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/AMRC
Advanced Manufacturing
Research Centre

Journal

25TH ANNIVERSARY
SPECIAL EDITION

ISSUE 20



25

CELEBRATING 25 YEARS
2001 – 2026

Celebrating the people and projects that made us

Twenty-five years of people. Twenty-five years of transformative projects. Twenty-five years of pioneering new products, processes and technologies that have reshaped manufacturing across South Yorkshire, Lancashire and Wales.

Celebrating the 25th anniversary of the University of Sheffield Advanced Manufacturing Research Centre (AMRC) in this, our 20th issue of the AMRC Journal, is more than a milestone. It is a moment to look back at the foundations that we are built upon, to the people who walked so we could run, and to look forward to where we're heading next.

Having been part of the AMRC for five of those 25 years, I feel an immense sense of pride. I may only play a small part in what we do here, but that small part sits within an incredible ecosystem that began as a singular bold vision: to bridge the gap between academic research and real-world industrial application. In this AMRC Journal, that vision translates into themes that have defined the last 25 years: **made here, made better** and **made for the future**.

In my role at the AMRC, I have the privilege of telling these brilliant stories that have made us in so many ways. Sitting down with everyone from apprentices and shop-floor engineers, to our executive leadership team and asking them face-to-face what motivates and drives them in their work gets me excited about what more I can bring to my own work.

As an organisation of humble individuals who treat game-changing innovation as just another day at the office, this issue is dedicated to them and to the ambitious projects transforming UK manufacturing.

You can read about the legacy of Dr Phil Yates, 'your favourite mentor's favourite mentor'. Phil's steady hand has guided generations of graduates, keeping vital

manufacturing skills and jobs right here in South Yorkshire.

We put the spotlight on Kim Butterfield, who sprinted from a graduate placement to driving key elements of the Rolls-Royce Small Modular Reactor (SMR) project at Factory 2050, proving just how quickly our people develop to make industry better.

And we point the way forward to the future with Composites at Speed and Scale (COMPASS), our largest collaborative R&D programme to date, designed to transform UK manufacturing through high-rate composite production at scale – a facility made for the future.

But none of this happens in isolation. Our success belongs equally to each and every one of our extraordinary staff, our visionary industrial partners and the key stakeholders whose continued faith, and funding, powers our vision to lead global manufacturing innovation through impactful research.

Our work shows no sign of slowing – in fact quite the opposite – and that makes the future immensely exciting. Not knowing what the next breakthrough will be, or who will discover it, is a journey worth taking.

Thank you for championing us, collaborating with us and believing in what we do.

Here's to writing our next chapter together.

Chloé Rothenburg

Guest editor



Don't miss the latest innovation, insights and news from the AMRC.
Sign up to our newsletter: amrc.co.uk/pages/newsletter

MADE HERE

From grassroots beginnings and gaming passions to shop-floor innovation and trust-first leadership, meet the AMRC pioneers shaping next-generation engineering.

Pages 10 – 19



MADE BETTER

Step inside the engine room of modern manufacturing innovation and see how we're driving industrial transformation – from de-risking delivery of new nuclear reactors and casting techniques, to paving the way for commercialisation of a high-tech spin-out.

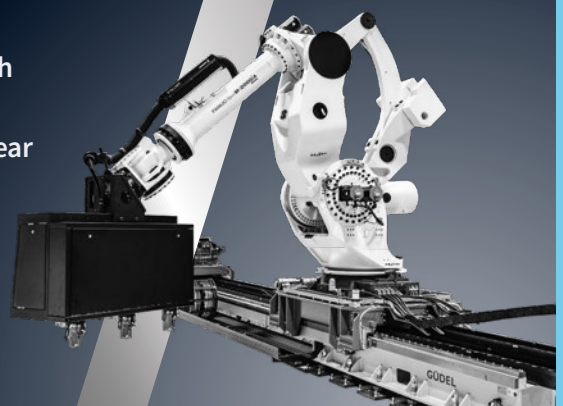
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MADE FOR THE FUTURE

UK manufacturing is entering a new era of sustainable growth driven by breakthroughs in high-rate composites, precision ceramic machining, hydrogen assembly, small modular nuclear power and decarbonisation. The AMRC has the cutting-edge facilities, technical expertise and industrial partnerships needed to lead this transition.

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Grounded by vision, powered by people: the AMRC turns 25

By Professor Ben Morgan,
Chief executive officer, University of Sheffield AMRC.



Twenty-five years ago, the University of Sheffield Advanced Manufacturing Research Centre (AMRC) was founded on a single, bold ambition: solving the impossible manufacturing challenges holding UK industry back, bringing pride back to South Yorkshire. The groundwork laid by our founders and Boeing, supported by the University of Sheffield and industry in the region, built the launch pad we stand on today.

This anniversary issue is all about being made here, made better and made for the future, showcasing some of the brilliant people, projects and drive behind a legacy built to last another 25 years. I invite you to explore these pages and discover a very special journey of pride, partnerships and perseverance.

The foundations

We've grown from eight people in one single building, to 553 spanning 12 buildings equipped with cutting-edge kit, delivering world-class expertise across South Yorkshire, Lancashire and Wales. Yes, we've grown and expanded our footprint. Yes, we've been able to buy some of the latest tech to innovate. Yet, the true core of why we remain successful has always remained the same: our people.

Our teams are driven by a shared passion for innovation, process improvement and real-world impact, which is second-to-none.

We have the end-to-end technology capabilities to support the full product

lifecycle, from concept design and prototyping, additive manufacturing, composites, casting, machining and large scale fabrication, through to automated assembly, robotics and assurance, all with an underpinning capability in digital manufacturing and sustainability. This cadre of capability sits seamlessly under one organisation. That combination, where we can do materials and first principle design ideas, through to engineering and high-value design, into advanced manufacturing and end of life, is rare. And our passion to deploy it is unmatched.

Sharpening our focus: aerospace, defence and nuclear

The world changes at an incredible speed. Industrial strategies set by the government evolve, geopolitics shift and global markets demand entirely new solutions. But it's reflective of the tools in our toolbox. To help lead in this environment, we are doubling down on three core sectors aligned with national industrial priorities.

- **Aerospace:** global demand requires an estimated 65,000 new aircraft by 2050. The launch of new single-aisle platforms represents a generational opportunity for the UK. By partnering with heavyweights like Rolls-Royce, Boeing and Airbus on single-aisle engine architectures, we are securing high-value manufacturing jobs and supply chain growth.
- **Defence and national security:** global stability requires national resilience. Across defence and national security, opportunities exist to bolster UK security, power economic growth and create high-value jobs through advanced manufacturing. Leveraging regional catalysts, like the South Yorkshire Defence Growth Deal in partnership with the South Yorkshire Mayoral Combined Authority (SYMCA), will accelerate these sovereign defence platforms and critical infrastructure.



- **Nuclear and clean energy:** operating in nuclear innovation since 2011 and bringing the former Nuclear AMRC fully into our primary stable consolidates our technical horsepower. From supporting Rolls-Royce Small Modular Reactors (SMRs), to advancing waste management technology at Sellafield, we are directly enabling the UK's clean energy transition.

Underpinning these pillars is *Make. Scale. Grow.* This is our approach to supporting businesses at every stage of their development through a complete innovation journey, from early-stage ideas to long-term growth and economic impact. It streamlines how high-growth businesses access our manufacturing toolkit, ensuring regional startups and established supply chains scale together and deliver.

A personal reflection

My journey to the AMRC wasn't planned on paper and was really rather fortuitous.

In 2008, amid the global financial crash and fresh from six months of travelling the world, I was made redundant before my first engineering job even began. At 22, a few months later, I was sitting, freezing on a dumper truck in three feet of snow at home in Lancashire, wondering what on earth came next.

A family connection prompted me to send my CV to AMRC co-founder Prof Keith Ridgway, and after a visit to the AMRC and

an informal chat, I joined the assembly group in February 2009.

I worked for pioneers like John Baragwanath and Jim Heley, under the kind mentorship of Phil Yates, Richard James and Andy Bell – many of whom are still in the organisation today.

More than 18 years later, stepping onto the balcony at the Future Energy Factory as the chief executive officer and looking across our advanced manufacturing ecosystem remains a 'pinch yourself' moment.

Going from graduate engineer to leading this institution at 40-years-old is an immense privilege. The pressure is real, but my confidence lies in the extraordinary leadership team and workforce that surrounds me.

And what strikes me most about the AMRC isn't just the mega-projects; it's the quiet coffee-machine conversations where engineers routinely solve global manufacturing problems with total humility, seeing it as 'just another day'. Working in a culture like that is priceless.

Through five years of industry disruption, the commitment and patience of our people have brought us out stronger than ever. I want to thank each and every person for the part they have played in getting us here.

In a volatile economic climate, the AMRC is stable, resilient and delivering results. The momentum is now back in our hands. I urge everyone to embrace that classic AMRC self-starter mindset that is in our DNA: take the initiatives, own the challenges and help shape our next chapter.

Our next era of growth

We operate today from a position of commercial stability and technical strength. After years of unprecedented disruption across global business, our team's hard work has secured our foundation. Now I believe the time is right to push forward faster.

As regional devolution expands and opens up bigger opportunities, our ambitions must accelerate to match it. I believe our strategy is strong and works well within the regions we serve, but we need to move faster.

Having already seen more than 2,200 apprentices recruited through the University of Sheffield AMRC Training Centre and £350 million in inward investment on the advanced manufacturing park in South Yorkshire, we are now aiming to quadruple that impact over the next decade. Our goal is big and bold: pushing for £2 billion inward investment and 10,000 apprentices. Those are the figures we need to try and deliver on.

And who knows, it might come from Boeing, it might be SpaceX. You don't know who it's going to be and where it's going to land. But what I do know is that our future has never looked brighter.



Explore our plan for lasting impact and growth.

The silver years

Explore a quarter-century of pioneering UK manufacturing: how a single building grew into 12 world-class facilities, driving £350 million in regional investment and now steers a future course to revolutionise aerospace, energy and defence.

2004

The first building

Opening of AMRC 1, the first building on the Advanced Manufacturing Park, used by a small team of researchers to pioneer innovative titanium machining strategies for aerospace applications.

Boeing 787 Dreamliner landing gear

In partnership with Messier-Bugatti-Dowty, the AMRC develops an innovative machining strategy for titanium alloy landing gear components, cutting machining time by a factor of 18 and reducing tooling costs by 30%.



2005

Airbus A380 titanium pintles

Optimised machining strategies reduce the manufacturing time for Titanium 6-4 landing gear pintles from 145 hours down to 19 hours.

Image: Airbus A380 by frielp, Flickr.com CC BY 2.0

2001

The AMRC is born

The AMRC is founded by Prof Keith Ridgway, in partnership with the University of Sheffield and Boeing, to bridge the gap between academia and industry. The vision was to use machining to create wealth for a depressed area. It would eventually lead to the transformation of the former Orgreave colliery into a global beacon for advanced manufacturing.



2003

Dowty Propeller Hub

Engineers design a twin-spindle configuration that enables a 'single-hit' machining solution, reducing non-machining cycle time from more than three hours to under 30 minutes.

