like hydrogen.

We must meet housing demand with a vast building programme of net zero or carbon negative homes, using innovative new materials and methods. And we must make better use of our current housing stock, increasing occupation rates and energy efficiency, and installing the low-carbon heating systems of the future.

Underpinning each of these moves, we must slash the emissions of manufacturing, from

concrete to cars, to ensure the things we need are not part of the problem. And we must also ensure low emissions from the decommissioning of the products they replace, maximising the ability to recover valuable raw materials for re-use.

It is important that we do not merely look at the processes on our own shores when considering our impact. We have the power to make a real difference in the global race to net zero by recognising our demand for overseas production, often in areas with less stringent environmental regulation, and changing our behaviour.

Achieving net zero is an opportunity for the UK to lead the pack.

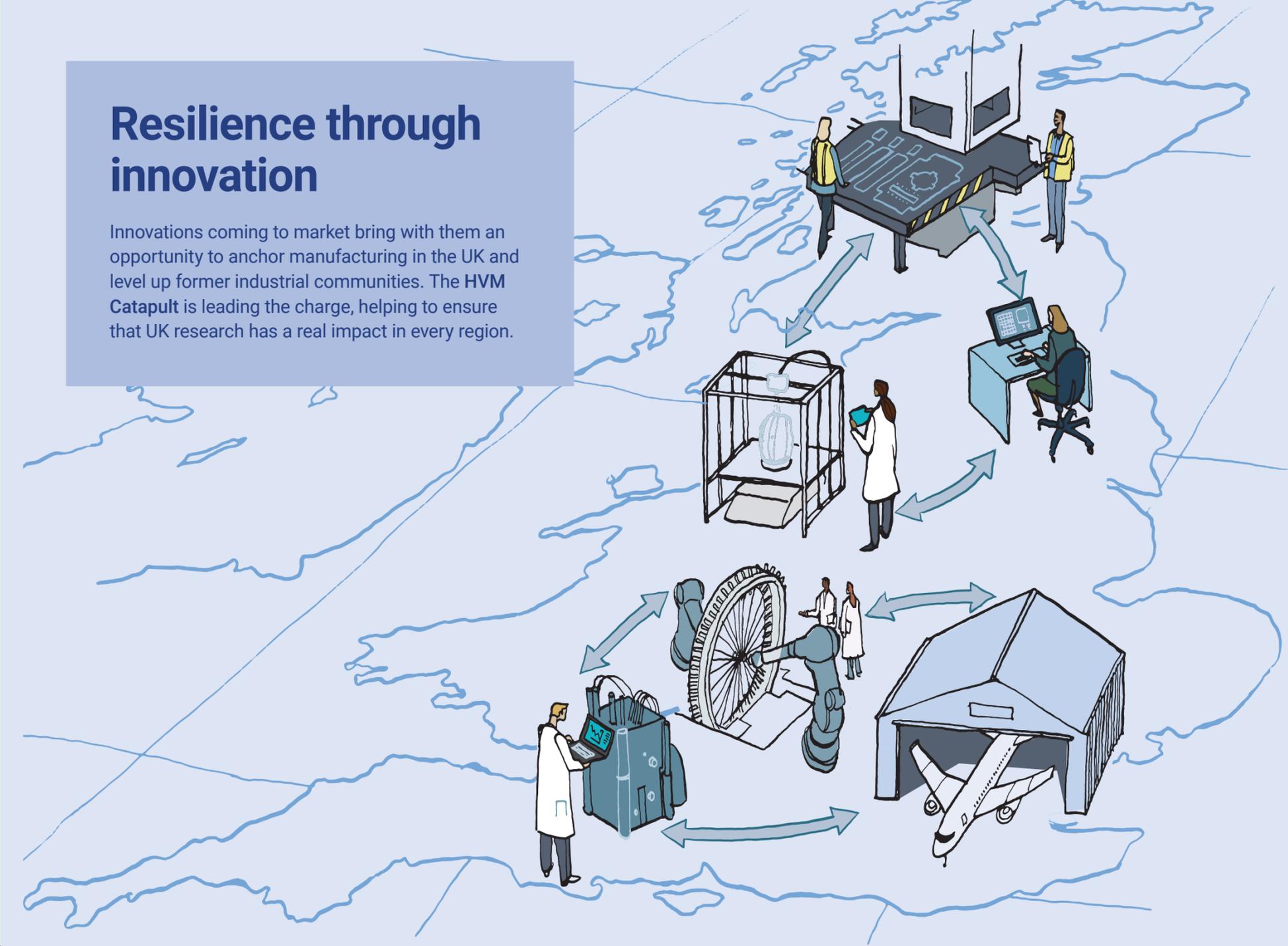
It is an opportunity to reinvest in the UK's regions and make our economy less dependent on cross-border supply chains. The **HVM Catapult** is already enabling some of this crucial work across the UK.

