



Footprint Tools and the rise of the robot

A lasting legacy

Interview with Steve Foxley, the new Executive Director of the AMRC.

Weaving a way to fusion

New composite advances for nuclear.

Time for digital is now

Manufacturers urged to transform with digital technologies.



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Welcome to the

AMRC/Journal



2020 vision

A lot has happened at the University of Sheffield AMRC since our last issue. Our visionary founders Professor Keith Ridgway and Adrian Allen have moved on to pastures new. Their departure in 2019 came on a colossal high with our regional hubs AMRC Cymru and AMRC North West secured along with major inward investment wins: Boeing opening its only European production facility on the doorstep of the AMRC and McLaren moving into Sheffield to bring its manufacturing work back to the UK.

We also said goodbye to our CEO Colin Sirett who was pivotal in securing AMRC Cymru. As Airbus' former head of research in the UK, Colin shepherded the £20m Wales deal to success and with the big job done, he is now looking for new challenges. We wish Colin the very best for the future.

To build on their remarkable legacy, we have put in place a talented management team, many of whom will be familiar faces to most of you. Between them, the team boasts decades of frontline experience of working with our partners - from global corporations like Rolls-Royce and Dassault to young tech start-ups such as Razor and traditional hand tool manufacturers Footprint, which both feature in this issue.

As we put 2019 to bed we start this new year and new decade with renewed optimism.

And what better way to kick-start 2020 than with the appointment of Steve Foxley as Executive Director at the AMRC. Steve joins us from global engineering powerhouse Siemens and in this issue he talks to the Journal about building high performing teams, having Juergen Maier as a mentor, and being the best version of yourself. An interview not to be missed.

While there may have been changes at the AMRC, there has certainly been no loss of momentum and that hasn't gone unnoticed.

No sooner had we flipped the calendar over to January than the calls started to come in from Westminster. As the month drew to a close we had already welcomed then Minister of State for Universities, Science, Research and Innovation Chris Skidmore, and Robert Jenrick Secretary of State for Housing, Communities and Local Government, both keen to see how our model for innovation is powering a manufacturing renaissance in the North of England.

Some of that innovative work can be seen here in these pages. We have research engineers exploring how AI-driven solutions and digital automation technologies can help the legal industry, a Composites Centre team weaving a way to fusion energy in collaboration with the United Kingdom Atomic Energy Authority, and a family-run manufacturer embracing robotics to bring a new lease of life to its skilled craftsmen and boosting productivity.

And all this without even mentioning the word Brexit...


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Cover image: Footprint Tools' secondhand robot being used to boost productivity.

A lasting legacy

The former Managing Director of Smart Infrastructure at Siemens, Steve Foxley, who has just taken up a new post as Executive Director of the AMRC, talks to the Journal's **John Yates** about building high performing teams, leaving a legacy and being the best version of yourself.

When Steve Foxley thinks of high performing teams, his mind turns to the rugby field and his days at Bristol University when he played alongside Josh Lewsey and Alex King who were later to become members of the 2003 World Cup winning squad.

"It's the best team I ever played for," says Steve, who retains a keen interest in competitive sport, sports psychology and its implications for building great business teams. "Training and playing with them, breaks would happen on that pitch that you would not have consciously thought about or planned. There was just a natural flow to how we played, there was always someone on your shoulder or someone anticipating your next move and there was an electric feeling throughout the team - like when the hairs on the back of your neck stand up. You can achieve a

similar feeling when a cohesive business team becomes a high performing team."

Steve cites James Kerr's book 'Legacy', on the legendary All Blacks of New Zealand, as essential reading for anyone striving to achieve world-class standards, day after day, week after week, year after year. The author's key message for Steve, however, is to be found in the title of the book: What do we leave behind after we're gone?

This idea of legacy is echoed in David Brook's TED Talk "Should you live for your résumé or your eulogy?" which had a big impact on Steve. "That is something I believe in one hundred per cent. I am not driven by my CV or what would look good as the next career step. I want to get to the end of my working life and be able to sit back and be proud that, whatever story will be told at my eulogy, it will be about the type of person I was."

For Steve that means a constant quest to be a better version of himself. His early life was spent in Newcastle, following his father's appointment to the new Nissan plant in Washington. "Family life was all about automotive manufacturing and Japanese philosophy," says Steve, whose father had worked for British Leyland and Jaguar Land Rover (JLR) before the move North.

"My dad was really passionate about manufacturing. He went on to set up the design centre for Nissan at Cranfield. We were always talking about engineering and the benefit manufacturing has on the economy and society. All those things rubbed off on me and my brother."

It was inevitable, therefore, that Steve and his younger brother Ian, would become engineers. While Ian went on to specialise in drivetrains and vibrations, working for Ricardo and then JLR,



Steve's passion for materials took him to Bristol University and a year at RWTH Aachen, the largest technical university in Germany.

"I was doing a Mechanical Engineering masters with a year studying abroad. I picked Aachen, first for its reputation in engineering and materials but second for its cultural diversity; it is not a very typical German city as it sits on the border with the Netherlands and Belgium, it is very multicultural and I was drawn to immersing myself in a completely different culture," Steve says.

From Aachen and the masters, his first job was with the Austrian-based metallurgical plant builder, VA Tech. This involved roles ranging from plant design through to commissioning aluminium and steel processing plants across Europe, South Africa and China.

When the company was taken over by Siemens, Steve had risen through the ranks to become the global head of the VA Tech's aluminium business. "I love the power of engineering. When you are rolling aluminium foil to a thickness of 6 microns (approximately a twentieth of the thickness of a human hair) at speeds of 100 mph, and the only way you can cool the aluminium foil without staining the material is with kerosene, the engineering challenges are totally amazing. Someone said to me that the engineering challenges of processing and manufacturing aluminium is like holding a tiger by its tail." No-one thinks about that, however, when they wrap the turkey leftovers in tinfoil after Christmas.

Steve's passion for engineering was to shift into a different dimension with Siemens' €1.2 billion takeover of the company in 2007/8. After a year spent helping integrate VA Tech into an \$80 billion business with more than 450,000 people, Steve's eyes were opened to aspects of leadership he had not seen before. "Steel making is quite a hard culture, very tight margins, very technically and operationally focused. Within Siemens I saw a broader culture. I saw managers and leaders inspire audiences, build and motivate high performing teams, shape strategic objectives with a long term vision to address global megatrends. It was these softer skills in how to motivate people that really intrigued me."

His new employers were keen to help Steve grow and suggested he identify a mentor to guide him. He had watched

videos of Juergen Maier, the CEO of the UK business. "He was really strong in all the things that I felt I was weak in. This wasn't about career progression, it was just about having somebody that I could talk to human-to-human and help me understand how to walk in to and inspire a room; how to create that one-on-one intimacy when you are talking directly to them, so they feel they are the only person in the room; how to work on things like body language, breathing and speech. I watched him and thought he had it in spades and I wanted to learn how to do that. It was nothing to do with technology or strategy."

While Juergen had natural charisma and talent, Steve quickly realised that his mentor's gifts were also the result of huge hard graft. "The amount of work he put in outside of office hours when everyone else had left, the way he put himself into challenging situations to build a new muscle, were remarkable," said Steve, who is on a similar quest towards becoming the best version of himself.

"I have admired the AMRC for so long that I just jumped at the chance to be part of the story."

"My relationship with Juergen was always about being a better version of myself and learning from him how to build muscles where I felt I was weak by putting myself in situations where I could understand myself better. He is a master of that."

For Steve, one element of his own legacy would be his role as project director for Siemens in the construction of Terminal Two at Europe's busiest airport: Heathrow. The project included the mechanical installation of 116 new check-in desks and, throughout the installation process, the system underwent independent trials to ensure that each of the one million bolts, 1,000t of steel, 5.2km of conveyors and 180,000m of cable functioned as required, and to scrutinise the baggage facility in a working environment.

From Projects Director for Siemens UK Airport and Postal, Steve moved into the Digital Factory side of the business, which spanned the complete spectrum of Industry 4.0 technologies and applications from retrofitting older manufacturing facilities to the cloud-based, industrial platform for digitalisation, Mindsphere.

This new role saw him working with Juergen and the Made Smarter initiative, and brought him into the orbit of the North West Business Leadership Team. This experience also made him more acutely aware of the role that the High Value Manufacturing (HVM) Catapult is playing in helping to deliver wider government policies like Made Smarter and the Industrial Strategy.

"The HVM Catapult is the piece of the jigsaw we have been missing in the UK for a long time, the piece that is going to realise a profound difference for manufacturing and the economy. I was massively aware of the AMRC, which was a role model for the Catapult network, and all that it had achieved in just 15 years," said Steve.

When he was shortlisted for the role of Executive Director at the AMRC he did his homework. He calculated he had already worked with 30 of our Tier One partners – and that doesn't include Siemens itself. He has also worked with more than 20 of our Tier Two partners. "It was a privilege to be invited to lead the AMRC, following in the footsteps of its founders and working with the university, government, the HVM Catapult and our partners to help UK manufacturing improve productivity in a way that supports the shift to a more sustainable, net zero economy."