2011

High Value Manufacturing Catapult is founded

The AMRC becomes a founding member of the UK's High Value Manufacturing Catapult, formalising its role as a national blueprint for bridging academic research and industrial application.

cATAPULT
High Value Manufacturing

2012

Cutting production time by half for Rolls-Royce

The AMRC worked with Rolls-Royce to reduce the production time and increase performance of machining aero-engine disks. Innovations developed by the AMRC allowed Rolls-Royce to reduce the time it takes to manufacture each disc by 50% and de-risked a £100m investment in its Tyne and Wear aerospace disc factory, producing more than 2,500 discs per year for Trent aero engines.



2015

Archaeological heritage preservation

Engineers use digital measuring and 3D modelling technologies to document and preserve historically important sites from Middle Ages.



Factory 2050 opens

Launch of the first fully reconfigurable digital manufacturing research facility.



2017

Footprint Tools

The AMRC integrates automated robotics into production for this Sheffield-based tool manufacturer, saving 150 workdays per year, preventing production outsourcing to Asia, and boosting company sales by 40%.



2014

AMRC Training Centre opens

The University of Sheffield AMRC Training Centre opens its doors on the Advanced Manufacturing Park, providing high-quality vocational pathways to bridge the regional skills gap.



2018

NASA spacecraft 3D printing

The AMRC's THREAD 3D printing technology is featured at NASA's Jet Propulsion Laboratory Spacecraft Additive Design Workshop – the only non-US innovation selected.

BAE Systems robotics workstation

AMRC engineers integrate and test collaborative robot (cobot) technologies to drive BAE Systems' 'Factory of the Future' assembly line.

Major inward investments

The AMRC is a significant factor in helping secure major regional investments with £40m Boeing Sheffield facility and £50m McLaren Composites Technology Centre.



Copyright: Beadyeye

2019

Opening of AMRC Cymru

Launch of the flagship facility in Broughton, North Wales, focused on aerospace and digital manufacturing.



Apprenticeship excellence

Then AMRC engineer-in-training Rebecca Wright, who now works for Aston Martin Formula 1, is named a finalist at the National Apprenticeship Awards 2019.



Western Sydney

Aerotropolis partnership

The AMRC partners with Australian leaders on a £20 billion regional economic plan to build a high-value manufacturing district around Western Sydney airport.

2021

Magnomatics generator assembly

Automation engineers streamline the manual placement of permanent magnets onto offshore wind generators, making the process 60 times faster.



2020

COVID-19 ventilator production

Within six months of opening, AMRC Cymru reconfigures its main facility into a production site to manufacture thousands of life-saving medical ventilators for the NHS.

Olympic track cycling

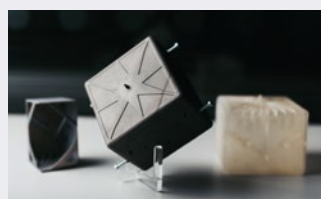
Custom track bicycle components manufactured at the AMRC help British cycling teams achieve marginal gains for world-record attempts.

Locomotive restoration scanning

Industrial laser scanning resolves long-standing discrepancies between historical 1960s technical drawings and actual locomotive parts.

MiniTANKS satellite fuel tank

Additive manufacturing engineers design ultra-lightweight fuel tanks tailored for small-scale satellites.



2022

Airbus Wing of Tomorrow

AMRC Cymru supports research streams on Airbus's Wing of Tomorrow program to develop advanced wing processes for the next generation of single aisle aircraft.

Opening of AMRC North West

Opening of the £20 million research centre at Samlesbury Enterprise Zone in Lancashire.

National Cyber Force location

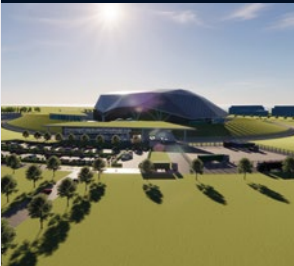
The presence of AMRC North West plays a pivotal role in attracting the UK National Cyber Force headquarters to Samlesbury, set to create an estimated 2,000 high-productivity jobs.



2025

New era for nuclear

The AMRC is using its adaptive research capabilities to develop a manufacturing process to help Rolls-Royce SMR deliver a factory manufactured nuclear power station.



From the AMRC to Tennessee

A test unit nuclear reactor vessel fabricated in partnership with the AMRC and Cambridge Vacuum Engineering is successfully installed by Kairos Power at its USA campus in Tennessee.

Advancing nuclear waste disposal

The AMRC collaborates with Deep Isolation on project to prove feasibility and commercial readiness of deep borehole disposal solutions, validating key technical aspects and identifying pathways to strengthen the supply chain for advanced nuclear waste disposal.

2026

One big birthday, a refreshed strategy and a new building

In October the AMRC celebrated turning 25, launching a new strategy focused on three key sectors – aerospace, defence and nuclear – and opened its latest open-access innovation facility, COMPASS, with Boeing as its first user.



Economic impact overview

Workforce growth

From eight original employees in 2001, the AMRC now directly supports **more than 550 full-time equivalent (FTE) jobs** across the UK.

Regional and national productivity

AMRC workers are **45% more productive** than the UK average, generating an annual direct Gross Value Added (GVA) contribution of **£55.8 million**.

Wage contribution

AMRC employees **earn 46% more** than the average full-time worker in South Yorkshire, directly boosting regional prosperity.

Inward investment magnet

AMRC's presence has attracted **more than £350 million** in private investment and **2,500 jobs** across the Advanced Manufacturing Park (AMP) and Sheffield Business Park.

Industry reach

The AMRC collaborates with an average of **1,100 private-sector businesses annually**, 42% of which are small-to-medium enterprises (SMEs).

2024

LISI Aerospace smart factory

The AMRC delivers a smart production line for the aerospace company, resulting in record turnover, increased productivity, £2m in new business, and 12 new job opportunities.



SME electric motor production blueprint

The AMRC devises processes to de-risk traction motor manufacturing, creating a pathway to scale UK SME's production rate from 60 to 5,000 units per year.

Autonomous grassland farming

AMRC Cymru trials the UK's first commercially available fully-autonomous tractor to build agriculture sector's confidence in emerging technologies.

Wentworth Woodhouse restoration

The AMRC and PES Scanning use high-definition 3D laser scanning to restore and preserve the 18th-century Germanicus statue.



Explore the moments that shaped us.

MADE HERE

'Made here' is all about people, our people. We're showcasing some of the heads, hearts and hands of the individuals who have played a part in making the AMRC the national asset it stands as today. In 25 years, we haven't just reshaped manufacturing, we've transformed the lives of the people behind it. Built on the former slagheaps of Orgreave colliery and coking works, the AMRC's legacy is rooted in empowering individuals to push the boundaries of what's possible: in careers in industry, in South Yorkshire. World-class innovation starts at home. By honouring our people, we hope to inspire the next generation to take pride in what is made right here.





Your favourite mentor's favourite mentor

By Lucy Hilton

Dr Phil Yates has always drawn a crowd of peers, post-grads and placement students.

Whether it was coursemates at university, where Phil joined as a mature student, or junior members of staff at the AMRC – Phil always has a flock.

After leaving school with two O-levels, Phil worked at garages and dealers across the whole span of the automotive industry, before getting a council grant to attend Sheffield Polytechnic – now Sheffield Hallam University – to earn his Higher National Diploma (HND).

Moving onto his PhD, Phil ended up sharing the same research office as

Garth Nicholson, now principal design engineer for the AMRC's design and prototyping group.

Garth remembers Phil in those early days as 'seeming to spend every waking hour torquing down cylinder head bolts'.

At the turn of the century, a time where industry was seeing a shift towards computing, Phil joined a number of

software companies, before Garth, who had already joined the AMRC from Forgemasters, suggested he give AMRC founder, Keith Ridgway, a call.

“When I joined the AMRC, I was asked if I knew anyone else who might be a good fit. I immediately thought of Phil,” said Garth.

“The early days suited Phil’s practical skills down to the ground: he built robotic and vision system demonstrators, solved IT and integration issues and tackled hands-on challenges without hesitation – including procuring the AMRC’s Jetstream fuselage and scrubbing years of moss off it with bottles of T-Cut scratch remover.

“For the 32 years I’ve known Phil, he has been the definition of enthusiastic and helpful – always willing to step up for anyone who needs a hand.

“On the countless factory and trade show visits in the early Centre of Excellence in Customised Assembly (CECA) days, his genuine passion for our work and the AMRC always shone through, no doubt playing a huge part in laying the foundation for the brilliant team the integrated manufacturing group (IMG) is today.”

Phil’s first manager, 19 years ago, was Phil Freeman, who had been seconded from Boeing for a year to help set up the

“I like to fix something, or make the world a slightly better place every day.”

Dr Phil Yates, technical fellow, University of Sheffield AMRC.

CECA, which was an early version of IMG.

“Back then, there were only a handful of us, satellite internet, no heating, one robot and a basketball court,” said Phil.

“I didn’t have to mentor anyone in those days; that didn’t come until we started employing graduates who were looking for guidance.”

One of Phil’s first mentees was then project engineer, now project delivery director on the AMRC Board, Chris Greaves. Chris and the AMRC’s CEO, Ben Morgan, were IMG’s first graduate engineers.

Chris said: “Phil was always there. He always helped you, and if something went wrong, or didn’t work, he’d just say ‘don’t worry, we’ll fix it’.

“The number of graduates that have come through IMG is enormous. So many

of those students have stayed on as full time staff, and it’s because of people like Phil who have made them feel welcome and helped them develop. The effect he’s had is immeasurable.

“A lot of young graduates end up on small and medium-sized enterprise (SME) projects so that they can learn a real-world problem with Phil’s guiding hand.

“That work he’s done is hugely impactful – it’s not massive multi-million pound projects, but it has an impact. It’s keeping jobs in South Yorkshire, it’s keeping manufacturing in South Yorkshire; it’s really what we’re here to do.

“He means so much to so many people.”

Routes like the AMRC’s postgraduate schemes, summer placements and apprenticeships are invaluable to Phil,



Phil Yates, technical fellow and Lucy Mello, machine integration engineer for automation, looking at the end effector of the Spirit Views robot cell, which is being used to test machine learning (AI) methods to improve robot accuracy.

especially with the widening skills gap in industry.

“The historic decline of manufacturing in the UK meant people didn’t have to be trained up anymore. We’ve lost those skills, and the people who are retiring now are taking them with them,” Phil said.

“Apprentices and young people are the future of a company. Without training, your company doesn’t have a future.

“I learn a lot from them myself; they have a whole different mindset. They’re such a joy to work with – all I have to do is point them in the right direction.

“The beauty of the AMRC is that we get some of the finest minds coming through our shop floors; we don’t just ‘do engineering’, we do everything. There is always someone, with a different background than you, that you can pick the brains of.”

One of those brains is machine integration engineer, automation, Lucy Mello, who came to Sheffield from Brazil to study for her masters degree before joining the AMRC, where Phil was her first

mentor. Working together on a number of projects, including the Siemens automated disassembly system, Lucy, who Phil describes as ‘brilliant’, said she has never stopped learning from him.

But it hasn’t all been smooth sailing – working with so many young female engineers, Phil has seen firsthand how women in the manufacturing industry can be disregarded by their peers.

“Working with good engineers, who happen to be women, and seeing how they’re treated? It drives me mad; I can’t let it go,” said Phil.