We are ready to help the UK secure its place on the world stage.



Resilience through innovation

Innovations coming to market bring with them an opportunity to anchor manufacturing in the UK and level up former industrial communities. The **HVM Catapult** is leading the charge, helping to ensure that UK research has a real impact in every region.



Backing SMEs in manufacturing

It's small and growing manufacturers that can have the greatest direct impact on communities, creating valuable jobs and investment for local people. Making up 56% of our industrial partners, the **HVM Catapult** is supporting Britain's smaller firms to commercialise their ideas and access new markets across the globe.

Deaf community hails new lip-reading face masks

Scientists and healthcare professionals around the world have underlined the importance of face coverings to reduce transmission of the coronavirus. While necessary for public safety, facemasks present huge challenges for the hard of hearing.

Face masks with clear windows allow better visibility of facial expressions and lip movements, but at the start of the pandemic there were few manufacturers or suppliers.

Edinburgh social enterprise Breathe Easy had products that could protect users within a social environment but were not certified for medical use. At a time when only a handful of labs in Europe were able to certify the product, there was a long queue for an appointment and applicants needed to present a comprehensive portfolio to secure product approval.

The **NMIS-AFRC** applied their expertise to help the company build a portfolio, documenting the design process and outlining the specifications of the product.

Demand has been incredible, with the **NMIS-AFRC** supporting Breathe Easy with growing its staff and increasing its production facility by 400%. With the expertise of **NMIS-AFRC** engineers, the social enterprise has now concluded all certification testing and self-certification against the relevant standard is now being sought for the BE CLEAR transparent face mask. Breathe Easy has received an initial order for 10,000 masks from NHS Scotland to be used in further live trials and discussions around an additional 500,000 are ongoing along with conversations with other NHS trusts across the UK and Ireland.

Less than five weeks to become the UK's largest supplier of critical PPE

The COVID-19 pandemic drove a sharp increase in demand for PPE. The Black Country-based Ramfoam secured a contract to supply the UK Government with 3.5 million face visors per week to help protect workers across the public sector.

To achieve this, they had to scale their output by 300 times in a matter of weeks. Add the pandemic-related supply chain disruption to the mix and the challenge might have seemed insurmountable.

With digital manufacturing and supply chain support from **WMG**, they were able to reach this target within five weeks, becoming the largest UK supplier of PPE to the NHS. This has created 550 new jobs for the local economy and secured a further 750 in the supply chain, with the company now having produced 55 million visors for the NHS to protect vital keyworkers. Ramfoam are now selling their RamfoamCare+ visors worldwide and exploring ways to improve manufacturing sustainability with **WMG**.

Image credit: Ramfoam



Bringing nanomaterials to County Durham

Nanomaterials and engineered particles are exciting innovations that have the potential to transform products as diverse as stain-repellent fabrics and diagnostic biosensors.

To encourage better use of these technologies in the UK, **CPI** partnered with Durham University to accelerate nanomaterial-enhanced products to market with SMEs across County Durham.

As part of the COAST programme, and with the research expertise of Durham University and scale-up experience of **CPI** at their fingertips, more than 60 SMEs were able to speed their ideas – including 11 products or processes which were completely new-to market. In addition to helping to cement County Durham as a national centre for nanomaterial manufacturing, **CPI's** work meant that 55 jobs were created, many in the County Durham area, demonstrating the strength of our regionally targeted SME development activity.