As someone who thrives on change, the chance to pick up the leadership baton at the AMRC was too big an opportunity to miss. "I have admired the AMRC for so long that I just jumped at the chance to be part of the story," he said. "There are so many things that make the AMRC unique, that are part of its DNA, that they absolutely have to carry on. The transition to a new team, with years of experience at the coal face of applied research, gives us all the opportunity to write the next chapter, building on this culture and this success to shape what the AMRC will look like for 2030. This will be a journey and a future we make together. Our chance to leave our own legacy."





Deputy Head of Digital at the AMRC, Jonathan Bray, speaks to Simon Cookson from Northern Value Creators.

Digital Meet Manufacturing is critical to economic success

Industrialists across the Sheffield City Region are holding back on investment in productivity-improving technologies such as robotics and automation because of poor access to funding, skills and hands-on ‘demonstrators’, according to a new report published by researchers at the University of Sheffield in collaboration with the Advanced Manufacturing Research Centre (AMRC).

In the first comprehensive review of smart industrial technology uptake in the region, the Regional Technology Foresight report provides an in-depth investigation into a broad suite of what are often termed Industry 4.0 technologies. These range from artificial intelligence, machine learning and data analytics through to augmented reality, metrology and additive manufacture.

One of the report’s authors, Dr Jorge Martins, Principal Investigator at the Regional Technology Foresight project, said: “We wanted to assess where companies in the region feel they

stand in terms of technological capabilities but we also wanted a vision to emerge of what might be important to firms in the Sheffield City Region in the near future.

“Our goal is to help policy makers and industry prioritise the technology areas that will have the biggest and most beneficial impact on performance. Once we know that, we can determine what external support is needed as part of a joined-up approach to regional economic strategy.”

His colleague on the Economic and Social Science Research Council (ESRC) funded project, Dr Ivan Rajic, added:



“Presently, there are problems prioritising which technology is important for companies, so we are trying to determine where efforts should be focused. Demand is there, we just need to direct businesses to the support that is already available.”

The report, the second to be published by the Regional Technology Foresight team, found that many of the region’s small and medium-sized enterprises (SMEs) want to innovate, but, due to lack of funds and skills, adopting new technology is not a business priority. Instead, firms prefer to invest their limited resources on more immediate activities. Changing this climate is critical to improving productivity in the region and to moving higher up the value chain in manufacturing.

“One of the things we found most interesting,” said Dr Rajic, “was that we identified concepts that are not currently in the public debate, but which can offer novel solutions to existing difficulties.

“The AMRC’s Digital Meet Manufacturing campaign, for example, is exactly what we mean in the report about needing expertise in the region to be a point of contact and help pool resources.”

Digital Meet Manufacturing (DMM) is the AMRC’s campaign to connect digital companies and manufacturers in a way that benefits both sectors. The AMRC’s Deputy Head of Digital, Jonathan Bray, who is spearheading the DMM programme, welcomed the report: “It shows a varied and challenging picture across a region, from world leaders eagerly embracing tech to those who see little immediate benefit, and considerable potential risk, to technological innovation.

“The AMRC’s Digital Meet Manufacturing programme, which is mentioned in the report, works across this entire spectrum from pioneering innovators to stubborn sceptics. We are raising awareness in the manufacturing community across the region about the many ways in which digital industrialisation can improve productivity, quality, safety and the bottom line.

“In addition to this, we are engaging the region’s fast growing digital/tech community, opening their eyes to an untapped market right on their doorstep. As the report shows, the global vendors of industrial digitalisation often overlook smaller and medium-sized firms in pursuit of larger contracts. This leaves

the door open to agile and innovative tech firms – such as Razor and Elements Technology here in the Sheffield City Region – to adapt their digital talents to win new work.

“Our ultimate aim is to help the Sheffield City Region become a global centre of excellence for digital manufacturing – putting Sheffield and ManTech on the same world stage as London and FinTech. There is so much potential in this area, both in our digital and our manufacturing communities, that it seems crazy not to bring them together.”

The authors found ‘substantial’ interest in automation, including robotic solutions, and businesses recognised the clear potential benefits in implementing autonomous systems. However, the cost of introducing automation and a perceived lack of a skills programme to operate systems were both identified as barriers to adoption. The report highlighted research being done at the AMRC which will make automation more applicable and more easily configurable.

Robotics and autonomous systems should be a priority technology area, said the report, because there is considerable interest among firms, there is active research on overcoming the problems companies face and simpler solutions are already feasible for SMEs.

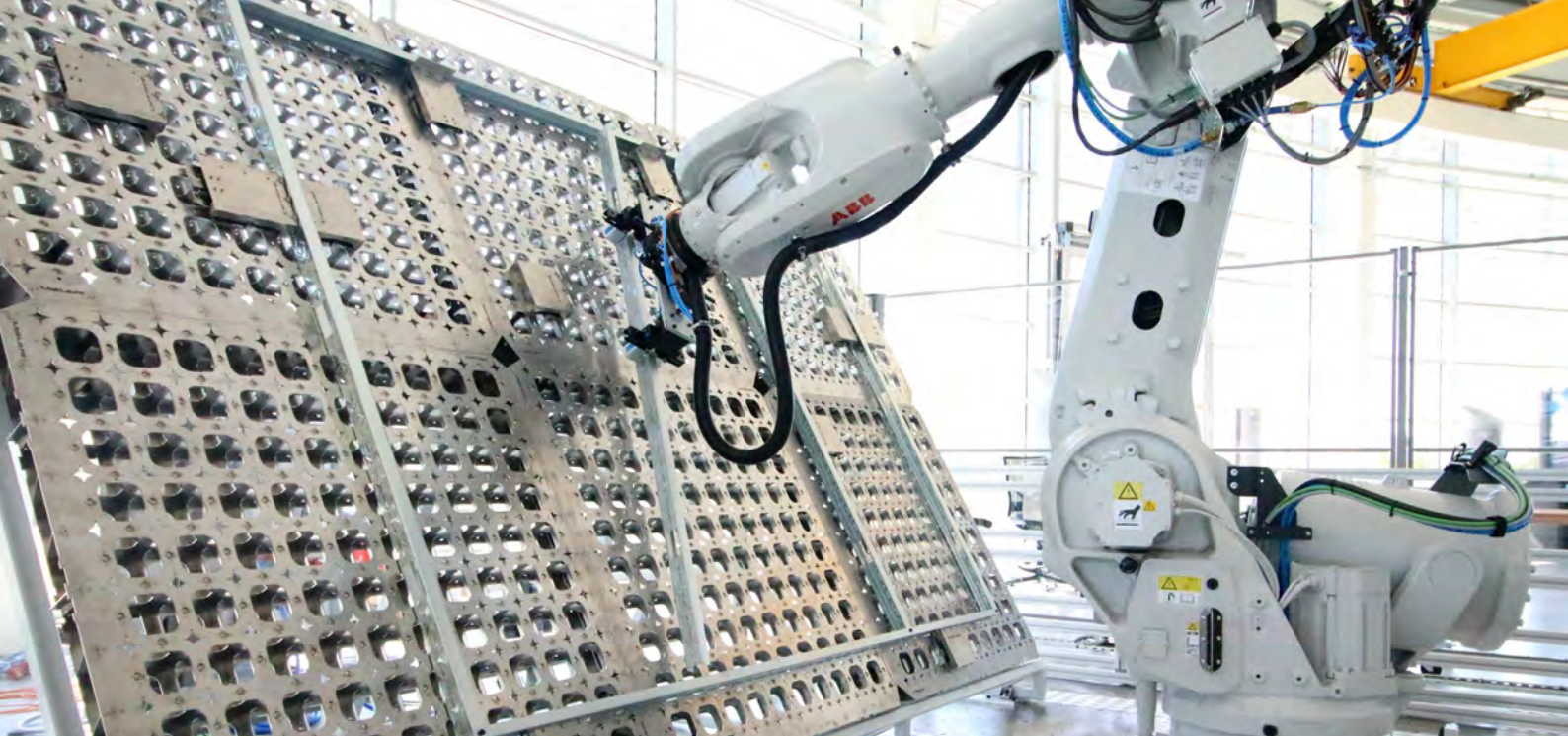
In machining, acknowledged in the report as a ‘mature technology’, it was recognised that there is ‘ample expertise’ at both the AMRC and Nuclear AMRC to optimise processes at smaller companies.

Additionally, the AMRC was identified as a supporting player in areas where cost was identified in the report as a prohibitive factor in adopting new technologies, such as in finishing, materials and product design. The Regional Technology Foresight report advocates a pooling of resources from companies which could be supported by the AMRC to achieve common objectives.

The report also asked businesses about advanced technology areas such as additive manufacturing, finishing, augmented reality and virtual reality. In areas which were considered by firms low on their immediate agendas, according to the report, the AMRC could demonstrate clear use cases, benefits and support implementation.

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Jonathan Bray, Deputy Head of Digital at the AMRC.



Regional Technology Foresight report: A business view on digital technologies

Additive Manufacturing

Businesses told the report that additive manufacturing is not high on their agendas as it doesn't solve immediate problems they are facing or enable them to exploit current opportunities. However, they recognise that additive manufacturing may prove beneficial in the future.

Augmented Reality and Virtual Reality

Most companies don't seem to have devoted any real consideration to either augmented or virtual reality as they can't see the benefits nor have the capacity to make them work. As it is low on (or completely off) agendas, the onus is on external actors to demonstrate clear use cases, benefits and support implementation.