“Lucy is consistently playing an absolute blinder in her work, but on occasions where I’ve seen people not take her seriously when they first meet her really bug me.

“It’s an industry problem. People might see it and not know what to do, but you have to call it out.”

Phil’s passion – for guiding young engineers, for backing his teams, and for supporting local SMEs – isn’t stopping any time soon. Almost 20 years since originally

joining the AMRC, Phil isn’t slowing down.

In fact, outside of his day job, Phil is working with a team of railway enthusiasts to build a Hengist Locomotive, rebuilding a Peugeot 205 car, and working on cars with his colleagues. But what’s next for him?

“The main thing is that I will be staying at the AMRC for the foreseeable future,” said Phil.

“I need something to get out of bed for; I need a purpose in life. I like to fix something, or make the world a slightly better place every day. When I go to bed, I want to feel like I’ve done something.

“Working at the AMRC keeps my brain young, because I have to push myself every day. When we get a new device in at work, the kids have got it working in 20 minutes, they understand it in an hour, and I’m still reading the manual.

“You have to keep your brain switched on to keep going with them – it’s brilliant. They’re headstrong and challenging, but if everybody toed the line, nothing would get invented.”

“If everybody toed the line, nothing would get invented.”

Dr Phil Yates, technical fellow, University of Sheffield AMRC.



Phil pictured in a McLaren sports car at Factory 2050 in 2017.



Phil holding a miniature replica of Wentworth Woodhouse’s Germanicus statue, manufactured as part of a project to preserve the real-life historic 180cm marble statue.

David King: a leader defined by deadlines, demand and drive

By Chloé Rothenburg

Feeling the weight of unmovable deadlines, unstretchable budgets and critical systems that had to deliver without fail was Prof David King's tough start into industry. Yet these challenges were more than professional hurdles, they proved to be the pivotal catalyst for his career move to the University of Sheffield AMRC.

David learned early on what it truly meant to lead, carry responsibility and act as an advocate for his team when the pressure was on. That industry-grounded discipline drove his path forward.

Now leading the digital design team for the AMRC's design and prototyping group, David applies those hard-earned lessons daily, fostering a trust-driven culture that empowers his engineers to push boundaries when it matters most.

Crucible of industry

Reflecting on his 18 years in industry, where he has held senior roles in software and control systems, David admits those early years shaped him in ways he didn't appreciate at the time.

"I learned what it feels like to carry responsibility," he said. "To know that a decision you make today affects delivery tomorrow.

"Having a good idea wasn't enough; it had to survive real constraints, real scrutiny and real-world pressure. When things failed, there was nowhere to hide. You fixed it, learned from it and moved forward."

That crucible came to a head on a top-level project facing unyielding deadlines and months of seven-day work weeks.



David King (centre), pictured with design centre colleagues Baslin James and Sam Hyde.

He said: "As a leader, there came a time when I had to say no, whatever the repercussions were for me. And it wasn't until now, being at the AMRC, I remembered how intense those times in industry could be."

A leap of faith: discovering the AMRC

After almost 20 years in industry, David was drawn to the emerging concept of Industry 4.0. Attending a workshop held at the AMRC presented by current chief executive

officer, Ben Morgan, proved to be a turning point for him.

"It was a revelation," David said. "I saw a whole other world at the AMRC and instantly knew I wanted to be part of it."

David joined the AMRC in 2016, describing the organisation as a place where he could unite his curiosity, passion for technology and desire to make a difference. "It offered the chance to combine the urgency of industry with the depth of academia," he said.

Over the next decade, David built the digital design team, established the digital lab and became head of digital design in 2022, where he led on award-winning projects across healthcare and defence.

MediTel crunch time: team trust

Uniting industrial reality with research ambition laid the foundation for David's project he is most proud of at the AMRC: telexistence. He was driven by a simple question: 'What if we could project human capability into places too dangerous for people to go?'

From that question grew a body of research into life-saving robotics culminating in MediTel, a ground-breaking medical telexistence platform developed in under 12 months.

"Our telexistence work is one of my proudest chapters," David said. "Not because of the trophies, but because of the team of brilliant engineers that pushed boundaries together. Seeing a system go from concept to a validated platform in an operational context was an extraordinary privilege."

The pressure of delivering a time-sensitive new robotic platform reminded David of working to similar demanding timelines in industry. The difference now is that David applies a transformed leadership approach that focuses on communication and trust.

"It was about making sure the team understood the pressures, why we were doing it and why it mattered," said David. "When people understand the goal, they take ownership. Each individual owns a part, but together we deliver."

"It was the first time that we as a team had been involved in robotics technology at this level. It was fine using the robots, but to develop a new robot that hadn't existed before was a challenge like no other."

That trust was put to the ultimate test the night before a major live demonstration in front of hundreds of industry experts. David said that back at the hotel the night before, engineers Rob Stacey and Baslin James were writing code until 2am to get the system working.



Inside the telexistence operator's chair – projecting human presence, skill and judgement into remote and hazardous environments.

"I barely slept that night and felt the full responsibility on my shoulders if it was to fail," he said. "I desperately wanted to help, but having more people there would only distract them."

"A big part of leadership is knowing when the best thing you can do is put total trust in your team and let them get on with it—and it paid off when it counted the most."

"It was something we'd never managed to make work fully in the lab, so to see it work to the point where the platform was doing things never done before was a moment I'll never forget."

The weight of a title

In January this year, David earned his professorship, an achievement he insists was never about the title. He views it as a responsibility to lead with integrity, build teams that outlast individuals and push the boundaries of human-machine systems.

"This professorship was not achieved alone," said David. "I stand on the

shoulders of my mentors, colleagues, collaborators and my family. I never set out to be a professor, but I've always had a passion for learning and took the opportunities that came up.

"But that sense of achievement when I called my wife and told my family I had done something pretty special meant everything."

"If my journey has taught me anything, it's that the greatest impact is created at the boundaries, where industry meets academia, where humans collaborate with intelligent machines and where imagination becomes real-world implementation."

For David, the most inspiring part of his story isn't the past, but the future to come.

He said: "Deploying world-class technologies with the power to save lives and extend human capability into challenging environments isn't just exciting, I feel it's a responsibility and a great privilege. I'm excited to see what comes next."

"It was a revelation. I saw a whole other world at the AMRC and instantly knew I wanted to be part of it."

Professor David King, head of digital design, University of Sheffield AMRC.

Passion, problem-solving and precision are Erica's keys to success

By Chloé Rothenburg

A chance trip to the job centre gave Erica Smith the 'serendipitous' moment that launched her engineering career instead of the retail job she expected. A decade on, the AMRC machining innovation fellow has built a career around high-stakes problem solving, reviving the niche art of machine grinding and opening up vital data and statistical training for her colleagues.

The steps Erica took towards a career path in engineering started when she was young; the thoughts of making and inventing things took the win over wanting to be a zoologist.

"I realised as I got older that I enjoyed inventing things more," Erica said. "My dad and grandad were engineers, so it goes back a long way. My dad was always encouraging me, making little planes and other things together."

Forged on the shopfloor

Erica's passion for machine grinding began purely by chance.

While studying mechanical engineering at Bradford University, she needed a job to help pay the bills. A visit to her local job centre, expecting a retail job, unexpectedly landed her an inspection role at the Federal-Mogul factory.

"This trip to the job centre ended up being very serendipitous," said Erica. "I was just expecting a retail or warehouse job, I wasn't expecting it to be engineering."

"When they found out I was an engineering student, they put me straight

onto a mass-manufacturing shop floor working 12-hour shifts at weekends, handling quality control for a factory that produced two million piston pins a month.

"At 3am, no one's picking up the phone to help, so my role quickly morphed into supporting the team with real-time process engineering on cylindrical and centerless grinding and helping to solve any problems that arose. That's where I fell in love with the physics, the dynamics and problem-solving."

After finishing her degree with six years of industry experience already under her belt, Erica moved to Sheffield to be closer to family and joined the AMRC as a project engineer, bringing a rare, sought-after expertise in surface finishing and grinding.

The problem-solver

No stranger to last-minute machining project rescues, Erica recalls stepping in when a complex stack-machining project hit a wall with its sensor setup. Her industrial experience retrofitting pre-war machinery with modern sensors proved crucial.

"I was originally just there for data capture," said Erica. "But adapting one sensor setup across completely different machines created unexpected complexities. I cleared my work decks for a few months to help get everything installed correctly and ensure the data was rock-solid."

Her hands-on efforts ended up paying massive dividends for the team. "We were able to publish several third-party papers off that data, making it mature enough for that to build on," she said. "The lessons we have learned mean we haven't made the same mistake twice, and have supported project after project ever since."

When the pressure is on, Erica relies on a sharp quality-control mindset, combined with a team-first philosophy. "Even just one other person makes a huge difference," she said. "You realise you're panicking together, so you can calm it down, step back and figure it out."

For her, successful troubleshooting at the AMRC isn't about being a lone hero, but providing a supportive sounding board where engineers combine their different strengths to solve the unfixable.



Innovation fellow Erica Smith sensorising the new AMRC Cymru drilling and fastening cell.

From expert to enabler

As less grinding work was coming into the machining group half-way into her career, Erica ended up pivoting her skills into drilling projects, where another skillset from her time in industry emerged: statistical analysis, which catapulted a plan to train the next generation.

“Having a joint background in engineering and statistics is less common,” Erica said. “It’s not where all my skillsets lie, but it’s something I’ve always been good at. A lot of the time, people’s work was already 95 percent there, but they lacked the confidence to know they were doing it right. But it helps to enable a closer working relationship between statisticians and domain experts to share and exchange their knowledge.”

Driven by this vision, Erica secured AMRC senior leadership support, collaborating with the statistical services unit at the University of Sheffield to launch bespoke training. Determined to make the knowledge stick, she visited every research group across the AMRC to build a network of local champions, naturally attracting an encouraging 50/50 split of male and female engineers.

For Erica, the goal was simple: turn her specialist insight into shared organisational strength.

Culture, curiosity and the freedom to try

Looking back over her ten years at the AMRC, what stands out most to Erica is the rare freedom to ask ‘what if?’

“Industry can be very focused on delivering a product or doing something the same way over and over,” Erica said. “At the AMRC, you can go: ‘Well, what if we tried this unusual idea?’ You get to speak to people who have decades of experience, learn from what hasn’t worked before, and push ideas forward without getting stuck in a rigid box.”

That spirit of exploration is backed by a workplace culture that has visibly evolved over her ten-year tenure. While engineering can often lean toward long hours and burnout, Erica appreciates the AMRC’s conscious push toward well-being and flexibility. It’s an approach that ensures engineers aren’t just solving complex industrial problems, they’re being looked after while doing it.

“You get to speak to people who have decades of experience, learn from what hasn’t worked before, and push ideas forward without getting stuck in a rigid box.”

Erica Smith, machining innovation fellow, University of Sheffield AMRC.

From hobby to high-tech: how Sam is shaping the future of virtual reality

By Chloé Rothenburg

A love for gaming helped technical fellow Sam Hyde to level-up his skills at work, moving from mechanical computer-aided design to software and immersive technologies.

Sam completed his degree in mechanical engineering at the University of Sheffield, but after his PhD funding ended before completing his research, he took a job as a university IT technician doing lecture theatre support.