55

Jobs created

£4.7m

of additional funding or investment secured by SMEs

GVA of between

£3.06m and £3.87m

generated

...as a direct result of this work

To go from an idea to a proven, commercial product in less than two years is nothing less than extraordinary.

Sandy Chen, CEO Graphene Composites



Without the AMRC I don't think we could have reached the point we are at now. It really was that decisive for us. It was a major factor in our business moving forward.

Zen founder, Nick Middleton.

Putting UK innovation on the world stage

The 'thoroughbred, highly educated, expert approach' of the AMRC has helped a South Yorkshire SME to revolutionise how top tier professional golfers practise and how we all watch the game on TV.

With support from the AMRC, SME Zen developed its Green Stage: the world's first fully adjustable, computer-controlled golf playing surface which accurately simulates the real-world playing conditions

found on an undulating course. It's such a valuable tool that you might have spotted it has been adopted by the Sky Sports Golf team in its coverage of every major championship since its debut for The Masters in November 2020.

Months before that, however, Zen found themselves stuck in a metaphorical bunker, with a stage that had to be calibrated manually by a hand-held digital

level and a system that used ultrasonic beams, compromised by the smallest spider's web. Utilising existing technology, AMRC engineers stepped up to the tee to design a new system with Zen, one that was more accurate, more resilient and quicker to produce. Now a key fixture in global golf, this project was all par for the course for the AMRC.

Developing UK supply chains

Sovereign capability is more important than ever to help tackle the supply chain disruption that can flow from problems at borders, transport hold ups, trade agreement changes and COVID-19. The **HVM Catapult** is helping local companies and global giants to seize the opportunity of British production and manage their supply chains through difficult circumstances.

Saving the Great British cuppa

In early 2020, uncertainty around COVID-19 caused panic buying in many UK supermarkets, doubling demand of essential consumer items.

Many manufacturers and distributors struggled to meet this demand, with basic products like toilet rolls, tea and pasta disappearing from shelves. Big brand firms were not immune from the difficulties, even household names like Tetley Tea, owned by Tata Consumer Products Ltd (TCPL).

To cope with this spike in demand, **WMG** supported TCPL to identify an optimal level

of production which was shown to keep the business competitive, while allowing spare capacity to deal with fluctuations. This 'buffer management' modelling helped shape the supply chain set-up and strategy for Tetley Tea, allowing TCPL to increase production by 35% and keep this national staple on our shelves.

By adapting quickly, TCPL was not only able to satisfy their customers, Tetley also took the lead in market share during this period, showing how a flexible supply chain can help a company gain competitive advantage. **WMG's** insights helped to keep the humble cuppa available throughout the pandemic.



Building up the Scottish 3D-printing supply chain

Additive manufacturing (or 3D-printing) is a transformative approach to manufacturing that allows companies to develop complex shapes which often can't be created by any other process. It's a valuable tool for manufacturers in every sector, opening up opportunities to cut waste and develop better, more sustainable products.

The **NMIS-AFRC** led Additive Manufacturing Business Technology Support project sought to grow the Scottish additive manufacturing supply chain, ensuring that more companies could harness the benefits of 3D printing technologies.

RAM Engineering & Tooling was one of the companies to seize the opportunity. **NMIS-AFRC** helped the Forfar-based engineering company to understand the complexities of the technology and de-risk their plans before adopting it in their business. The leap to this technology had a tremendous impact on their business, who are now securing orders from new markets across Europe, Australia and the Middle East.

Developing the UK energy supply chain

The low carbon transition creates real opportunities for companies up and down the UK. The **Nuclear AMRC** is now adapting its proven Fit For Nuclear (F4N) supplier development programme to help SMEs win work in other low-carbon sectors.

More than 860 companies have already completed the online F4N assessment, with most receiving ongoing support and development from the **Nuclear AMRC's** team of industrial advisors. To date, participating companies have reported that F4N has helped them win around 20,000 new contracts in nuclear and other sectors, worth over £1.3 billion total.