Asset Manufacturing

Companies can realise significant benefits from monitoring their own assets but most lack the skills needed to extract value from asset manufacturing, particularly if it requires data analytics. Businesses with older equipment would gain the most, but it is easier for them to buy new equipment that acquire the necessary skills, hardware and software.

Finishing

Polishing is a dying skill; very few young people want to learn it but there is no technological solution to replace it. Research is being done, but it is very expensive, so the report suggests a pooling of resources and grants, combined with technical support from the AMRC, so that multiple companies can use an expensive piece of automated polishing kit.

Machining

The report claims companies in the region have no pressing issues in machining, however there is a lot of potential to optimise processes and there is ample expertise in the region, including at the AMRC and NAMRC. Change would be moderate rather than transformative.

Materials

Smaller companies have no real interest in exploring new materials and only bigger companies have the capacity to develop them. Therefore, any regional efforts around materials should be concentrated around larger firms and the specific projects they wish to pursue.

Product Design

For many SMEs, the cost of CAD or CAM software is too high, so the report recommends that support should consist of simple direct actions such as finding a way to provide the use of CAD software on a pay-per-use basis.

Robotics and Autonomous Systems

Many companies showed substantial interest in automation and the potential benefits, including increased precision, productivity, cost and time savings and reduced labour requirements are clear. The cost of introducing automation is one of the biggest barriers, followed by a perceived lack of a skills program to operate them, but research is being done into making robotic systems easier to use and more easily reconfigurable.

Despite the above, the report's assessment is that robotics and automation have the potential to be very beneficial for the region and should be one of the priority technology areas.

Driving a resurgence in the regions

A recent paper on Britain's productivity problem by University of Sheffield physicist, Richard Jones, is gaining traction at the highest levels in Number 10. The Journal's John Yates looks at the growing interest of policy makers in his Resurgence of the Regions paper and the role the AMRC and applied research might play in defibrillating a flatlining economy.

The American economist, Paul Krugman, once said that 'productivity isn't everything, but in the long run it is almost everything'. Anyone who doubts the truth behind the quip should take time to read a recent paper recommended by the PM's favourite policy advisor, Dominic Cummings.

Cummings, widely regarded as the man who won the 'leave' campaign and now a powerful behind-the-scenes figure reshaping the UK's research funding landscape, suggested the 50-page Resurgence of the Regions article is a must for anyone 'interested in ideas about how the new government could really change our economy for the better, making it more productive and fairer'.

Its author, Richard Jones, reminds us that productivity matters because it affects not just our everyday living standards but also our public services; an economy where productivity has flatlined since the financial crash and produces wages that are, on average, 20% less than they might have been had it kept to trend. This weakness in productivity growth also means a downward trend in tax receipts and a negative impact on public spending: welcome to austerity.

Quoting Sarah O'Connor's observation in the Financial Times that, when economic growth stalls and the pie stops getting bigger, the fights over how to divide it get fiercer and dirtier, Jones adds his own commentary: 'I don't think it's far-fetched to ascribe our

current dysfunctional and bitter political environment, in large part, to a decade of stagnation in productivity growth'.

The physicist-turned-economic-pundit is clear as to why we are in the mess we are in. The UK is essentially two economies. A thriving and incredibly prosperous capital city and its hinterlands, with Singaporean levels of productivity. Outside this boom belt, however, the rest of the UK is like a spluttering Trabant with East German levels of growth.

For those who point to the inequity of this, Jones reminds us that there are only three regions of the UK that pay out in taxes more than they receive in government spending: London, the South East and the East of England. So what is to be done?

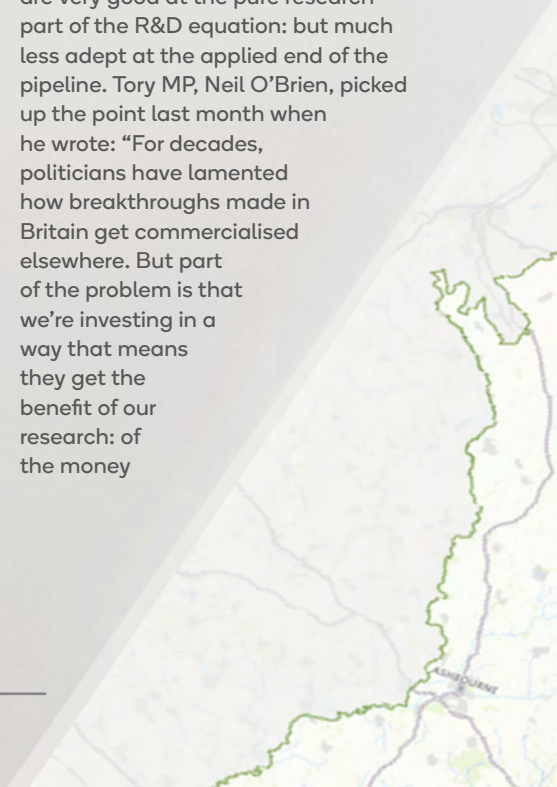
Jones is clear: "Our aim should be for the rest of the UK to narrow the gap in economic performance with the prosperous Southeast, so that the whole country is fulfilling its potential. Rather than putting up with large scale transfers of funds from South to North continuing into perpetuity, we should make the investments that will allow what are now economically underperforming parts of the country be both wealthier and more self-sufficient."

To do that will require a substantial boost to R&D spending, both public and private. The government is committed to a target of 2.4% of GDP being spent on R&D. While this is hugely ambitious, it will only bring us up to the OECD average. To get an idea of what this kind

of spending looks like, former Universities Minister, Sam Gyimah, noted that it is the equivalent of four new Rolls-Royces, four new GSKs and four new Oxford Universities, together with making Manchester and Birmingham as R&D intensive as the East of England. And a new Tech City for good measure.

While welcoming this focus on R&D spend, Jones and a growing chorus of opinion point to a serious geographic imbalance in where that money is currently being spent. The UK spends £4 billion on university R&D in London, the South and the East of England, and just £1.5 billion in the north. That needs to be addressed as a matter of urgency. But there is another problem.

Again Jones is clear. UK universities are very good at the pure research part of the R&D equation: but much less adept at the applied end of the pipeline. Tory MP, Neil O'Brien, picked up the point last month when he wrote: "For decades, politicians have lamented how breakthroughs made in Britain get commercialised elsewhere. But part of the problem is that we're investing in a way that means they get the benefit of our research: of the money



government spends on R&D in Britain 13 per cent goes on later phase development. In the US it's 45 per cent, and in China 56 per cent."

Two policy implications emerge from this critique. First, we must shift the direction of R&D travel to those regions with poor productivity like the North and the North East; and second, we should focus that spend on translational or applied research. This not only makes good economic sense, but the shorter timeframe for seeing the impact of applied research means that the government may get an electoral bounce from the investment in time for the next election. So, where to invest?

This has now become the big debate in Whitehall. Both Jones and O'Brien argue that policy and investment should

now focus on the success of places like the University of Sheffield Advanced Manufacturing Research Centre and the Warwick Manufacturing Group. Voices echoed by the former Brexit Secretary, David Davis, a Yorkshire MP who recently advocated tripling the level of spending on the AMRC to boost innovation and productivity.

Davis, in particular, highlights an observation in the Resurgence of the Regions paper on 'technology leaders and laggards and the diffusion problem' in which the author cautions against a focus on tech unicorns and university spin outs, which he feels are something of a distraction. In contrast, Jones argues that: "The underrated backbone of productivity growth is the relentless incremental improvement of existing products and processes. Some of this is visible, in the form of better aeroplanes

and new car models, or mobile phones with better cameras and brighter screens. Some are less obvious: new household products, higher performance medical equipment, the re-engineering of existing products to meet higher environmental standards. And much of this kind of innovation is totally invisible to the outsider, such as better ways of organising production or service provision, reducing costs and improving quality."

This crucial passage could so easily be a description of the R&D focus of the AMRC: the relentless, incremental improvement of existing products and process is the very thing we excel at. The recent spate of ministerial and policy visits to Sheffield/Rotherham would suggest that the government is not only listening to Jones, O'Neil and Davis but also making the connection with the AMRC. That is the way to cure the UK productivity problem.



Historic day for Wales

AMRC Cymru, a £20m state-of-the-art research and development facility in North Wales, is open for business.

AMRC Cymru is a purpose built research and development facility close to the Airbus wing-manufacturing plant in Broughton, and has been described by Welsh government ministers as a ‘game changer’ for the economies of Wales and the northern powerhouse.

It was officially opened by First Minister of Wales Mark Drakeford and Economy and North Wales Minister Ken Skates, who accompanied Professor Koen Lamberts, President and Vice-Chancellor at the University of Sheffield, on a tour of the new building to see the new technologies that will be available to manufacturing companies across Wales.

Speaking at the event, Professor Lamberts, said: “We are really proud to be working with the Welsh Government on this bold and ambitious project which will help keep Wales at the forefront of wing manufacture and put world-leading research and development at the heart of a vibrant Welsh economy.

“The University of Sheffield AMRC has built a truly global reputation for world-class, industry focused innovation which drives manufacturing and productivity growth and we’re delighted to be bringing our extensive expertise and experience to Wales.”

Colin Sirett, the then CEO of University of Sheffield AMRC said: AMRC Cymru is a landmark moment for both Wales and the UK.

“We share the Welsh Government’s ambition and vision to spark growth and productivity for the area and are very proud of this new addition to the AMRC’s stable of world-class facilities which will be a beacon for innovation and advanced manufacturing in Wales and the northern powerhouse.