“I saw a job advertised for a new design and prototyping group at the University of Sheffield AMRC in 2013,” Sam said. “I didn’t really know what the AMRC was, but it sounded like a great fit. I wanted to push the boundaries of what I could do in engineering.

“I never did go back to finishing up the PhD research, but I’m glad of the path I ended up on instead.”

Home gaming to engineering curiosity

Joining the AMRC as a design project engineer, Sam initially focused on mechanical CAD. But as his role progressed, it aligned with his personal passion for 3D graphics and virtual reality (VR), steering him down a digital path.

Now as technical fellow for software and immersive technologies, Sam’s home interests in gaming, programming and electronics actively feed into his work. His expertise spans using 3D data as a communication tool, building 3D product models, and conducting VR/mixed reality design reviews.



Technical fellow Sam Hyde.

“I’ve always been a bit of a gamer at heart,” Sam said. “Tinkering and trying stuff at home has real value because I can apply it to my work. There’s a great synergy in being able to carry across interests from home to work and vice-versa.

“It’s a general sort of engineering curiosity that I can’t help but have. You look at the world around you, try and analyse how things work and what’s behind the surface of everyday items and systems.”

Never one to fully switch off, Sam said his home setup is the helpful cheat code for explaining his job to family and friends.

He said: “It can prove difficult to explain the day-to-day of what we do and get it across in an understandable way, but thanks to the explosion of accessible home VR consoles, it’s now a lot easier.

“I can show people technologies not necessarily work-related, but be able to explain how I’ve done something like that for a particular project — rather than a rollercoaster game or fighting zombies. It’s nice to see that side of the technology has become more accessible and publicly available.”

The MediTel career high

One of Sam’s most rewarding projects to date is MediTel: a mobile, uncrewed ground vehicle (UGV) equipped with VR capabilities, which allows medical operators to remotely triage casualties in hazardous environments while ensuring their safety.

Developed in just nine months, MediTel delivered a first-of-its-kind telexistence solution, with Sam stepping up as technical lead.

“I was responsible for delivering the functional system,” Sam said. “I brought in the tracked user interface, made



Sam's expertise on MediTel enabled him to showcase his skills in tracked user interface, bringing the physical elements into VR.

physical buttons and tracked them into the real world so they appeared in VR. It was really rewarding work to sink my teeth into, but was also one of the most complicated webs of different data structures I've ever worked on.

"I had many small wins, but they had a very big impact. Just fixing one little bug meant a whole subsystem would start working.

"With lots of long hours, evenings and weekends, the pressure peaked ahead of a live demo for more than 100 Ministry of Defence officials and stakeholders, with the system failing as late as the night before. But after my colleagues stayed up until 2am fixing the problem, the big day came and the system worked.

"Just being in that room to witness the system working perfectly and getting to play my part was one of my proudest career moments."

The project not only tested Sam in his day-to-day work but also his confidence, something he states has been the biggest change in his career.

"There were a lot of nerves for me standing in a room full of people, ensuring I explained how the system worked in a way they could understand, as it's something completely out of my comfort zone," he said.

"I didn't really know what the AMRC was, but it sounded like a great fit. I wanted to push the boundaries of what I could do in engineering."

Sam Hyde, technical fellow for software and immersive technologies, University of Sheffield AMRC.

"I remember starting out at the AMRC having only done very small presentations and even those were frightening to me. But working with the great team we have in the design and prototyping group, their guidance and direction has boosted my confidence beyond what I ever would have imagined.

"Now, I'm able to stand up front and centre and explain complex concepts confidently."

How culture brings confidence

Sam pinpoints one of the biggest drivers of his success to the culture and structure the AMRC offers its staff.

"How the AMRC operates has been key in enabling me to turn my personal passions

into a new technical direction," he said. "I've never been stuck in a system that pigeonholes skillsets.

"I feel able to speak my mind when I believe there is a different approach to things and be offered the scope and flexibility to try new things when the opportunities come.

"Working at the AMRC has enabled me to carve out a niche for myself and it wasn't something I had to ask permission for; instead I've always been encouraged to pursue what I felt passionate about.

"It has helped me grow not only as an engineer but as a person too."

MADE BETTER

‘Made better’ puts the spotlight on exactly that – making things better: pairing technical excellence with a relentless drive for results. For 25 years the AMRC has turned industry’s toughest challenges into game-changing manufacturing victories thanks to partnerships, performance and progress. We’re proud to help businesses of all sizes solve complex engineering problems and scale smarter. From global aerospace giants to regional SMEs, our collaborative approach ensures every breakthrough delivers measurable value and real-world impact. Your challenges, our expertise. Together we deliver.





Hitting the ground running

By Lucy Hilton

Kim Butterfield joined the AMRC at a sprint.

In the span of one year, she started a week of work placement, a summer placement, and a full-time role, all during and following the final year of her degree.

Soon after starting her full-time role as project engineer for metrology, Kim was tasked with working on EXPERI – the Rolls-Royce Small Modular Reactor (SMR) prototype module manufacture and test facility housed in the AMRC's Factory 2050.

To meet demand, Rolls-Royce SMR nuclear plants will be built in parts,

constructed using transportable modules that are manufactured and tested in off-site factories – modularisation. This allows the plants to become operational quicker than conventional nuclear plants, as well as reducing cost and uncertainty for developers.

Working with the automated assembly team, Kim helped the build process

by aligning component placement, and verifying components were manufactured to their design specification. By proving out the manufacture, this work is de-risking delivery; moving Rolls-Royce SMR from design and prototype manufacture to full modular assembly and power plant delivery.

“The nature of the assembly task is challenging; it requires multiple engineers working together to align multiple parts, over a large working volume, to tight tolerances,” said Kim.

“When metrology – the scientific study of the accuracy, precision and repeatability of measurement – is being used to guide the process, the metrologist needs to understand every aspect of the task before the measurement system can begin capturing data. It requires a lot of forward planning, before the next challenge of processing all of the information in real-time and communicating back to the assembly team.

“Rolls-Royce SMR was a great opportunity to get into large volume metrology; to start to understand what it actually takes to produce a nuclear power site.”

Kim Butterfield, project engineer for metrology,
University of Sheffield AMRC.

“It was great for me because I already had awareness and interest in nuclear manufacturing from the modules I had completed at university.

“The impact SMR work could have on society is fascinating, and it was a great opportunity to get into large volume metrology; to start to understand what it actually takes to produce a nuclear power site, and how metrology fits into that as a critical component.”

Kim’s journey into engineering wasn’t a straight path, but she wouldn’t change a thing.

Growing up in the Middle East with an architect dad and a cake business owner mum, Kim didn’t grow up around the UK’s manufacturing industry, but she did have a household that had found careers in the intersection of science, technology, engineering, art, and mathematics (STEAM).

Choosing between the creativity of art, and the problem-solving of maths, Kim landed on studying physics at the University of Leeds.

“I tend to follow what I enjoy, and a physics degree is very theoretical; it starts to narrow, and force you into an academic or research role, whereas I get a lot of gratification out of creating something and seeing it work,” said Kim.

“I had studied biology too, but I couldn’t see myself going into the medical field. I’d really enjoyed medical physics – which was focused on scanners, like X-rays, computed tomography (CT) and magnetic resonance imaging (MRI) – and liked the idea of doing something; helping someone; getting involved in the community in some way.

“I wanted to take modules that had some impact, or could lead me to somewhere with significant change, so I took a few offered by the school of chemical engineering around nuclear operations, from how the physical reaction works, to decommissioning nuclear power sites.”

Whilst studying for her degree, Kim attended the White Rose Industrial Physics Academy (WRIPA) careers fair looking for a week of work placement.

“I was going around the fair, asking everyone what their day-to-day looked like. I met James Moore, who was on an AMRC table, and his day seemed the most interesting, so I decided that’s where I’d want to be, if they’d have me,” said Kim.

Towards the end of her week’s work experience, James mentioned that the



Precision: Kim working with a 3D measuring arm.



New era: Kim working in the Rolls-Royce SMR cell at Factory 2050.

AMRC also had summer placements, and encouraged her to apply. Then, a week into her summer placement, a permanent job became available, and Kim stepped into the role of an AMRC project engineer.

"I didn't quite appreciate what manufacturing research was until I spoke to James at the fair, and I didn't understand the extent of what it meant until I came in for my placements," said Kim.

"I don't know if the reason why I didn't take up engineering sooner is because it wasn't offered at school as an option, and I hadn't gone looking for it."

Nearing the end of the Rolls-Royce SMR project, Kim conducted exploratory work around the various metrology systems that could be used for the assistive build of the module.

Researching different technologies led her to AMRC Cymru to meet with Richard James, head of technology capability for assurance.

Richard was working on Metralis, a project looking at a new prototype metrology system from National Physical Laboratory (NPL) spinout, K3Metrology (K3M).

The Metralis system takes a different approach. Most measurement equipment is calibrated periodically and then simply trusted to stay accurate until the next check, leaving a blind spot in how reliable a reading really is in between.

Metralis instead checks its own accuracy continuously while it's being used – effectively calibrating every time it takes a measurement – whilst also telling you in real time how good that measurement is, and how much confidence you can place in it. Unique to Metralis, this feature unlocks the possibility of automated decision-making on live data in real time and opens the door to new manufacturing processes that weren't possible before.

By creating redundancy in the system, it's able to give an estimation of real-time measurement uncertainty for each of the measurements, becoming essentially self-monitoring.

Whether it's for small businesses like K3M or larger companies like Rolls-Royce SMR, Kim wants her work to make a positive change to society.

"Even if it's years ahead, it's rewarding to know that the work you're doing is driving something that's going to make an impact," said Kim.

What's next for her is following the gut instinct that she's followed her whole life; not the path that's laid out for her, but the path that interests her the most.

"I'm enjoying what I'm doing at the moment; I've assumed more responsibility and I'm in a position where I can start to choose what direction I want to go in," said Kim.

"Where I want to go is back into large volume metrology. There are some massive opportunities for metrology work in SMR that would answer questions other projects have raised. It would be great to pursue the answers to these questions and apply the learning across the various packages of work we do at the AMRC."

"Even if it's years ahead, it's rewarding to know that the work you're doing is driving something that's going to make an impact."

Kim Butterfield, project engineer for metrology, University of Sheffield AMRC.

Bridging the valley of death

By Lucy Hilton

The valley of death is defined by the Science and Technology Committee as ‘the point where a business has a working prototype for a product or service that has not yet been developed enough to earn money through commercial sales’.

To bridge that gap, the company needs enough money, or support, to develop the prototype to a point where it can be sold, become self-sufficient and grow.

Before K3Metrology (K3M) spun out from the National Physical Laboratory (NPL), its product, Metralis, wasn't off-the-shelf – it was a prototype system, from a company not traditionally known in industry as an equipment supplier.

AMRC Cymru purchased the prototype system in 2022 whilst the Metralis system was at a low technology readiness level (TRL).

Now, four years on, K3M has since spun out of NPL through its internal spinout framework and is on the road to commercialising Metralis as a real-time metrology platform for advanced manufacturing.

“Without AMRC Cymru, Metralis risked being a lab prototype without

an application. We provided a sandpit to develop that application, so they could present it to the customer in a representative application and environment,” said Richard James, head of technology capability (HTC) for assurance at the AMRC.