The **Nuclear AMRC** is now working with the Offshore Renewable Energy Catapult, which has seized on the approach, to roll out a new Fit 4 Offshore Renewables initiative. More than 50 companies in key regions of England and Scotland are now working through the programme.



Levelling up the UK's regions

The HVM Catapult is attracting investment to the UK from around the world and anchoring it in our regions. We use our national capabilities to deliver regional growth, often helping to bring high-skilled jobs and prosperity back to deprived communities. The expertise and facilities found in our Centres are a powerful magnet for multinational firms and national institutions who come to locate close to us creating jobs and boosting local economies as they do.



Attracting global firms to Renfrewshire

Six miles west of Glasgow, on former greenfield next to Glasgow Airport, the **Advanced Manufacturing Innovation District Scotland (AMIDS)**, led by **Renfrewshire Council** is coming to life.

This is now home to an £11.8 million R&D programme with the world's largest aerospace company, Boeing. The programme, run by the **AFRC** has already seen the company hire a team to work at a newly refurbished facility set to formally open in Autumn 2021.

Already home to the **AFRC** and Lightweight Manufacturing Centre, both part of the **National Manufacturing Institute Scotland**, as well as renowned manufacturing companies including Rolls-Royce and Thermo Fisher, the newly formed 52-hectare district has the flagship **NMIS** HQ site at its heart.

The new district is the result of collaboration between industry, academia and the public sector and sees two of the **HVM Catapult's** Centres working side-by-side. Next-door to the new **NMIS** HQ facility will sit **CPI's** Medicines Manufacturing Innovation Centre (MMIC), a collaboration between the Centre, University of Strathclyde and Scottish Enterprise which is bringing the pharmaceutical giants GSK and AstraZeneca to the region.

Forging new relationships with both industrial leaders and local communities alike, **HVM Catapult's** presence in Renfrewshire is bringing tangible benefits to the region and Scotland as a whole.

Greening the UK's most carbon-intensive industrial region

The **AMRC** and **Nuclear AMRC** are supporting a major new project to decarbonise the industrial cluster around the Humber and help **UK manufacturers win work in emerging low-carbon sectors including hydrogen fuels and carbon capture.**

Funded by UKRI's Industrial Strategy Challenge Fund, the Zero Carbon Humber (ZCH) Partnership, will accelerate decarbonisation in the UK's most carbon-intensive industrial region, supporting clean growth and future-proofing vital industries, whilst protecting and creating jobs.

The **AMRC** and **Nuclear AMRC** will work together to apply their expertise in developing the UK supply chain for the low-carbon energy sector, building on the proven Fit For Nuclear model to meet the challenges of industrial decarbonisation.

The **ZCH** proposals alone could reduce the UK's annual emissions by 15 per cent, and safeguard 55,000 existing jobs in the region. This will help to build resilience in the local economy and retain the vibrancy that makes the Humber a great industrial powerhouse.

Supporting the next big thing

Cutting-edge technologies need to be nurtured by experts to move effectively beyond the lab. The **HVM Catapult** is taking early-stage innovations and demonstrating their usefulness for commercial applications, ready for the next generation of manufacturing.

Quantum leap in data security in UK first

The processing power of quantum computing will challenge the security of today's encryption technologies.

This has serious implications for many industries which rely on ultra-secure data transmission, including design and manufacturing projects where this can be a matter of national security.

Quantum key distribution (QKD) has been identified as one of the solutions to maintaining this security, using principles from quantum mechanics to keep data encrypted and reliably detect eavesdropping attempts. But its suitability for real-world manufacturing applications has been largely untested – until now.

Built in partnership with BT and Toshiba Europe, the UK's first industrial quantum-secure network is now jointly hosted by our **NCC** and the Centre for Modelling and Statistics. This is also the first time that the technology has been demonstrated using 'off the shelf' components, marking a key success in the shift to future-proofed smart factories. Created as part of the West of England Combined Authority's Digital Engineering Technology & Innovation (DETI) programme, this global success is set to bring real opportunities to the West of England in the longer-term.