“We are supported in this by Innovate UK and the High Value Manufacturing (HVM) Catapult, along with the vital backing of the Aerospace Technology Institute, which shares our ambition to keep the UK at the forefront of the global aerospace sector.

“AMRC Cymru will not only help Welsh industry to develop new capabilities that build on an already rich manufacturing heritage, but it will strengthen collaboration between industry and academic partners, and put Wales centre stage with a leading role in developing cutting edge research, technologies and skills that are key to boosting productivity and growing the economy.”

AMRC Cymru will bring businesses new research and development opportunities and allow industry to access advanced technologies which will drive improvements in productivity, performance and quality.

Situated in the Deeside Enterprise Zone the facility will focus on advanced manufacturing sectors including aerospace, automotive, nuclear and food. This region has a strong manufacturing base and AMRC Cymru will build on this, driving world-class research and expertise across the supply chain.



It is predicted the new facility could increase GVA to the Welsh economy by as much as £4 billion over the next 20 years.

The facility will operate a 2,000 square metre open access research area. In addition Airbus will be the first major tenant and will have a platform to develop their next generation wing technologies aligned to its 'Wing of Tomorrow' programme, which is part of a global Airbus investment in research and innovation.

First Minister Mark Drakeford, said: "This is truly a historic day for North Wales. This is a world-class facility which, with its partners, will be a key driver in bringing the latest research, technology and skills to Deeside and the wider region.

"The Deeside Enterprise Zone has a strong manufacturing base and this development will further strengthen its position for the future, sparking innovation and productivity. It will ensure the area is at the forefront of cutting-edge skills in manufacturing.

"AMRC Cymru will be of benefit for generations to come in North Wales and is part of our aim to have a more prosperous and equal Wales."

Economy and North Wales Minister Ken Skates, said: "AMRC Cymru is a real game-changer for the economy of North Wales. It will boost the region's reputation for manufacturing excellence and its impact will be felt across Wales.

"It will play a key role in bringing academia and businesses closer together, boosting skills and innovation.

"It's an amazing facility, developed by Welsh Government, operated by the University of Sheffield AMRC, bringing the very latest innovations and potential opportunities straight to North Wales. It will raise productivity in the region and along with the North Wales Growth Deal and our investment in infrastructure will allow North Wales to fulfil its economic ambition.

"It's a very real pleasure after only three years from concept to delivery for me to see it now ready to open for business."

AMRC Cymru was designed and project managed by Arup and the construction was carried out by Galliford Try.



Airbus' Senior Vice President, Paul McKinlay.

AMRC Cymru is an **enormous opportunity** for Airbus to go green

The head of Airbus' Broughton plant in North Wales has said becoming the first major tenant of AMRC Cymru is an 'enormous opportunity' for the aerospace giant to develop more environmentally friendly manufacturing systems. Paul McKinlay, Airbus' Senior Vice President, spoke at the opening of the state-of-the-art research and development facility.

Backed by £20m from Welsh Government, AMRC Cymru has been built on the Deeside Enterprise Zone close to where Airbus is developing the Wing of Tomorrow programme, which is part of a global Airbus investment in research and innovation.

McKinlay said: "AMRC Cymru is an enormous opportunity to create much more environmentally friendly product and manufacturing systems. It is going to be an enabler and a game changer for Airbus to change its environmental footprint for the future.

"This facility is world-class and the perfect home for our most significant research and development programme, the Wing of Tomorrow.

"The programme will inform the next generation of wings so when we launch a new aircraft programme, we'll have the technologies and systems ready to design and build the wings at the rate we need them."

Sue Partridge, Head of the Wing of Tomorrow programme at Airbus, added: "We are really mindful of the environmental impact of the aircraft that we build and by bringing improved performance to the wings, reducing fuel burn, we make a big contribution towards improving the sustainability of our product.

"There are many, many other aspects within our industrial system where we are also looking at those environmental challenges as well."

AMRC Cymru, part of the High Value Manufacturing (HVM) Catapult, was officially opened on 29th November 2019 by Welsh Government First Minister Mark Drakeford, Economy and North Wales Minister Ken Skates, University of Sheffield Vice Chancellor Professor Koen Lamberts and Paul McKinlay.

Professor Lamberts said AMRC Cymru's potential environmental impact is hugely important: "Airbus is a company that is at the very forefront of bringing zero emission technology to aviation. Our research teams will be working with Airbus on the Wing of Tomorrow and the aim is to push the boundaries of what is possible in aerospace.

AMRC Cymru's Research Director, Andy Silcox, said: "Our talented team of manufacturing engineers are incredibly enthused by the opportunity to help Welsh manufacturers across all sectors, not just aerospace, evolve and adopt the new technologies of Industry 4.0.

"We believe that we can be a major catalyst for a culture of innovation in Welsh manufacturing, which will drive our industrial partners to become global leaders in sustainability and profitability."

Green light for high-tech facility to drive innovation in Lancashire

The University of Sheffield AMRC has been given the green light to build a dedicated facility in the North West of England which will boost Lancashire’s reputation as one of the UK’s most innovative regions for advanced manufacturing and act as a powerful magnet for inward investors.

Planners at South Ribble Borough Council and Ribble Valley Borough Council granted permission to the University of Sheffield Advanced Manufacturing Research Centre (AMRC) to build and equip a £20m state-of-the-art facility in a landmark location at the heart of the Samesbury Aerospace Enterprise Zone, one of four zones that make up the wider Lancashire Advanced Manufacturing and Energy Cluster.

James Hughes, Research Director at the University of Sheffield AMRC North West, said: “We are delighted that work can now begin on an applied research

facility that will equal the best in the world, consolidating the reputation of Lancashire and the wider Northern Powerhouse as the go-to-place for innovation expertise and skills in advanced manufacturing.”

The new 4,500 m2 facility, which will have a focus on vehicle electrification, battery assembly and lightweighting technologies, is being built with capital funding provided through the Lancashire Enterprise Partnership (LEP)s Growth Deal. In addition, a £2.5 million revenue grant from the European Structural Investment Fund (ESIF) matched with £1.6m from the High Value

Manufacturing (HVM) Catapult, will secure the creation of a high-performing technical R&D team that will enhance the manufacturing base of Lancashire, working with manufacturing companies and their supply chains.

Dave Petley, Vice-President for Research and Innovation at the University of Sheffield, said: “The University of Sheffield has a long-standing reputation of developing specialist regional hubs providing valuable engineering expertise and access to advanced capabilities tailored to the needs of local industry sectors. The new facility in





Innovation hub: The artist impressions showing how the new AMRC North West might look.

the North West will be the catalyst for manufacturing growth, supporting the supply chains in the region to drive up productivity and attract inward investment to create a sustainable future for advanced manufacturing in the region.”

Melissa Conlon, Commercial Director for the University of Sheffield AMRC North West, added: “Our mission is to ensure that Lancashire and the North becomes the engine room of the fourth industrial revolution, harnessing the latest digital technologies, from robotics and automation to artificial intelligence and augmented reality,

to support the transition to a low carbon economy, accelerate the move to transport electrification, drive up productivity, improve the competitiveness of indigenous industries and make the region a magnet for global manufacturing brands to invest.”

Chairman of the LEP, Steve Fogg, said: “We have worked hard to attract the AMRC to the Samlesbury Aerospace EZ and backed it with £20m of Lancashire Growth Deal Funding.

“The AMRC will play a key role in helping the county’s aerospace and advanced manufacturing sectors to maintain their

leading position in the UK, by driving growth, productivity and innovation and supporting Lancashire firms to compete nationally and internationally.

“The AMRC is also another hugely important investment in the Samlesbury Aerospace EZ. We expect considerable synergies between the AMRC and the growing number of top-class, high-tech facilities that are already on the site and it will also complement UCLan’s Engineering Innovation Centre, which the LEP also helped fund.

“With world-class facilities like the AMRC and high-quality infrastructure



AMRC



The University of Sheffield

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Vision: Designs showing the exterior and interior of the new research and development hub in Lancashire.

and support, Lancashire's EZs combine to make an economic and investor offer of Northern Powerhouse significance, which will drive job creation and economic growth in the county for years to come."

The LEP and University of Sheffield are part of a consortium which identified opportunities for investment and enhanced research innovation and infrastructure along an Advanced Manufacturing Corridor taking in the two regions and the AMRC North West is the product of this strategy.

Stephen Young, executive director of growth, environment, transport and community services at Lancashire County Council, said: "We welcome

the AMRC as our latest tenant at the Samlesbury Aerospace Enterprise Zone. "Lancashire's advanced manufacturing sector is at the forefront of cutting-edge innovation, and the AMRC will support Lancashire's existing businesses and act as a catalyst to attract new business into the county and the Enterprise Zone."

Currently operating from interim facilities provided by the University of Central Lancashire (UCLan) in the centre of Preston, the rapidly growing University of Sheffield AMRC North West team is already working with more than 65 small and medium sized manufacturing firms from across the region, as part of its mandate through

the ESIF funding to enhance the regional economic base and its supply chains.

"The University of Central Lancashire has been a great support," says Melissa. "We are working on a number of collaborative R&D projects with a number of key stakeholders to drive forward advanced manufacturing across Lancashire."