“This is a good example of how the AMRC supports new ideas to bridge the valley of death – we provide the time and space needed to develop capability. We give the freedom to fail, so that companies can develop the minimum viable product, to demonstrate to a customer and enable investment.”

To build that bridge, Richard's team of engineers got to work helping to identify what Metralis' potential applications could be, exploiting its functionality and building a digital twin to demonstrate to potential customers what the benefits of an application could look like.

Through a series of workshops with AMRC partners, they were able to show businesses how Metralis could add value to what they do, opening up collaboration opportunities and direct connection to potential customers. They also helped to identify who customers were likely to be, and provided use case studies for specific challenges, as well as application dashboards to show how the system was performing.

The AMRC's support and industry connections have been invaluable for founders Prof Ben Hughes, chief technology officer, and Dr Mike Campbell, chief executive officer, who worked together for more than 12 years at NPL developing the technology.

Dr Campbell said: “It's only through showcasing our technology at AMRC Cymru that we've been able to get the attention of major industry giants.

“This is a good example of how the AMRC supports new ideas to bridge the valley of death – we provide the time and space needed to develop capability.”

Richard James, head of technology capability for assurance, University of Sheffield AMRC.

They've provided critical support on our journey through the valley of death."

A £2.75m seed investment raised in March 2026 gave them the means to grow the team in North Wales – including hiring the AMRC Cymru engineer who had previously worked on the project, Matt Groves, to join as an instrument scientist.

For Matt, he said he found the Metralis concept fascinating because it was so new – both to him, and to industry.

"It was an entirely new way of looking at measurement," he said. "The idea of developing a metrology system that's directly traceable to the meter was fascinating. Where normal metrology systems get results sent back to a lab for calibration, Metralis has the calibration device built inside of it.

"After working with the founders Mike and Ben for a number of years, I was interested in joining them because I could see how engaged they were. Who better to work with than two people I already knew and respected?"

Now four months into his new role with K3M, Matt is getting the best of both worlds: a new high-stakes role in an emerging startup, located in the same building as his friends and former colleagues.

"Because K3M is incubating in AMRC Cymru, we still get access to the AMRC's knowledge and resource. So, as with all of Richard's mentees, I still go and bother him with questions at least three times a week.

"It's hectic, it's challenging, there's pressure, but I feel like I'm really involved in building something from the ground up. It's enjoyable because I feel like I'm really making an impact – for Mike and Ben, for K3M, and for industry."



**Explore how
AMRC Cymru
can help you**

"It's only through showcasing our technology at AMRC Cymru that we've been able to get the attention of major industry giants."

Dr Mike Campbell, chief executive officer, K3Metrology.



Matt Groves, instrumentation engineer (right), pictured with Prof Ben Hughes, chief technology officer and co-founder of K3Metrology.

Talent and tech transform time-tested craft – with huge rewards for industry

When the skies fell silent in 2020 because of a global pandemic, the Aerospace Technology Institute saw a rare window of opportunity: pioneering new ways to deploy centuries-old casting techniques to make aircraft parts lighter and more sustainable. **AMRC technical experts Matt Cawood and Jack Naylor** share how pairing deep foundry experience with a data-driven mindset is opening new frontiers for the future of flight. **Mrudula Jadhav reports.**

The Wright brothers' 12-horsepower four-cylinder engine that powered the 1903 Wright Flyer biplane and inaugurated the aerial age, relied on a cast aluminium block.

Yet today, more than 120 years on from the Wrights pioneering many of the basic tenets and techniques of modern aeronautical engineering, aircraft manufacturers default to carving flight parts out of massive, solid blocks of metal – often throwing away more than 80 per cent of expensive alloys as scrap swarf.

“The industry traditionally accepted waste as the price of structural safety,” said Matt Cawood, head of castings at the University of Sheffield AMRC.

That mindset went unchallenged for decades until 2020, when the pandemic brought production lines to a standstill. Seeing an opportunity to reimagine aircraft manufacturing for a new era, the Aerospace Technology Institute funded the AMRC's Foundry 2030 research programme to demonstrate how advanced casting could eliminate material waste.

“Our goal was to show that casting doesn't have to be treated like a primitive craft born in the bronze age,” Matt said. “The challenge with casting has always been process variability. Machining starts with certified,



Jack Naylor interacting with the automated shelling system to test mould production with iMOLD sensor data tracking.

uniform metal, whereas casting creates the material structure and part geometry simultaneously. Any slight shift in alloy or cooling changes the internal structure.

“And while that unpredictability led aerospace away from casting, we're here to prove that advanced digital methods can deliver the consistency the sector demands.”

The AMRC collaborated with Brunel University and industrial partner

Sarginsons to deliver on three key aims: using digital tools to design lighter parts; adopting automation to guarantee process repeatability; and embedding real-time digital monitoring to eliminate shop-floor defects. The teams put these principles to the test on a real-world benchmark: a primary wing flap roller from an aircraft still in production and traditionally machined from solid aluminium across nine separate bolted pieces.

Nine parts, one casting – zero compromise

Using digital topology software and casting simulations, the engineers optimised the component's geometry to minimise weight, consolidated all nine parts into a single casting and verified its structural integrity under load.

In aerospace, however, simulation alone is never enough. To guarantee flight-ready process reliability, the team turned to automated counter-gravity casting – which draws liquid alloy steadily upward into the mould from underneath – think of it like drinking through a straw. This eliminated the turbulence, air pockets and internal defects caused by traditional top-pouring.

The results were transformative. Across ten consecutive melts, every component matched strict industrial production criteria, proving the process was completely repeatable. Consolidating the assembly slashed component weight from 7.02 kg to 3.30 kg and reduced raw material waste from 86 per cent to just 14 per cent – all while maintaining full structural strength. Multiplied across the eight flap rollers on every aircraft, this will slash fuel burn while proving advanced casting can unlock massive weight and waste savings across the airframe.

Pushing circular economy principles further, the team melted down dirty sectioned castings from old manufacturing lines and cast fresh parts. Mechanical testing confirmed that components cast from 100 per cent recycled scrap suffered zero loss in performance.

Replacing intuition with real-time data

With structural strength and material savings proven, the team shifted focus to the next challenge: integrating real-time digital monitoring into traditional casting workflows – specifically within investment moulding, a process where wax models are repeatedly dipped in ceramic slurry to build a hard shell.

Historically, foundries relied on operator skill for manual slurry measurements, checked only periodically, which caused production downtime. This led to inconsistent shell construction and casting failures.

This is where Jack Naylor, AMRC technical fellow, brought a skill seldom seen on foundry floors: data analytics.

“Mould manufacture has traditionally been driven by basic measurements and intuition,” Jack said. “If an operator misjudges slurry characteristics, the mould



Matt Cawood pictured alongside the counter-gravity platform that was used to produce a single aircraft casting, consolidated from a nine-part assembly.

could rupture during firing – wasting hours of processing time.”

“Through Foundry 2030, we introduced sensors to track weight gains per coat and moisture loss during drying. It gives engineers visibility to respond to issues long before the shell reaches the furnace.”

Scaling smart monitoring onto the shop floor

This breakthrough sparked Investment Mould On-Line Detection (iMOLD), a follow-on project led by Jack. Combining data analytics with process engineering, he set out to further scale Foundry 2030's early weight-tracking experiments into a permanent, shop-floor capability by building weight sensors directly into a robotic shelling cell.

As a heavy industrial robot dips a wax model into ceramic slurry, hoists it up and weighs the dripping shell to the exact gram, the iMOLD system streams live mass data back to engineers without stopping the production line.

“We transformed manual, periodic checks into an automated stream of actionable data,” Jack added. “iMOLD monitors the separate slurry and sanding cycles that form the shell coats in real time, giving foundries the precise control to stop scrap events before they happen.”

By eliminating manual measurement errors and offline inspection bottlenecks, the iMOLD setup is projected to save over 700 production hours annually while accelerating root-cause defect analysis.

Shaping the new age of castings

This is industrial strategy and impact in action. What the AMRC has learned from Foundry 2030 and iMOLD can support the wider UK supply chain. As the only casting specialists within the UK's High Value Manufacturing Catapult network, the AMRC is already working with commercial suppliers to apply these techniques to active global aircraft platforms.

For Matt, this success relies as much on developing people as developing processes.

“We're not only building the future of casting technologies; we're nurturing the minds that will drive them,” he said. “Casting may be a time-tested craft, but its future is digital. By pairing deep foundry experience with diverse, new-generation talent like Jack, we're showing industry that digital workflows and automated precision don't just optimise modern factories – they can completely revolutionise traditional manufacturing and ensure this ancient art is fit to power the future of flight.”

“Casting may be a time-tested craft, but its future is digital.”

Matt Cawood, head of castings, University of Sheffield AMRC.

MADE FOR THE FUTURE

'Made for the future' marks the next bold chapter in the AMRC's mission to shape manufacturing, building on our 25-year proven track record of industry-driven innovation. This is not about looking back. It is about looking forward. That's why we're concentrating our expertise and resources on three key sectors where we believe the greatest impact can be made: aerospace, defence, and nuclear and clean energy. Our goal is to be a force for good by driving global competitiveness, accelerating industrial transformation and building the skilled workforce required for the future and prosperity of UK manufacturing.





COMPASS points the way: a new direction for high-rate composites

By Mrudula Jadhav

World-class research facilities do not appear overnight. They are built with vision, persistence and great teamwork. The innovative minds behind COMPASS – the AMRC’s largest collaborative R&D programme to date – share how this game-changing capability came to life and is set to

transform UK manufacturing through high-rate production at scale.

And it all started with a tea tray. Not an antique one, but rather a sleek carbon fibre tea tray demonstrating composites manufacturing capability that was sat on a meeting table in the AMRC in 2019. That single piece proved a critical concept, sparking a conversation between the AMRC and Boeing around

how to redefine next-generation aircraft manufacturing.

Those early conversations with industry, including industrial automation specialist Loop Technology, gained rapid momentum. The demand signal coming from industry was an urgent need to develop and de-risk high-rate processes. The AMRC responded with Composites at Speed and Scale (COMPASS).

In July 2026, the doors opened to the £54 million open-access COMPASS facility in the heart of the South Yorkshire Investment Zone with Boeing as its first user – anchoring a global manufacturing capability in the UK’s industrial north.

The facility, deemed a ‘national asset’ by industry, government and academic leaders, houses state-of-the-art equipment, including giant 1,700kg-capacity industrial robots and the world’s largest-of-its-kind RTM press – co-funded by the Department for Business, Innovation, Science and Trade (BIST) through the ATI Programme, a partnership between the Aerospace Technology Institute, Innovate UK and the Department for Business, Innovation, Science and Trade.

So what makes it a national asset? And why now?

“Timing in industrial innovation is everything,” said Rob Hewison, who brings more than three decades of industry experience to his AMRC role as head of technology capability for composites.

For Rob, the facility represents the answer to a question the industry could no longer ignore: composites are vital for reaching net-zero, but current manufacturing processes remain costly, time-consuming and heavily manual.

He said: “Let’s take aerospace: composite wings are the clear choice for

“COMPASS provides that pre-production environment required to validate automated processes at speed, scale and precision to help secure the UK’s position as a global aerospace leader.”

Rob Hewison, head of technology capability for composites, University of Sheffield AMRC.

next-generation aircraft to cut weight, improve performance and reduce emissions. But with global demand reaching 40,000 new aircraft over the next 20 years, production volumes need to jump from a dozen units a month to hundreds – traditional methods simply cannot bridge that gap.