Breakthrough in intelligent robotics

A robot can often perform many tasks that people find incredibly difficult – meticulous number manipulation and data recall among them. But it can't easily identify unknown objects from a random tray or bin and pick them up, until now. The **MTC** has made a breakthrough in intelligent robotics by developing a system that can teach itself how to pick up unknown objects, without the need for expensive sensors or lengthy programming.

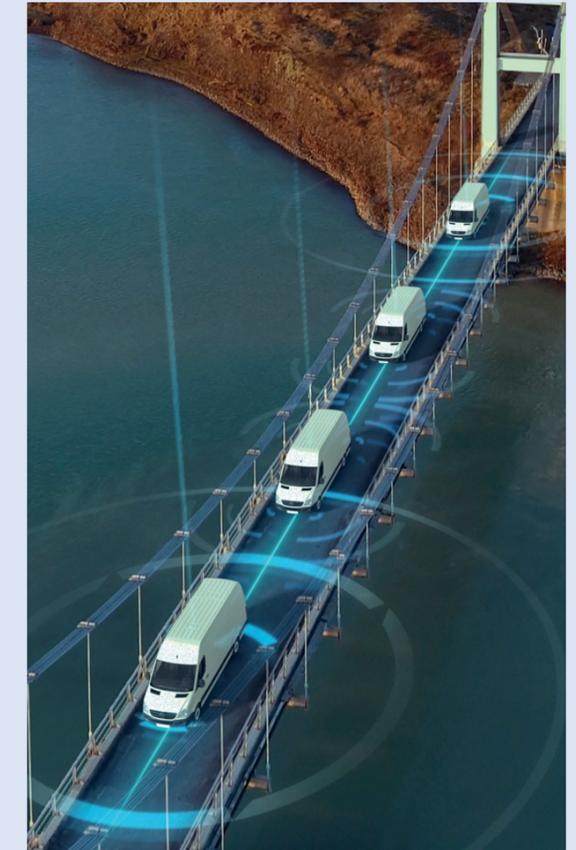
The new robotic process uses a deep neural network, low-cost depth cameras and robotic arms with vacuum pick-up cups. The inexpensive components and highly flexible self-learning mean that the system can be put in place quickly and affordably, adapting to the individual needs of different industrial uses from picking components to cosmetics containers and even fruit. Working alongside a company's workforce, this system is set to revolutionise item picking across all industrial sectors.

Bringing connected and automated vehicles one step closer

Connected and automated vehicles (CAV), such as self-driving cars, have long seemed like science fiction, but with technological change happening quickly, they are moving closer to reality.

However, companies often need to produce reams of data on scenarios a vehicle might encounter, via simulation or real-world testing, which can delay innovation. Enter the SafetyPool™ Scenario Database, the world's largest public scenario database for testing CAV solutions, with over a quarter of a million scenarios.

Developed by **WMG** in collaboration with Deepen AI, a Silicon Valley start-up, with support from the World Economic Forum, the SafetyPool™ Scenario Database enables manufacturers to take safe connected and automated vehicles to market faster through a precise, simulated testing process. Funded by Zencic and Innovate UK, the database is reaching companies across the world with major global stakeholders coming on board. The next big thing in transport is one step closer.



Identifying areas for UK growth

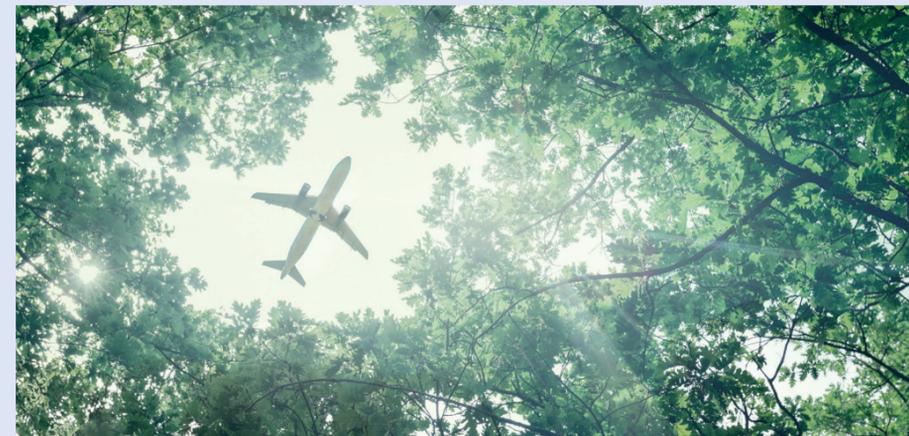
The cradle of the first industrial revolution, Britain has historic strengths in many areas of manufacturing, alongside present-day research excellence in many others. The **HVM Catapult** is working to identify the most promising areas for growth and developing realistic plans to make it happen, building on the UK's existing strengths.