The new University of Sheffield AMRC building in the North West will include, among others, machine tools, additive and hybrid manufacturing, automated assembly, robotics, and autonomous manufacturing processes and systems.

Weaving a way to fusion energy

A 3D woven composite component, capable of withstanding extreme temperatures inside a fusion nuclear reactor, is being developed at the University of Sheffield Advanced Manufacturing Research Centre (AMRC) in collaboration with the United Kingdom Atomic Energy Authority (UKAEA) to accelerate the delivery of limitless zero-carbon fusion energy. James Crossling reports.

The work was commissioned by the Joining and Advanced Manufacturing (JAM) programme, which forms one of three Fusion Technology Facilities at UKAEA. The AMRC, part of the High Value Manufacturing (HVM) Catapult, worked with Technical Lead for non-metals, Dr Lyndsey Mooring, to explore how composite materials could produce components that are stiffer, lighter and easier to manufacture than those currently in use, but which retain the necessary capabilities.

The UKAEA is involved in developing the next generation of magnetic confinement reactor called a tokamak at their site in Culham, Oxfordshire. Research is focussed on preparing for the international tokamak experiment

at the International Thermonuclear Experimental Reactor (ITER) in Saint-Paul-lès-Durance in southern France and for the following machine that will demonstrate the generation of power from fusion.

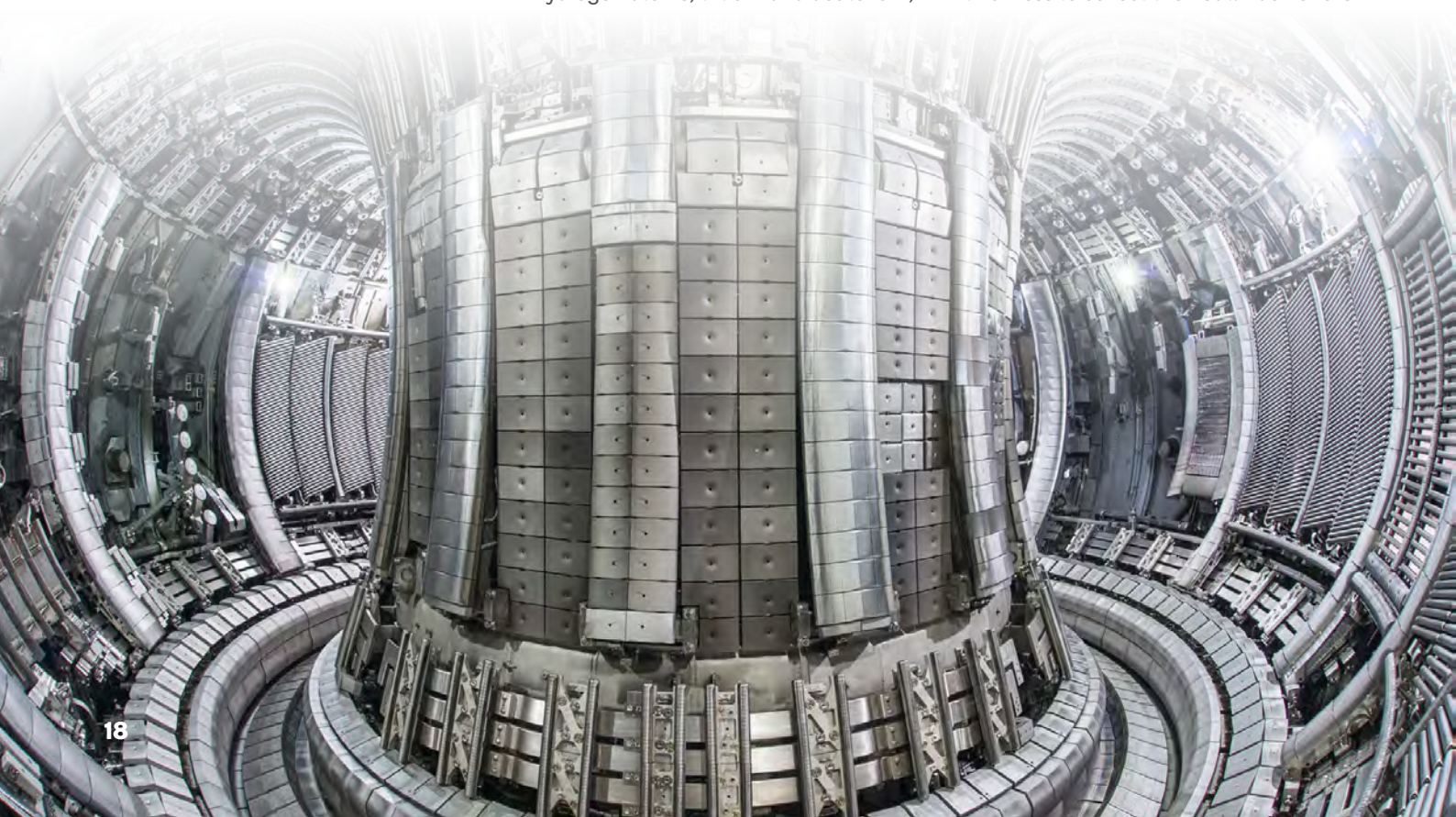
In September, the UKAEA announced that they would be building a new £22 million fusion energy research facility at the Advanced Manufacturing Park in Rotherham that includes a test facility that reproduces the thermohydraulic and electromagnetic conditions in a fusion reactor. The centre will work with industrial partners to commercialise nuclear fusion as a major source of low-carbon electricity.

Fusion occurs when two types of hydrogen atoms, tritium and deuterium,

collide at enormously high speeds to create helium and release a high energy neutron. Once released, the neutron interacts with a much cooler breeder blanket to absorb the energy.

The breeder blanket must capture the energy of the neutrons to generate power, but also prevent the neutrons escaping and 'breed' more tritium through reactions with lithium contained in the blanket. Each blanket module typically measures $\sim 1 \times 1.5\text{m}$ and currently weighs up to 4.6 tonnes.

"At the moment the designs being tested in ITER use steel for the breeder blankets structure, which have a network of double walled tubes of 8mm internal diameter and 1.25mm wall thickness to collect the heat. Each one is



welded into place and every connection has to be inspected. That is what we were asked to replace,” said Steffan Lea, research fellow at the AMRC Composite Centre.

“Currently, their steel modules are limited to approximately 500°C so UKAEA asked us if there was anything we could do to get it up to 600°C. We set out to see what materials we could use, that would enable higher temperature operation.”

Engineers at the AMRC proposed to make use of high performance ceramic composite materials and to form a unitised 3D woven structure with additive manufacture components. The cooling tubes in the breeder blanket would be integrated into the material and 3D printed parts used to define features such as connectors and manifolds.

Senior Project Manager at the AMRC’s Design and Prototyping Group, Joe Palmer, was involved in the design of the component demonstrator, and said: “We wanted to maximise the available surface area for heat transfer while being as lightweight as possible, but ensure it occupied a similar volume to the existing breeder blanket designs.

“To achieve a lightweight, temperature resistant structure, a silicon carbide composite material was chosen for the breeder blanket, with the internal flow channels being created by forming the composite around a disposable core.”

With a computer-aided design (CAD) model produced, Chris McHugh, Dry Fibre Development Manager at the AMRC Composite Centre, then created a weave design for the composite: “The design I created had multiple weave zones and had multiple layer weaves. The structure needed holes robust enough to include tubes and needed to maintain the preform shape without distortion.

“What we were able to produce on the loom was a 3D woven structure with pockets for the 3D-printed tubes which could be formed into a ridged component.”

Steffan continued: “What we were able to do was replace a metallic box, made of different steel components, with a malleable textile fabric which had cooling pipes running the length of it.

“Using advanced manufacturing technologies available at the AMRC we have integrated the functionality of cooling, simplified the design and

removed the welding operation, so lessening the burden of qualification.

“When maintenance happens in the nuclear fusion reactors, these components are lifted in remotely using a robot, so using these materials, which are far lighter and can also be stiffer, would bring great benefits in terms of how the reactors are built going forwards.”

A delegation from the AMRC took their demonstrator breeder blanket concept made from carbon fibre reinforced polymer (CFRP) to the UKAEA in Culham, where it was presented to Head of Technology, Dr Elizabeth Surrey.

Dr Surrey said: “Designing a fusion reactor is possibly the most challenging engineering project ever undertaken. We need to explore disruptive manufacturing technologies to satisfy the operational requirements of high temperature, low weight and high strength structures using materials that offer low nuclear activation.

“For fusion to become a commercial, clean energy source the structures need to be modular and easily manufactured and provide operational lifetimes of decades. Standard manufacturing routes struggle to deliver across all of these requirements. That is why we turned to the expertise of the AMRC to investigate the possible application of silicon carbide to this problem.