“COMPASS provides that pre-production environment required to validate automated processes at speed, scale and precision to help secure the UK’s position as a global aerospace leader.”

World-class facilities like COMPASS do not appear overnight.

Translating those early conversations and ambitions into reality took years of groundwork. It drew on capabilities across

the AMRC, bringing together innovative minds from its composites and integrated manufacturing groups to solve complex industrial bottlenecks holistically.

The primary technical hurdle was the huge increase in rate. Darren Wells, AMRC senior technical fellow for composites, knew scaling up required breaking away from traditional methods.

“You simply cannot scale an autoclave-based process to hundreds of units a month without an astronomical footprint in floor space and energy. For too long, the industry’s default response to production bottlenecks was to throw more people and floor space at the problem. We have reached the limit of that approach,” he said.

Currently, aerospace carbon fibre relies on resin pre-impregnated materials



Inside COMPASS: Housing giant 1,700kg-capacity industrial robots and the world’s largest-of-its-kind RTM press – delivering the future of high-rate manufacturing at speed, scale and precision.

requiring energy-intensive cold storage and manual handling. To unlock automation, the team developed dry-fibre processing along with resin transfer moulding (RTM) – a process proven in high-volume automotive production – and scaled it to massive structural dimensions. By laying dry textiles first and injecting liquid resin into a closed mould under pressure, industrial robots can manipulate material cleanly at high speed.

Darren added: “This facility marks the end of the bespoke workshop era for large composite structures. We’re bringing pace to the high performance standards required for primary structures, while drastically reducing energy consumption and material scrap as a natural byproduct of better engineering.

“What excites me is that we are proving the entire integrated journey under one roof – showing that synchronised, high-tech composite manufacturing is a reality delivered today.”

Yet, physical speed on the shop floor is only half the equation.

Maintaining aerospace-level precision across such a complex facility requires a detailed understanding of how every system performs, interacts and evolves over time.

To address this, AMRC senior technical fellow Chris Scraggs and his team developed a digital backbone that captures operational data across the facility, providing continuous insight into the performance and condition of key assets.

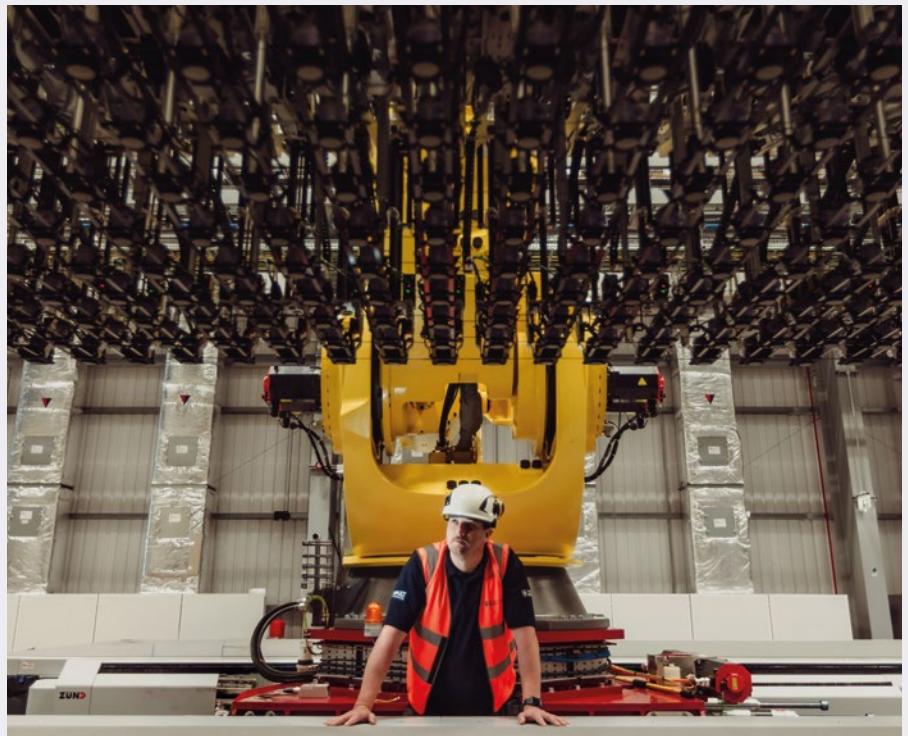
Underpinned by Factory+, the AMRC’s open-access digital framework, COMPASS will collect and contextualise real-time data to create a digital twin, giving engineers a deeper understanding of the manufacturing processes throughout their development.

Chris said: “We’re developing a robust digital twin of our equipment, powered by real-world telemetry. This enables us to validate processes, improve simulation accuracy and create rich datasets that can drive innovation across both industry and academia.”

So, what is happening behind the COMPASS doors right now?

Walk onto the shop floor today, and that capability is already hard at work. Boeing is using the open-access facility for its largest global research programme, Isothermic High-rate Sustainable Structures (IHSS).

Backed by the ATI Programme, IHSS aims to reduce manufacturing times for



COMPASS factory manager, Ricky Rowett, pictured inside the £54m open-access facility in South Yorkshire.

large components from 40 hours down to just four, and has the potential to create up to 3,000 UK jobs and generate £2 billion annually in exports.

Loop Technology is a key partner in both the COMPASS facility and the IHSS project – deploying its FibreLINE robotic preforming system to enable ultra-high-rate composite manufacturing, and serving as robotic systems integrator to ensure seamless, end-to-end operation across all equipment.

COMPASS extends far beyond a single project or sector.

Rob said: “While the facility is currently dedicated to aerostructures, the infrastructure inside COMPASS is entirely sector-agnostic. The same automated dry-fibre moulding, sensor-integrated tooling and digital twins can be deployed across defence, rail, urban air mobility and renewable energy hardware like wind turbines and tidal blades.”

Crucially, COMPASS operates as an open-access sandbox for the wider UK supply chain, validating high-rate processes at technology readiness level (TRL) six. Companies of all sizes can book machine time on a part-process basis or validate their software via the digital framework – enabling smaller UK suppliers to enter global, tier-one supply chains.

Delivered through joint-funding from the South Yorkshire Mayoral Combined Authority, Sheffield City Council, the University of Sheffield and the High Value Manufacturing Catapult, the facility establishes a sovereign capability for the UK. By bringing together industry, government and academia, COMPASS drives long-term economic growth, secures high-value jobs and cements South Yorkshire’s status as a premiere hub for advanced manufacturing innovation.

Looking back to 2019, that carbon fibre tea tray remains a powerful symbol of what the AMRC and cross-capability engineering can achieve – a quiet reminder of how sustained collaboration turns even the simplest of ideas into a revolutionary step-change for UK manufacturing.



**Find out more
about COMPASS**

Fueling an era of clean propulsion with hydrogen

By Mrudula Jadhav

“People have got to get around,” says Lee Wheeler, future mobility lead at AMRC Cymru. “They need transport for work, for family, for everything. But for over a century, we’ve relied on what we know: combustion engines and technologies forged during previous industrial revolutions to keep us moving.”

Now, the target has shifted. It’s no longer just about moving faster – it’s about stripping out carbon, pioneering clean propulsion and giving UK manufacturers the confidence to actually build those solutions at scale.

And that is exactly what Lee is in charge of at the AMRC: developing the very manufacturing processes that make that transition happen.

Lee’s connection to the AMRC didn’t start on the shop floor as a researcher, it started as a customer.

Before joining the AMRC, Lee spent 14 years at Airbus, where his work brought him into frequent contact with the High Value Manufacturing (HVM) Catapult network. But it was a visit to the AMRC in South Yorkshire that left a lasting impression.

“I was completely blown away by the place,” Lee said. “Walking around the Factory 2050 facility and seeing the drive, ambition and sheer capability of the team was inspiring.”

So in 2019, when an opportunity knocked right on Lee’s door with the opening of AMRC Cymru in Broughton, North Wales, he knew he couldn’t turn it down. Joining as a manufacturing research engineer, Lee stepped into a new facility with a chance to make a direct impact.

That scope expanded quickly when Andrew Silcox, then AMRC Cymru research director and now chief technology officer for the wider AMRC, challenged the team to dive into green innovation, placing hydrogen right at the top of the agenda.

“I’d never worked directly on hydrogen technologies before,” said Lee. “My focus had always been aircraft manufacturing, smart tooling, exoskeletons and digital data processing. But I wanted a real challenge. So I raised my hand and said, ‘Yeah, I’ll take that on.’”

That leap sparked a multi-year effort to take hydrogen technologies from whiteboard concepts and onto factory floors. Lee teamed up with Stuart Dawson,

who was leading the AMRC’s hydrogen efforts at that time, to map out critical industry gaps. Together, they established an industrial steering board featuring major sector players including Airbus, Rolls-Royce, ZeroAvia, Toyota and Hypermotive.

Lee said: “We held workshops with these industrial leaders to ask what roadblocks they were facing and where we should invest our research capital.

“The consensus was clear: industry needed a dedicated, de-risked testbed where they could build up manufacturing capability and trial new processes safely. That’s where the idea for the HEPS cell came up.”

Backed by the HVM Catapult, that insight became the Hydrogen Electric Propulsion

“By de-risking shopfloor technology, bolstering supply chains and shaping national policy, we’re ensuring the UK doesn’t just witness the future of clean, sustainable transport – we lead it.”

Lee Wheeler, future mobility lead, University of Sheffield AMRC Cymru.

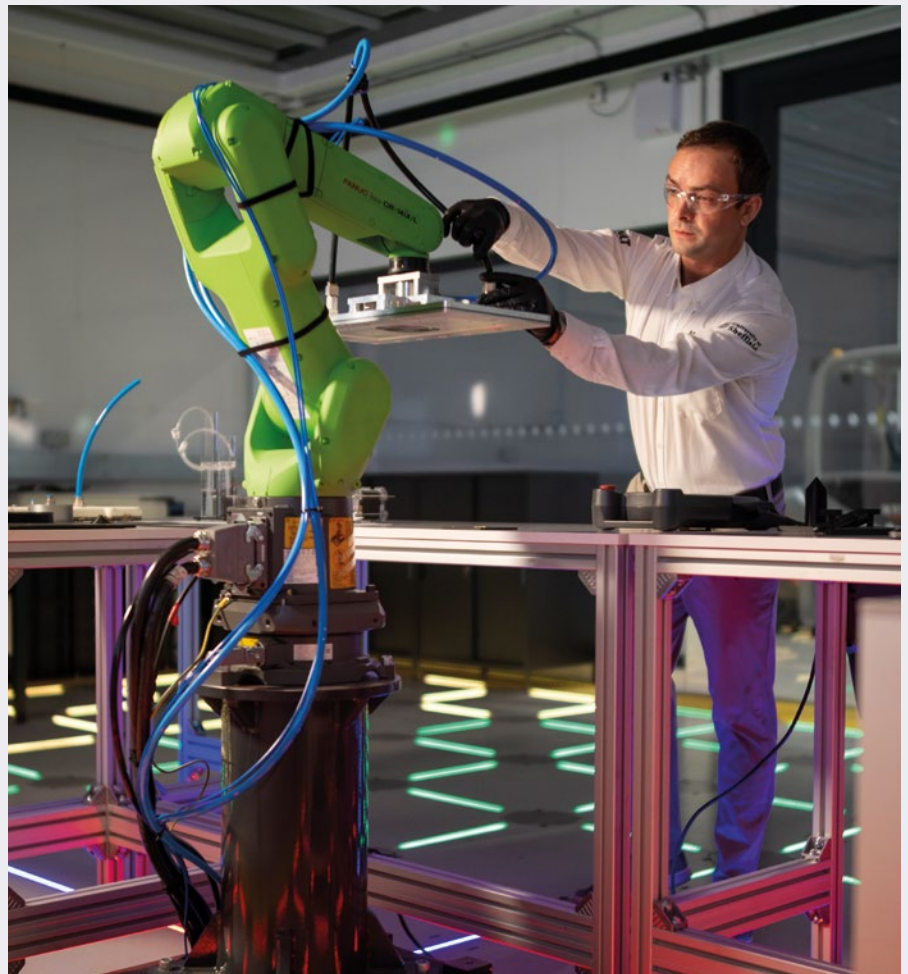
Systems (HEPS) testbed at AMRC Cymru – a £600,000 self-contained assembly floor equipped with collaborative robotics, reconfigurable shopfloor layouts and digital Industry 4.0 inspection tools.