Mapping aerospace innovation to 2035

The UK aerospace industry is the second largest in the world, representing a 17% global market share. It's right then that the UK should also play a leading role in developing the future of aerospace, including driving down the sectors carbon emissions.

To do so, we need clear goals and a strong plan which will make sure we achieve them. Working with the Aerospace Technology Institute and industry, the **HVM Catapult** has developed roadmaps that lay out the future manufacturing research and innovation priorities for the sector to deliver the next generation, low emissions aircraft by 2035.

Aligning to the ATI's 'Accelerating Ambition' strategy, the roadmap identifies the UK manufacturing capabilities needed to deliver the propulsion, structures and systems for future aircraft. Based on consultations across the industry, we found key challenges in all areas: from accelerating product development and reducing cost to through-life sustainability and weight optimisation. To overcome these challenges will demand innovations in sustainable composites, tooling and life-extension technologies. The roadmaps we produce will be used to inform projects across the UK and help to identify funding priorities for the ATI and government, leading to transformation of the aerospace sector by 2035.



Manufacturing the future workforce

Workforce development is key to harnessing the full value of our world class research output and anchoring manufacturing success in every region of the UK.

Upskilling the workforce

The workforce crisis in UK manufacturing is well known. There is an acute skills gap that prevents manufacturers from successfully exploiting new technologies.

Launched in January 2020 with support from the Gatsby Foundation, the **HVM Catapult's Manufacturing the Future Workforce** report provides a blueprint for the way forward.

The Skills Value Chain Approach

The Skills Value Chain (see right) is an approach that connects workforce development with the wider innovation ecosystem, leveraging the technological know-how of Centres of Innovation (like the **HVM Catapult**) to build an industrial

skills base fit for the future. We found that Centres of Innovation can use their key positions at the interface between research and industry to play three leading roles:

1. **Convening the partners, resources and expertise required to establish educational needs for the future workforce**
2. **Curating and creating curricula and content for modular courses, and helping to set up accompanying training standards**
3. **Delivering early-stage training and helping partners to scale-up their offering across the UK**

Our Recommendations

The Manufacturing the Future Workforce report made five recommendations for the UK system, based on good practice around the world.

1. **Develop and pilot the application of skills foresighting**
2. **Support the development of Higher Technical Qualifications and National Standards**
3. **Develop modular training and resources to support future workforce skills development**
4. **Promote 'Learning Factories' as an education model to enable industrial digitalisation**
5. **Improve recognition and funding of modular and lifelong learning**

As the UK recovers from the effects of the pandemic with a need to 'Build Back Better', these recommendations have become even more relevant.

We are pleased that these principles have received national recognition through our work on the Emerging Skills Project.

Emerging Skills Project

Funded by the Department of Education, the **Emerging Skills Project will pilot our Skills Value Chain approach across key regions in the UK.**

Working closely with Institutes of Technology, we are developing high-quality modular training courses focused on upskilling employees for work with new and emerging technologies, like robotics and AI, electrification, additive manufacturing, and advanced composites. We are also designing and delivering detailed content for 'training the trainer',

allowing the courses to be more widely disseminated.

With continuing support from the Gatsby Foundation, we have been able to develop the Skills Value Chain approach and prove our foresighting processes work (see right). Joined by a wide collaboration of employers, universities, and colleges, we can now use this knowledge of future skills needs to co-ordinate the modular content needed to bring these learnings into the workplace.