“Recent advances in silicon carbide manufacturing technology may offer the possibility of using this material in a fusion reactor; it has so many advantages it has to be considered. I was impressed, but not surprised, by the progress made at the AMRC in such a



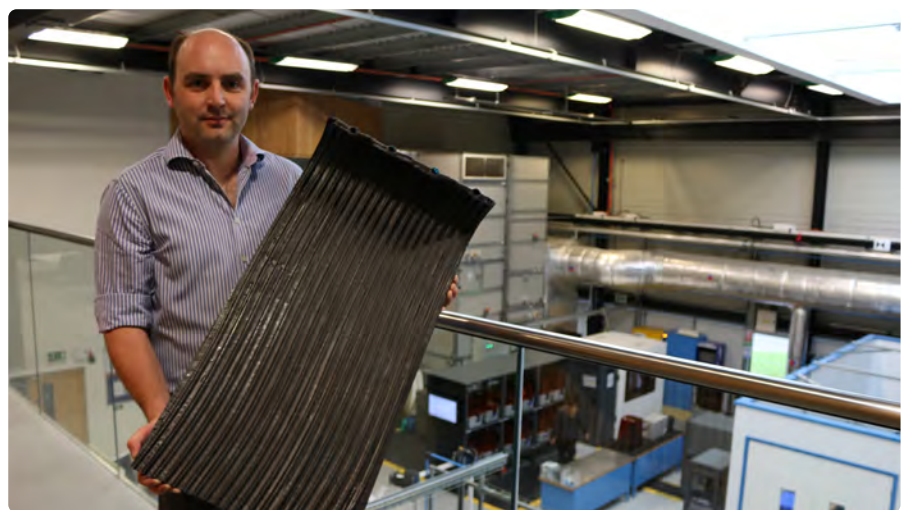
short time.”

Steffan said: “We have successfully demonstrated the initial concept works but their designers understand what performance and functionality is required.

“The next step is to continue the silicon carbide composite development and build a demonstrator that can be tested inside a reactor test facility in order to understand how it performs and reacts to the environment.

“If nuclear fusion is going to be realised, you need a simple design for breeder blankets that are manufacturable and easily replicated. That is what we have tried to create.”

Dr Mooring added: “This successful project has been an excellent first step in demonstrating alternative structural materials and manufacturing routes for scalable fusion reactor components. This opens the design space available for our colleagues and offers problem solving solutions that can assist in realising a future fusion power plant.”



AMRC research fellow Steffan Lea with the demonstrator and left, the interior of a JET tokamak. Credit: EUROfusion.

Digital Propulsion: Propelling air travel to a sustainable destination

A £20 million project to develop lightweight propeller blades that will help the UK aviation sector reduce its carbon footprint and noise emissions at airports, is being carried out by composite researchers at the University of Sheffield Advanced Manufacturing Research Centre as part of an industry-led consortium with two other members of the High Value Manufacturing Catapult. Katia Harston writes.



The AMRC, along with the National Composites Centre in Bristol and the Manufacturing Technology Centre in Coventry, is supporting private sector partner Dowty Propellers (part of GE Aviation Systems) for the Innovate UK funded Digital Propulsion project.

The consortium is tasked with growing the UK's aerospace propeller manufacturing base by harnessing composite technology with industrial digitalisation to cut production costs and increase the performance of future

propulsion systems in Europe's €200 billion aviation sector.

Elaine Arnold, Automation Technical Lead for the AMRC Composite Centre, said: "In a world of increasing passenger numbers the demand for cleaner, cheaper and yet more comfortable air travel has never been greater. To meet this demand, it is vital that the UK maintains and extends its world leading capability in sustainable UK aviation propulsion technologies."

It is also key to achieving Europe's

Flightpath 2050 vision, which is for: 'The European aviation community to lead the world in sustainable aviation products and services, meeting the needs of EU citizens and society'.

Elaine says the development of technologies to reduce propeller noise and lower fuel burn through the Digital Propulsion programme demonstrates a clear commitment to these goals.

She added: "The Digital Propulsion project aims to evolve technologies within a new digital infrastructure





to realise innovations in propulsion performance and cost.

“Part of the role of the AMRC is to explore novel and innovative ways to design and manufacture varying types of propeller blades, from regional to small, including the load bearing structure, the cores, the blade roots and relevant hub connections. This is being carried out alongside the National Composites Centre (NCC) who will be exploring the use of their specific manufacturing and design technologies.

“The other side to it, and much more excitingly, is that both the AMRC and NCC are collaborating to form a new braid that fits these new shapes. Engineers have been coming up to Sheffield and we have been going down to Bristol which means a cross pollination of ideas and for everyone to see that we are better working together.”

Elaine says the work being done by engineers at the AMRC draws on the North’s rich and proud textile heritage and the incredible capabilities offered by a collection of state-of-the-art equipment recently purchased by the AMRC with funding from the Aerospace Technology Institute (ATI) which will enable the development of novel braiding designs.

She said: “Our portfolio of cutting edge equipment means we’re able to access a wide range of advanced technologies to do this work including finite element analysis, braiding, tailored fibre placement, resin transfer moulding and press forming.

“The next steps will be to look at the braiding of multiple parts of the blade and then the thermoforming of the foam that sits on the inside of the blade. Excellent progress has been made so far and the goal is for us to make a section of the full blade.

“It is very much a collaborative piece of work and a great example of why collaboration across the High Value Manufacturing (HVM) Catapult centres is of tremendous benefit to industry; engineers from the AMRC and NCC are exchanging their understanding and knowledge of capabilities to find and develop innovative manufacturing methods that will not only reduce costs but increase performance, positioning the UK as a world leader in this field.

“Dowty has flown the flag for the British aerospace industry across the world for many years, and this project will ensure it continues to do so into the future. For the AMRC, the outputs of the programme will be a proven cost-effective route to manufacture

composite blades and a springboard for further research and development.”

The three-year programme has allowed Dowty to investigate multiple technologies to design the next generation of composite propeller blades, incorporating new and novel geometries beyond current capabilities offered by existing manufacturing techniques.

Jonathan Chestney, Dowty Propellers’ Engineering Leader, said: “This programme paves the way for new business opportunities within Dowty. The technology development led by the Catapults is allowing us to explore both current and emerging markets and create offerings for prospective customers which are both innovative and cost effective. The cross-Catapult collaborative effort is enabling detailed technology development to occur at a fast pace due to the sharing of resource and expertise, all of which benefits Dowty and, ultimately, its customers.”

The AMRC is working with Catapult colleagues in the Bristol-based National Composites Centre and the Coventry-based Manufacturing Technology Centre in the ATI-funded programme. They are also investigating the shift from manual to automated blade manufacturing processes.

Collaboration: The AMRC Composite Centre team who are working on the £20m Digital Propulsion project using the latest radial braider tech.

Mimic the brilliance

The leaders of an audacious £20 billion transformation plan for Australia’s third largest regional economy have teamed up with the University of Sheffield Advanced Manufacturing Research Centre (AMRC) to build a high value added manufacturing district connected to an emerging aerotropolis around the new Western Sydney airport.

The Premier of New South Wales, Gladys Berejiklian, and members of her Cabinet, flew in to the UK to sign a ‘foundation status’ deal with the founder and then Executive Dean of the AMRC, Professor Keith Ridgway, opening the door to the creation of an Advanced Manufacturing Research Institute (AMRI) at the heart of Australia’s newest economic hub and modelled on the Sheffield City Region’s hugely successful AMRC.

Premier Berejiklian said: “We want to mimic the brilliance of the AMRC model to allow companies to work together with our finest research brains and to allow the young people of Western Sydney to access STEM education in their own backyard.”

During her high-level tour of the AMRC’s Rotherham campus she made a special point of talking to a group of apprentices at the AMRC Training Centre, as upskilling the workforce is vital to Western Sydney’s goal of creating the 200,000 new jobs.

Professor Ridgway said: “It’s been an honour to show the Premier around

our research facilities and to meet our apprentices, who are our proudest achievement. We are delighted to be invited to help her team turn their vision for a Western Sydney Aerotropolis into a reality. This is also a massive opportunity for the Sheffield City Region to learn and benefit from the partnership with New South Wales, as this inspirational project takes wings. Her visit is testimony to the fact that the AMRC has become a global brand with a reputation for economic and social transformation driven by high value-added skills and serious R&D engineering talent.”

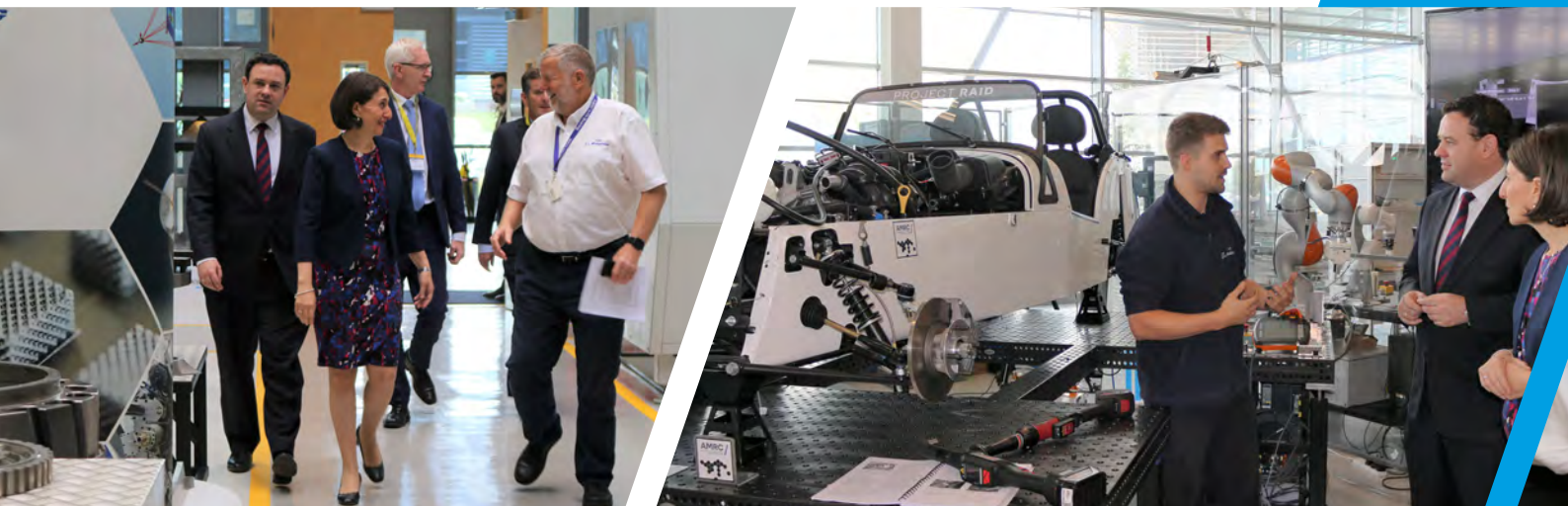
The architects of the new city are keen to explore the idea of a Manufacturing Skills Academy (MSA) based on the AMRC Training Centre to support training at all levels including craft and technician apprenticeships, degree apprenticeships, postgraduate training and continued professional development.