The HEPS facility quickly turned AMRC Cymru into a magnet for leading clean-tech pioneers seeking to take fuel cells out of laboratory environments and prepare them for high-rate mass production. Key collaborations built on the testbed include:

- **Toyota Motor Manufacturing UK** partnered with AMRC Cymru to develop fuel cell assembly concepts, driving transport decarbonisation and digitalisation. Supported by the Welsh Government's Low Carbon Automotive Transformation Fund, the team used digital modelling and discrete event simulation to help Toyota evaluate smart technologies for scaling future production lines.
- **ZeroAvia** is collaborating with AMRC Cymru to design an optimised pilot assembly line for next-generation flight as part of the £17.5 million Advanced Fuel Cells for Aviation Decarbonisation (AFCAD) project funded by the Aerospace Technology Institute (ATI). Engineers are tackling high-temperature fuel cell stack assembly to overcome manufacturing bottlenecks and ensure zero-defect production at required rate and scale.
- **Intelligent Energy** is working with the AMRC to commercialise its IE-FLIGHT™ 300 modular platform under project HEIGHTS, a £17 million ATI-funded programme. To fast-track zero-emission propulsion systems for regional aircraft within the decade, the initiative addresses critical thermal management and weight reduction challenges – supported by the AMRC's design expertise and electric motor development under the Engineering and Physical Sciences Research Council (EPSRC) – funded Future Electrical Machines Manufacturing (FEMM) hub.

For the AMRC, advancing clean mobility extends far beyond individual projects – it is about shaping long-term, sovereign UK manufacturing capability.

Lee represents the AMRC across government roundtables and industry discussions, including the Hydrogen Innovation Initiative (HII) – a HVM Catapult-led alliance uniting government, industry



Lee Wheeler pictured inside AMRC Cymru's HEPS testbed, leading the drive for clean propulsion manufacturing.

and academia to strengthen UK supply chains for hydrogen technology.

To build that supply chain resilience and boost long-term market confidence, he champions two critical levers: production diversification and fleet retrofitting.

He said: "In my position, I see many suppliers who make one specific component exceptionally well. Our role is to help those manufacturers diversify across the full product lifecycle. If a business produces components for fuel cells, their machinery and expertise mean they could also manufacture heat exchangers or compressors, for example.

"At the same time, we need to get serious about retrofitting existing transport fleets. It is a massive opportunity that we simply aren't exploiting enough."

Lee believes that, while hydrogen remains a cornerstone pathway for net-zero transport, scaling these technologies across the UK manufacturing ecosystem requires holistic innovation.

"Sovereign capability relies not just

on individual stack components, but on mastering the entire 'balance of plant' – which includes all the surrounding systems that make clean propulsion work in commercial reality," Lee said.

"If we want UK companies to establish true sovereign leadership, we have to support the full supply chain lifecycle. The technology is advancing rapidly, but economies of scale take time and industry needs both government backing and clear market confidence to invest."

The premise has been clear from the start: the need to move people and goods isn't going away, but the way we fuel it must change.

That is where the AMRC and experts like Lee are driving real change. As Lee said: "By de-risking shopfloor technology, bolstering supply chains and shaping national policy, we're ensuring the UK doesn't just witness the future of clean, sustainable transport – we lead it."

Timing, tenacity and talent: the next generation of nuclear

By Lucy Hilton

Sean Delaney had just finished his A-Levels when a chance encounter in a pub changed the trajectory of his life.

Much like the AMRC's bright and humble beginnings, Sean's journey started when he met Adrian Allen. Sean's friends had spoken of Allen's work forming the AMRC, and he wanted to know more. After spotting him whilst out, Sean introduced himself and explained his interest in engineering, and desire to see what was behind the doors of the ominously large AMRC buildings in Rotherham.

"When I met Adrian, I told him I wanted to be an engineer and asked if he had any advice," said Sean.

Allen had more than advice: he offered Sean a tour of the AMRC facilities the very next week and, in a moment of fortuitous timing, mentioned how one of its technology groups was recruiting apprentices through the AMRC Training Centre. Sean applied, soon starting his three-year machining apprenticeship.

"I don't come from an engineering background. My dad worked down a mine, which wasn't manufacturing but is still embedded in that South Yorkshire heritage," said Sean.

"I did my A Levels but I didn't enjoy them. I could have gone to university, but I took the decision to start from the beginning again with a secure job. By the time I finish my education, I'll have got my

"I could never have imagined my career was heading in this direction."

Sean Delaney, machine technician, University of Sheffield AMRC.

degree five years later than I would have with a university route, but with secure employment, without the debt, whilst learning along the way, and with work opportunities. It was a trade off, but it came with a lot more opportunities than drawbacks."

From there, Sean moved from stepping stone to stepping stone, with a hop over to the AMRC's integrated manufacturing group (IMG) for a Level 4 Higher National Certificate (HNC), where his strong skillset and capabilities shone through, resulting in him being drafted to work on Rolls-Royce small modular reactor (SMR) project portfolio, where he is also working towards his degree apprenticeship.

"My Level 3 apprenticeship was almost exclusively machining, before taking on more responsibilities around structural testing – not just making parts, but helping assemble them into something we could use to test different components," said Sean.

"It was a little bit out of character for me to move into robotics; it wasn't something I'd ever imagined doing. It turned out, in an odd way, that though I moved to IMG expecting to do what it's known for – robotics – instead I'm dealing with large assemblies."

Sean's move into large assemblies was no accident; he was spotted by the IMG team because of the traditional manufacturing skills he'd developed such as assembly and working with cranes.

"I could never have imagined my career was heading in this direction," he added. "In a way, I've gotten really lucky. I've always been interested in civil engineering, nuclear power and in the more traditional manufacturing, and now my work with small modular reactors is where all those three combine."

"The scale of it is interesting in itself; the assemblies are massive – they can weigh ten tonnes or more – but also the impact of the work I'm doing for UK industry and the clean energy sector."



Sean Delaney, machine technician, combines three key interests; civil engineering, nuclear power and traditional manufacturing skills while working with small modular reactors.

His work is part of the ongoing partnership between Rolls-Royce SMR and the AMRC, helping to deliver a factory-built nuclear power station to meet the world's future sustainable energy needs.

Sean said: "The first SMR project I worked on was proving that we could use skids to accelerate the manufacturing of the modules – each module will have assembly inside of it, but thousands of these modules are going to be built – if that assembly can be built elsewhere on a metal frame, then put into the module, we'd improve the efficiency of the manufacturing massively.

"The second one we've just completed focuses not on what's inside the modules, but how they interact with each other.

"We take two different modules, with two different meeting points inside them –

for example two pipes – and those modules have to be joined together, but those pipes also have to meet. Then the modules have to stack together.

"It sounds basic, that one of the big challenges is 'can these be stacked on top of each other with what's assembled inside meeting?', but no one's really done it before, and it's got to be done eventually; you can't leave it until the final design and then hope it all comes together in the end."

The AMRC's SMR project team hasn't stopped noticing Sean's work since; he won a University of Sheffield inspirational technician award after being nominated by his line manager, Mike Portnell, who said Sean's drive to improve and develop has been outstanding, and hasn't gone unnoticed by the team or the customer.

For Sean, the award symbolised a moment of reflection. He said: "It feels like I'm getting to the point where I could do anything. I can stand on my own two feet as an engineer. I can increasingly point back to things over the past seven years that I can be proud of – things that I've worked on, different qualifications I've achieved. It gave me an excuse to look back and see how far I've come.

"I've been lucky. Other people would describe it more generously, but for me, I'd say I've had three pieces of good luck: meeting Adrian Allen, getting into IMG, and being invited onto the Rolls-Royce SMR project. Those are my three stepping stones, which have come alongside my educational stepping stones."

To everyone else around him, Sean is too humble: all three of those steps were steps he took himself. Not luck, but bravery and boldness; finding an opportunity and going for it.

As for his advice to anyone trying to find their own pathway, this is what he said: "If you don't know what to do, get out there and see what there is to be done."

"It feels like I'm getting to the point where I could do anything. I can stand on my own two feet as an engineer. I can increasingly point back to things over the past seven years that I can be proud of."

Sean Delaney, machine technician, University of Sheffield AMRC.

The resilient rebrand of sustainability

By Lucy Hilton

Finding ways to make the manufacturing industry more sustainable is a significant challenge. For **Tace Morgan, head of technology capability for sustainability at the University of Sheffield AMRC**, it is a necessity.

“Manufacturers are always asking, ‘why is sustainability important?’ – they can think it’s something they can ignore,” Tace said. “But issues became obvious during the Covid-19 pandemic lockdowns, when the positive environmental impacts of not travelling, and not manufacturing, became apparent.

“The political landscape has changed significantly since then, but whether it’s a global priority or not, especially with new legislations and regulations coming in, manufacturers are starting to see the importance of sustainability as resilience; against global trends and pressures, for cost saving and productivity.”

Tace sits on several sustainability committees, including with the High Value Manufacturing (HVM) Catapult, looking at cross-centre work that can use the strengths and expertise of the six centres, and lobby the government to put funding in the right places to secure UK manufacturing.

For the AMRC, the sustainability research she heads up concentrates on four key pillars: circular economy, resource efficiency and energy efficiency, decarbonisation and social sustainability. This is a reflection of industry demand seen by the HVM Catapult.

Green technology is a massive opportunity for UK manufacturers; the clean energy transition will need engineers, technicians and

“Manufacturers are starting to see the importance of sustainability as resilience.”

Tace Morgan, head of technology capability for sustainability, University of Sheffield AMRC.

manufacturers, which the UK has. It will need tons of material – all currently sourced from abroad in finished products. Domestic decarbonisation needs an estimated 19 million heat pumps, mostly sourced from abroad. Why not the UK?

“The AMRC’s research and development (R&D) looks at how we can use research to learn for ourselves, and also show what we’ve done to share that learning with the wider industry,” she said. “Lots of companies are interested in the sustainability of their supply chain, and how they can select sustainable suppliers. We find out how it works, and share that knowledge.