With a proven concept and follow-on projects now confirmed, this pilot project is a first step in the UK's journey to a more skilled workforce.



What is foresighting?

Foresighting is a process of assembling experts across relevant groups to identify the likely 'future-state' of needs in a sector or economy. This 'future-state' need can then be compared with 'current-state' of provision to highlight both matches and gaps that need action. Key to filling the gaps in education and training is identifying the learner groups that will require these future skills and which parts of the existing, adult workforce they will be drawn from.

Sharing our expertise with the country

We know that it is crucial to ensure our world-leading expertise is partnered with both industry and academia for the UK to remain a global giant. We are leading the way in joining the UK's powerful manufacturing sector with its cutting-edge research to bring real value to the national economy.

106

original research publications

36

student placements into industry

8

Knowledge Transfer Partnerships

22

Researchers in Residence

261

projects with academic institutions

1,136

engagements with UK academic institutions

268

engagements with international academic institutions

Sharing research excellence

Every researcher has their own unique knowledge set, bringing with them ideas and approaches that could benefit the UK. That is why collaboration and co-creation remains at the heart of the Catapult Network's activity.

Working with the Engineering and Physical Sciences Research Council (EPSRC), the HVM Catapult led an initial knowledge transfer scheme in 2014 to strengthen our links with the wider academic base. Based on this work, we have established a broader EPSRC Researchers in Residence programme, bringing leading academics from across the country into both our Centres and other Catapults to undertake research into the technologies that will provide much-needed impact for the UK economy.

With more than 40 researchers hosted within the **Catapult Network** each year, we are working to extend this programme in 2022, bringing industry, researchers and innovators closer and closer together each day.

Making Scotland's Future

The Scottish Government's flagship programme 'Making Scotland's Future' brings together leaders from across the manufacturing landscape to realise the opportunities presented by a low carbon economy.

Led by a Strategic Leadership Group which includes **NMIS** CEO John Reid, the programme is working to boost productivity, drive innovation and transform the skills of the current and future workforce in Scotland to help achieve net zero. The development of **NMIS** will be a vital part of realising the ambitions for Scotland's industrial future.



UK Manufacturing Forum

When thought leaders are brought together, incredible things can happen. This is why we partner with the University of Cambridge's Institute for Manufacturing to convene the single largest group of leading academics, researchers and industry representatives each year. The UK Manufacturing Forum is a space for these leading lights to combine their strengths in service of the wider community.

Now in its third year, the forum has identified key challenges and collaborative opportunities in areas crucial for UK

manufacturing development, from net zero design and make to FlyZero and industrial digitalisation. The forum is also producing a detailed report on the strengths and weaknesses of the current research and innovation climate in the UK. With the voices of academia and industry aligned, we are making recommendations that will allow far greater collaboration between organisations, increasing the effectiveness of the country's greatest minds. This report will be published later in 2021 and we look forward to working with government, academia and industry to build a manufacturing research and innovation community that truly has no equal.

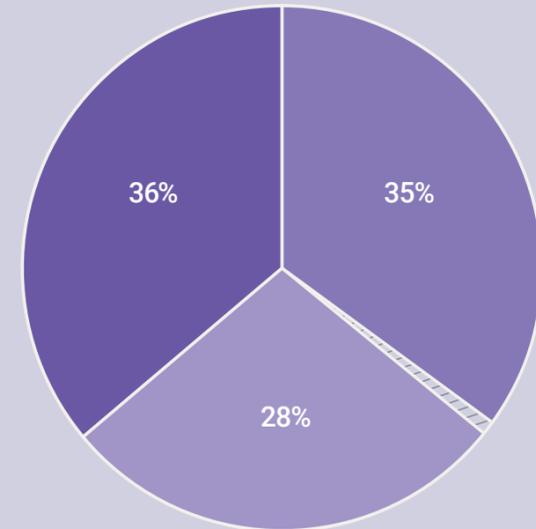
Our resources

Based on internationally-benchmarked best practices, including the renowned German Fraunhofer approach, the HVM Catapult strives to secure broadly equal amounts of income from:

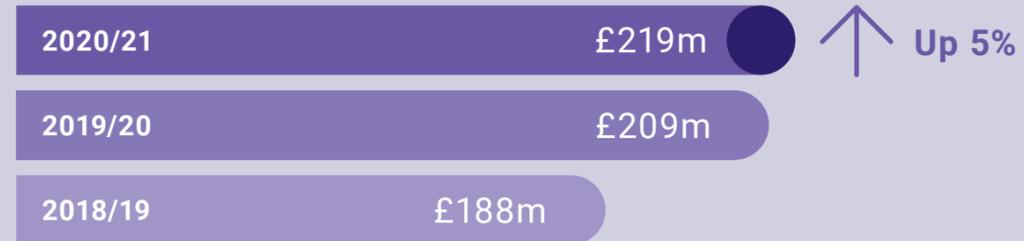
- Core public funding from Innovate UK for long term investment in infrastructure, expertise and capability
- Collaborative R&D projects funded jointly by the public and private sectors and awarded on a competitive basis
- Commercially funded R&D contracts

Maintaining the funding model in proportion helps to keep our activity in an innovation 'sweet spot' which encourages risk-taking, collaboration and development in areas that are beneficial for UK industry.

HVM Catapult Income Sources 2020/21



HVM Catapult Collaborative R&D and Commercial Income*



*Excluding collaborative R&D in land and build

Manufacturing a greener world



Katherine Bennett
Chief Executive,
HVM Catapult (2021–)

New chief executives need to be lucky in their predecessors. At the HVM Catapult, I have inherited an organisation nurturing ground-breaking ideas and technology that touches and improves everyone's lives, in every part of the country.

Dick Elsy has fostered a collaborative approach across seven independent centres, working from 17 sites, supporting some of the most brilliant minds the UK has to offer.

For me, that success was best exemplified by the Ventilator Challenge, a race against time in the midst of a pandemic that has caused so much pain. Dick and his team should be extremely proud of the way they helped to ease the suffering of thousands of people by pulling together an industry consortium so quickly and effectively.

The foundations are in place for the **HVM Catapult** to be at the heart of the post-pandemic recovery. Our ambition

is to make the UK a leading industrial superpower by the end of this decade, **doubling the value of manufacturing as a proportion of the economy to 20%.**

By 2030, we want to have supported the growth of 20,000 SMEs and brought 10,000 new products or processes to market.

As awful as the pandemic has been, it has reminded us that nothing is more important to the economy than people. We will focus relentlessly on skills over the coming years, making sure the UK is equipped for a digital and sustainable industrial transformation.

We aim to train or upskill 200,000 scientists and engineers a year once the 2020s draw to a close.

Greening the economy is no longer a buzz phrase in business and politics. This decade will be defined by the drive to net zero and the **HVM Catapult's** Centres will deepen their collaborative spirit as they lead those efforts.

This year, expect our Centres to launch a range of initiatives in and around the UN Climate Change Conference - COP26 - in Glasgow. We're hugely ambitious for this work and believe we can hit a target of **reducing greenhouse emissions from UK manufacturing by more than 40 megatons during the 2020s.** To put that in context, manufacturing 46 bags of cement is estimated to create one tonne of greenhouse gas emissions – so we're looking at incredibly advanced technology and processes to achieve such a turnaround. My first task, though, is to listen, so that I understand the challenges, risks and opportunities facing our centres.

I do believe that embedding further collaboration can only better position **HVM Catapult** to attract inward investment to the UK and meet our target of **doubling R&D expenditure in UK engineering & manufacturing to £44bn.** But I am also aware that the **HVM Catapult's** structure was designed to support and enhance the work of our Centres, not interfere.

From Renfrewshire to Bristol, Liverpool to Coventry, the **HVM Catapult** is always here to help, co-ordinate where necessary, but never impose.

By working together, we will lead the UK's clean, green recovery in 2021/22 and its industrial transformation over the years to come.





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