“We have learned that vocational and apprentice training is more accessible if delivered at the local level thus a skills academy could act as a hub

connecting with spokes at strategic sites networked across the state,” said Professor Ridgway. In addition to local delivery, the MSA would be responsible for curriculum development, quality and delivery across the network and ensuring that the training provided is consistent with the high-level technologies being developed within AMRI.

Early ideas clearly draw on the AMRC experience, with AMRI supporting the NSW advanced engineering and materials and construction sectors which will be a catalyst for a High Value Manufacturing Innovation District (HVMID) which will enable the Aerotropolis to realise its vision for a vibrant community of manufacturing and technology businesses that will congregate around AMRI due to their shared interests and capabilities.

“The issues and potential solutions are not unique to Western Sydney,” said Ridgway. “There is clearly an opportunity to establish a global network of



Innovation Districts and Advanced Manufacturing Research and Training Facilities. A global network, with Sheffield City Region at its heart, would share best practice, develop complementary research programmes and jointly develop and share training and skills courses and support material.”

Premier Berejiklian said. “Over the next decade, Western Sydney will be transformed into a world-leading agglomeration of science, technology and education. We are bringing together the best knowledge available globally to help build a new city that will create jobs and skills for future generations with the amenities that will be required to meet the expectations of a growing population.”

Looking round the AMRC Training Centre – built on what was once the site of the Battle of Orgreave between striking coal miners and the police in the mid-1980s – the Premier remarked on the scale of the transformation.

“Forty years ago, this region was a declining wasteland of 19th-century industry, so the transition from old to new, in creating jobs of the future is incredible to see,” she said. “Today’s partnership is another commitment by the NSW Government to the creation of high-quality education and jobs in the Science, Technology, Engineering and Mathematics (STEM) field for young people in Sydney’s West.”

A recent report by the University of Western Sydney notes that the region has higher than average unemployment and lower than average salary levels. Western Sydney is home to 1.9 million

people of which 35% were born overseas. The population is projected to reach 3 million by 2036 and to absorb two thirds of the population growth in the Sydney region. It is one of the largest growing urban populations in Australia.

Many people first settling in Australia choose Western Sydney and over the past decade 50% of those settling in Western Sydney were from Iraq and Sudan. Western Sydney has a high proportion of low income families and high school retention rates for years 7 to 12 are the lowest in the Sydney metropolitan area.

“Western Sydney shares similar aspirations to many other regions worldwide– to regenerate the economy through a combination of inward investment and indigenous organic growth,” said Ridgway. “There is a realisation around the world that growing and maintaining the high value manufacturing sector is a key enabler for generating sustainable, well-paid jobs and a thriving community and a balanced economy.”

“The vision is a thriving community based on a cluster of high value manufacturing companies and their supply chains co-locating with research, education and training establishments that can meet their future innovation and training needs.”

The Premier thanked the AMRC for the ‘wonderful opportunity to see the miracles performed in such a short space of time’ and for ‘showing us how it can be done’.

She said: “Sheffield has gone from a town that was really distraught after the coal industry left and in just 15 years has built up a research and development capacity that is now central to the UK’s economic success story.

“Not only is the AMRC providing a research and development capacity with 125 partners of key industries across the globe but they’re also performing that special opportunity through apprenticeships and university to really qualify those individuals, especially young people, to get those jobs for the future.

“It was fantastic speaking to some apprentices who have gone on to get engineering degrees and are providing R&D support and working in industries really at the cutting edge of technology.

“I’m really excited about putting this model into the Western Sydney Aerotropolis; I’m excited about what this means for future generations. I want to thank Professor Ridgway, along with our signing the MoU which will take this further into the future and also ensure that we replicate this success story for Western Sydney.”



Premier Gladys Berejiklian with AMRC founder Prof Keith Ridgway at the signing of the MoU and tour of the wider AMRC campus.



She added: “Western Sydney will become the advanced manufacturing hub – not just for New South Wales but for Australia.

“This is nation-building stuff and I’m so proud that we have been able to secure this relationship to ensure we have the University of Sheffield AMRC really holding our hand through this process; not only ensuring we replicate this success in Western Sydney but actually add to it. I’m really excited by what that means.”

She said the government is already committed to establishing a ‘super TAFE’ (a technical and further education institution) on the Aerotropolis site which she said is key to ensuring the R&D

functions are transferred into the TAFE courses. Four leading universities will also have their R&D facilities based on the site and MoU’s have been signed with 15 organisations, including the AMRC.

“It’s government working with universities, working with private sector, to make this become a reality and that’s why the AMRC has been such a success in Sheffield.

“What we have seen here (the AMRC) is what industry has been telling me since I came to the UK and that is you really need a strong vocational education and training system, a TAFE system, alongside a university system, alongside the capacity to turn research and

development into products and jobs.

“Again, this isn’t just a vision for Western Sydney or the airport precinct; what will be happening in the Aerotropolis is actually nation-building. It’s great for New South Wales, critical for Australia - and this is the type of vision that is required to make it happen.”

“We will be the manufacturing capital of Australia,” she added. “That is the most exciting prospect our state has had in a long time when it comes to future

“This is nation-building stuff and I’m so proud that we have been able to secure this relationship to ensure we have the University of Sheffield AMRC really holding our hand through this process; not only ensuring we replicate this success in Western Sydney but actually add to it. I’m really excited by what that means.” Premier Berejiklian



jobs and not only is it a fundamental criteria for young people to get those jobs but we know many people from all ages are having to retrain for different parts of their careers, so this site, the Aerotropolis, will be huge potential for people of all stages of their life looking to participate in some of those emerging technologies but also for New South Wales to be at the cutting edge of R&D, which is what Sheffield is.”

Stuart Ayres MP, Minister for Jobs, Investment, Tourism and Western Sydney, described the AMRC as ‘world-class’ and wanted to be able to deliver the same for Western Sydney.

“Our vision for Western Sydney is about making an advanced manufacturing

and innovation capital, not just for New South Wales but for all of Australia and what we see here is a town a long way away from London actually changing the way the workforce is developed into the future.

“This very precinct here is training young men and women, often at the age of 16 and 17, to be the workers of the future to make sure the economy here in the United Kingdom stays strong and they continue to build things; and that’s something that’s very important to us in Western Sydney.

“There’s a lot of lessons to be learned here. We can learn from these experiences – to go from a town in decline with falling jobs and limited skills

to now being a centre for innovation and advanced manufacturing – and not just here in the north of England but right across Europe, partnering with global firms building parts of aircraft that people fly on every single day – that’s the type of vision we want to sell to people right across Western Sydney.”

The 11,200 hectare Western Sydney Aerotropolis will be Greater Sydney’s newest economic hub. Encompassing an airport city at its core, and surrounding the planned Western Sydney Airport, the Aerotropolis sits at the heart of the emerging Western Parkland City.

The AMRC welcomes Kordsa

AMRC / KORDSA
ADVANCED MANUFACTURING RESEARCH CENTRE / THE REINFORCER



Former AMRC CEO Colin Sirett and Kordsa CEO Ali Çalışkan sign the MoU and right, the Kordsa delegation during their tour of the AMRC.

Reinforcing global partnerships

A global player in the tyre and construction reinforcement markets has teamed up with the University of Sheffield Advanced Manufacturing Research Centre (AMRC) to develop new advanced composite technologies.

A high-level delegation from Kordsa, which has facilities across the world, visited the AMRC to sign a Memorandum of Understanding (MoU) in which both organisations agreed to collaborate in the composites industry, as well as establish a connection between the University of Sheffield and Sabancı University in Istanbul.

Kordsa, which has invested in composite technologies over the last few years, sees the collaboration as an opportunity to quickly scale up the business journey to new composite technologies. Combining the AMRC's groundbreaking manufacturing techniques with their own expertise in composite materials,

Kordsa aim to be among the major players in the UK aviation and automotive network by developing new advanced composite technologies.