“We also have a project running looking at how we can decarbonise the AMRC sites, with wind turbines, solar panels and electric cars, as well as how we use energy within the business, on screens and machinery. As well as a cultural change piece – what individuals can do, and how they can have an impact – the project is also looking at how we can work with the wider Advanced Manufacturing Park (AMP)

and the University of Sheffield network to see where we can collaborate.

Before she took up the helm to push the AMRC to be a more sustainable organisation, Tace was on her own journey of postgraduate research in additive manufacturing at the University of Sheffield. One day, whilst on a tour of the AMRC, she turned to her coursemate and said: “I want to work there.”

She started at the AMRC in 2018 with the design and prototyping group, working on additive manufacturing nanosatellite fuel tank design, as part of a pioneering UK Space Agency-funded programme.

“We worked on a self-supporting, cube-shaped fuel tank. It was a pressurised fuel tank, so it had to fill the space available within the cube-shaped satellite, but a cube is not a strong shape – it bows out in the middle when pressurised. We created lattice designs within it that would hold tension as the fuel tried to expand,” she said.

After her progression to project engineer, Tace moved to the integrated manufacturing group in 2021, working on automated

guided vehicle projects, testing what their specifications say they can do, versus what they can actually do – pushing boundaries for manufacturing shop floor applications.

As part of the automated assembly team, Tace worked with industry giants BAE Systems, Leonardo, Nissan, Accenture, Intellium, GKN Aerospace, Moy Park and academics at the University of Lincoln on Project Butterfly.

That's where her sustainability focus began. Tace said: "I started working on one or two sustainability projects, then more and more kept coming in. Project Butterfly was a cross-sector programme, which was really interesting to work on – we got to look at our tools' application on everything from frozen chickens, to painting cars and manufacturing composites."

A direct response to the urgent need to decarbonise the manufacturing industry, the work focused on driving forward the innovation of digital technologies at the heart of manufacturing processes – with an aim to reduce environmental impact and accelerate the industry's journey to net zero through two key AMRC tools: a process sustainability calculator and guidance for process decarbonisation.

"Often companies think they have unique problems. But sustainability is a challenge across every sector; by its nature, the solutions that work for one sector will often work for multiple other sectors. There are obviously different challenges within sectors, but it's nice to see that an application or solution can be a common thread," said Tace.

Since starting in the role ahead of technology capability in 2025 Tace is now responsible for the wider AMRC strategy for sustainability, as well as research, to set the direction for where the organisation wants to – and needs to – go.

"Part of my role is pulling on the right experts from across the organisation; getting the right people in the room," she said. "It's about looking at where the challenges are in industry to see where we need to help the most, and making sure that our research strategy, across all of our funding sources, can deliver the best impact for industry.



Tace Morgan, who leads the AMRC's strategy and technology research for sustainability, focused on circular economy, resource and energy efficiency, decarbonisation and social sustainability.

"Some of the most exciting things we're working on focus on supporting small and medium-sized enterprises (SMEs). We're creating standard toolkits to help SMEs in the supply chain, unifying that offering across the AMRC – whether a company comes to us through the AMRC in Sheffield and Rotherham, AMRC Cymru in Wales or in Lancashire at AMRC North West.

"I've been lucky to have exposure to lots of different aspects of

manufacturing, and sustainability is the one that really feels worthwhile doing; there are so many applications to it, it could never get boring.

"The work we do doesn't always show its impact initially, but it's exciting thinking about how, years in the future, you could be flying on a sustainable aeroplane, working in a smart factory, looking out over a renewable energy-powered park, that you helped create."

"Sustainability is a challenge across every sector; by its nature, the solutions that work for one sector will often work for multiple."

Tace Morgan, head of technology capability for sustainability, University of Sheffield AMRC.

Beyond the melting point: mastering the art of machining advanced ceramics

Modern aerospace engines must run hotter to maximise fuel efficiency, demanding components be built for extreme heat. But how do you machine a part when the material is harder than most cutting and grinding tools? University of Sheffield AMRC experts **Daniel Whitehead** and **Dr Leon Proud** explain the innovation bridging this gap to unlock a crucial UK machining capability. **Mrudula Jadhav writes.**

“Developing a revolutionary material is the first step; but figuring out how to machine functional components from these emerging materials without damage is a significant challenge,” said Daniel Whitehead, senior technical fellow at the University of Sheffield AMRC.

For nine years, Daniel’s work has revolved around a paradox: innovating precision-machining methods for materials built to resist extreme heat, friction and stress.

He points out that while material science can develop substances with incredible theoretical properties, a massive disconnect remains between raw material and functional engineering components.

“We might know the end goal, but how we actually machine it to get there is often the missing piece,” Daniel said. “That’s what we do at the AMRC.”

Nowhere is that missing piece more critical than in high-temperature engineering.

“For nearly a century, aviation has relied on nickel-based superalloys for turbine blades, but traditional metallurgy caps out around 1,000degrees celsius,” said Daniel.

“Today, the hottest jet engine parts operate at temperatures greater than the metal’s melting point, surviving only because of complex internal cooling systems. To cut carbon emissions, boost fuel efficiency and squeeze maximum power out of every fuel drop, engines must run far hotter. But superalloys are at their limit.”

Enter silicon-carbide ceramic matrix composites (CMCs). Engineered to cross that thermal boundary, this material operates at temperatures reaching nearly 2,000 degrees celsius when paired with cooling systems. As global demand surges for these materials, the race is on to master CMC manufacturing at commercial scale – unlocking lighter, cleaner power systems while securing high-value capability within domestic supply chains.

So what does it take for the UK to build that capability at scale?

“The challenge was never a lack of British research or manufacturing expertise, but connecting the different capabilities needed to produce functional CMC components within the UK. With key parts of the supply chain historically concentrated overseas, building an integrated domestic capability is crucial for UK industrial resilience.”

Daniel said: “The UK has significant CMC knowledge, and Archer Technicoat Limited (ATL) is a prime example, having developed and exported processing technology for decades. The opportunity now is combining domestic material specialisms like ATL’s with advanced machining R&D to establish a more complete UK production route in an open, collaborative research space.”

Born out of the AMRC’s collaborative research enterprise framework and driven by industry demand to de-risk advanced ceramics, a UK consortium set out to prove CMC production capability through a high-value aerofoil demonstrator – a specialised, curved blade component that manages airflow inside an engine.

UK coating specialist ATL collaborated with two High Value Manufacturing (HVM) Catapult centres, the AMRC and the Manufacturing Technology Centre (MTC), to execute the complete end-to-end processing, laser-shaping and precision-

“This is about self-reliance and putting the UK at the forefront of advanced high-temperature manufacturing.”

Daniel Whitehead, senior technical fellow, University of Sheffield AMRC.

finish pipeline for the component in the UK. However, turning raw ceramic weave into a flight-ready component demanded a shift in shop-floor logic.

Dr Leon Proud, AMRC senior project engineer leading the machining challenge, said: “When you work with CMCs, traditional machining rules don’t always apply. You can’t clamp a brittle ceramic part in a standard vice because it might crack, and the material is so abrasive that ordinary tools just won’t do the job.”

This gave rise to a three-stage manufacturing relay.

First, ATL subjected woven silicon carbide fibres to an intensive chemical vapour infiltration cycle inside a custom graphite mould – developed alongside the German Aerospace Center (DLR) – to grow solid ceramic matrix material inside the weave.

Because CMCs can rapidly destroy cutting tools, the densified component moved to the MTC, where researchers deployed laser cutting to dynamically trim surplus composite without tool wear challenges associated with traditional machining. This produced a clean, trimmed densified preform, and helped establish high-throughput laser cutting as one of the optimal methods for initial profiling of CMCs.

The final stage called for extreme precision machining, which brought the preform to the AMRC. To avoid crushing the fragile part, the team secured it using the Blue Photon adhesive workholding supplied by UK tooling provider NCMT. Using cutting tools from AMRC partner Tyrolit, the team applied advanced metrological scanning-informed CNC abrasive grinding strategies to finish the curved aerodynamic surfaces.

With the outer profile finished, the team tackled one of the hardest machining feats in brittle ceramics: drilling. Using small-diameter core drills and CNC helical interpolation, they precision-machined three intricate fastening holes into the trailing edge without causing observable damage.

Leon said: “In brittle CMCs, improper drilling strategy can lead to cracking, delamination and in extreme cases, catastrophic part failure. Proving that load-bearing holes can be drilled cleanly and repeatedly means that manufacturers can bolt ceramic parts directly into engine assemblies, saving time, reducing scrap rates and making full commercial assembly viable.”



The high-value CMC aerofoil demonstrator, produced through a three-stage manufacturing relay between ATL, MTC and the AMRC to withstand extreme engine temperatures.



AMRC experts Daniel Whitehead (right) and Dr Leon Proud (left) pictured with the aerofoil demonstrator, bridging the gap to unlock UK high-temperature manufacturing capability.

To establish a benchmark for future commercial production lines, the team deliberately left select laser-cut edges alongside ground surfaces on the final demonstrator. As Leon explains, this dual finish shows the two techniques complementing each other: high-speed laser sectioning delivers rapid primary shaping, while precision grinding achieves structural integrity and micro-tolerances required for production use.

The resulting aerofoil is proof that advanced CMC manufacturing is an operational reality in the UK, growing the capability to technology readiness level (TRL) five for domestic shop floors. While developed for aerospace, this processing playbook opens a direct route

to manufacture extreme-temperature hardware across defence, space and nuclear fusion.

For Daniel, who has spent almost a decade pioneering machining strategies for extreme materials, the project marks a fundamental turning point for UK industry.

He said: “This is about self-reliance and putting the UK at the forefront of advanced high-temperature manufacturing. We’ve proved that we can produce these next-generation technologies at scale – securing a resilient supply chain and developing the tools to build a cleaner, decarbonised future on our own terms.”

“The creation of the AMRC, in which Boeing is proud to have played a key role, provided a catalyst which has helped produce a cluster of world-class manufacturing and research facilities in South Yorkshire. It’s a growth story of which the AMRC plays an important part.”

Sir Jeremy Quin, President of Boeing UK and Ireland.

“As a founding partner of the High Value Manufacturing Catapult in 2011, the AMRC’s unparalleled expertise and world-class facilities have been instrumental in helping our network generate more than £5 billion in GVA for the UK economy.”

Katherine Bennett CBE, CEO, High Value Manufacturing Catapult.

“The AMRC played a fundamental role in FourJaw’s journey. It gave us the environment, expertise and support to turn an idea into a business that’s now helping hundreds of manufacturers around the world maximise their productivity.”

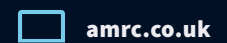
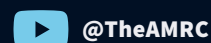
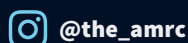
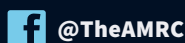
Chris Iveson, founder and CEO of FourJaw.

“The AMRC has helped change the story people tell about South Yorkshire. It reminds the world that we’re not just the birthplace of industrial innovation, we’re where the next generation of our country’s industrial innovation is being created right now.”

Mayor of South Yorkshire, Oliver Coppard.

“For 25 years, the University of Sheffield’s AMRC has proven the power of university-led innovation. By bringing industry, academia and government together, our unique model has transformed communities, turbocharged growth and helped build the future-ready workforce businesses need.”

Professor Koen Lamberts, President and Vice-Chancellor of the University of Sheffield.



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