Through its supply of the aerospace and automotive markets, Kordsa has been a market leader in tyre reinforcement since the company was founded in 1973 and has earned the moniker 'The Reinforcer' due to its reshaping of the industry and innovative approach. In 2016, Kordsa established the Composite Technologies Centre of Excellence (CTCE) in Istanbul in partnership with Sabancı University as part of an initiative to push the boundaries of advanced composite material technologies.

Kordsa CEO, Ali Çalışkan, said: "As a company with an open innovation approach, Kordsa works with many different universities, companies and research organisations both in Turkey and abroad, engaging in joint projects with world-renowned specialists in their fields. The AMRC is a good fit for Kordsa and the Centre of Excellence we have in Turkey. Each passing day we strive to reinforce a larger area and build a more reinforced future. We are looking for opportunities for collaboration and growth globally and that is the reason for signing the MoU. I can proudly say, our passion for innovation will always drive us to find new and better ways



to reinforce life in every geography we operate.

“The AMRC business model, where partners and industrial players collaborate together, presents us with new ideas for growth and provides opportunities for the future. There are many aerospace companies and other industries that we could join forces with in a similar ecosystem in Turkey. Dedicated to reinforce life, we invest in the future to create unique value through innovation and redesigns that reshape the industries in which we operate. This partnership with the AMRC is going to help us a great deal in putting a new ecosystem in place and we also expect some opportunities to invest in the United Kingdom as we develop further advanced materials in the composites industry.”

The Kordsa delegation was given a tour of the AMRC by the then CEO Colin Sirett, who said: “Kordsa were hugely impressed with the scope and depth in technology we have. They can see parallels with the technology streams they’re planning to develop for the future and are developing at the moment, so there is a perfect match for future work together.”

Colin said this offers the prospect of both strong research links and inward investment: “There are all the elements

in this: the technology, the potential for manufacture and then the jewels in the crown are the research links and potential joint PhD delivery between Sabancı University and the University of Sheffield.”

The CTCE will enable AMRC engineers and University of Sheffield PhD students to work in a state-of-the-art facility, Mr Çalışkan said: “The site at Technopark Istanbul is 3,500 m² and has capabilities for material and mechanical characterisation tests, additive manufacturing, polymer processing and advanced composite manufacturing methods using several methods including autoclave and automated fibre placement as well. It is the only production and test centre in Turkey which meets the international aerospace requirements. Established to produce the technology of the future, the CTCE serves as an innovation hub.”

Colin noted that with the continuing uncertainty around Brexit, building associations with organisations outside the EU is essential from the AMRC’s perspective. The MoU also demonstrates the international reputation of the AMRC as the go-to place for advanced manufacturing and composite technology. “If you look at the positioning of the University of Sheffield for the future, with everything else that

is going on, which is completely outside of our control, these are critical, strategic relationships.

“These links work best when there are shared gains as well as a shared opportunity; they will give us a footprint for education, technology and potential investment in both directions.”

Bahattin Koç, Professor at the Faculty of Engineering and Natural Sciences at Sabancı University, said: “Beyond the initial scope of this MoU, we are very hopeful about the academic scope of the collaboration. Together with the University of Sheffield, we will be exploring the opportunity of joint PhD programmes, collaborative research, and we intend to support the foundation in establishing a training centre based on the successful model operating in Rotherham.

“Additionally, a five-year support programme will be generated covering all aspects of the centre’s operation. The agreement also includes a Master Research Agreement, which will search for long-term funding opportunities and will have an initial focus with the R&D Group and provide access to the appropriate Tier One AMRC Partners. I am confident that both academy and industry will benefit from this collaboration.”

Cloud lifts to reveal the power of data

Cloud data solutions being trialled at the University of Sheffield Advanced Manufacturing Research Centre (AMRC) could provide a secure and cost-effective way for small and medium-sized manufacturers to explore how machine learning and Industry 4.0 technologies can boost their productivity. By James Crossling

Jon Stammers, AMRC Technical Fellow in the Process Monitoring and Control team, said: “Data is available on every shop floor but a lot of the time it isn’t being captured due to lack of connectivity, and therefore cannot be analysed. If the cloud can capture and analyse that data then the possibilities are massive.”

Engineers in the AMRC’s Machining Group have researched the use of the cloud to capture data from machine tools with new Tier Two member Amido, an independent technical consultancy specialising in assembling, integrating and building cloud-native solutions.

Jon added: “Typically we would have a laptop sat next to a machine tool capturing its data; a researcher might do some analysis on that laptop and share the data on our internal file system or on a USB stick. It is quite old school.

“There is a lot of data generated on the shop floor and it is our job to capture it, but there are plenty of unanswered questions about the analysis process and the cloud has a lot to bring to that.”

In the trial, data from two computer numerical control (CNC) machines in the AMRC’s Factory of the Future, the Starrag STC 1250 and DMG MORI DMU 40 eVo, was transferred to the Microsoft Azure Data Lake cloud service and converted into parquet format, which allowed Amido to run a series of complex queries over a long period of time.

Steve Jones, Engagement Director at Amido, said handling those high volumes of data is exactly what the cloud was designed for: “Moving the data from the manufacturing process

into the cloud means it can be stored securely and then structured for analysis; the data can’t be intercepted in transit and it is immediately encrypted by Microsoft Azure.

Security is one of the huge benefits of cloud technology, said Jon: “When we ask companies to share their data for a project, it is usually a blanket ‘no’ because they don’t want their data going off site. Part of the work we’re doing with Amido is to demonstrate that we can anonymise data and move it off site securely.”

In addition to the security of the cloud, Steve said transferring data into a data lake means large amounts can be stored for faster querying and machine learning.

“One of the problems of a traditional database is when you add more data, you impact the ability for the query to return the answers to the questions you put in; by restructuring into a parquet format you limit that reduction in performance. Some of the queries that were taking one of the engineers up to 12 minutes to run on the local database, took us just 12 seconds using Microsoft Azure.

“It was always our intention to run machine learning against this data to detect anomalies. A reading in the event data that stands out may help predict maintenance of a machine tool or prevent the failure of a part.”

Storing data in the cloud is extremely inexpensive and that is why, according to Software Engineer in the Process Monitoring and Control team Seun Ojo, cloud technology is a viable option for

SMEs working with the AMRC, part of the High Value Manufacturing (HVM) Catapult.

“SMEs are typically aware of Industry 4.0 but concerned about the return on investment (ROI) in new technology. Fortunately, cloud infrastructure is hosted externally and provided on a pay-per-use basis. Therefore, businesses may now access data capture, storage and analytics tools at a reduced cost.”

Steve added: “Businesses can easily hire a graphics processing unit (GPU) for an hour or a quantum computer for a day to do some really complicated processing. You can do all this on a pay-as-you-go basis; so you use it, see if there are any benefits, but know that you can stop at any time.

“The bar to entry to doing machine learning has never been lower. Ten years ago, only data scientists had the skills to do this kind of analysis but the tools available from cloud platforms like Microsoft Azure and Google Cloud now put a lot of power into the hands of inexperienced users.”

Steve said the trials being done with Amido could feed into research being done by the AMRC into non-geometric validation: “Rather than measuring the length and breadth of a finished part to validate that it has been machined correctly, I want to see engineers use data to determine the quality of a job.

“That could be really powerful stuff and if successful would make the process of manufacturing much quicker. That shows the importance and relative value of data in manufacturing today.”





Smart thinking: Sean Wilson, technical lead for AI at the AMRC Integrated Manufacturing Group working on the proof-of-concept machine learning model.

Artificial Intelligence makes the case for legal tech firm

By Katia Harston

Artificial Intelligence (AI) researchers at the University of Sheffield Advanced Manufacturing Research Centre (AMRC) used smart software and powerful IBM hardware to help a legal tech firm de-risk a ‘deep learning’ solution to time-consuming paper-based processes experienced by clients.



Sheffield-based DISPUTED.IO's Casefunnel product enables law firms to work with high volumes of clients, avoiding offline form filling, making working with clients easier and automating legal workflow.

To improve productivity within law firms, the company asked the AMRC to explore how AI-driven solutions and digital automation technologies could greatly speed up the time-consuming process of email and phone by moving to a client-orientated online user experience.

Steven Shinn, chief executive officer and co-founder of DISPUTED.IO, says the expertise of research engineers at the AMRC proved very valuable to the company: "Access to AMRC AI developers to build a proof-of-concept for interpreting legal documents provided much needed validation that a problem space our customers face can be solved with Artificial Intelligence. Without access to the team at the AMRC we would have carried all the risk of this exploratory work."

Sean Wilson, technical lead for AI at the AMRC's Integrated Manufacturing Group, investigated how machine learning could identify relevant information in documents so that it could be automatically extracted and used with text recognition software, or be directly stored in a database, thus removing the need for manual inputting.

Sean said: "Companies deal with lots of client documents which are often either old or have been scanned and DISPUTED.IO believed AI could be a way of gathering information from these documents. We were asked to help put together a proof-of-concept to show that an AI solution was possible.

"We looked at whether advances in computer vision algorithms that use

'deep learning' - a type of machine learning - could be harnessed to develop and train a model that is able to detect features in documents.

"The challenge with any AI solution however is that it's neither simple nor quick unless you use something like the IBM cell we have here at the AMRC. This was the first dedicated piece of work we did for an SME using this very powerful hardware."

IBM's PowerAI Vision software, combined with the computational muscle of the IBM Power9 AC922 server, allowed Sean to make speedy work of developing an algorithmic model that can recognise features within a form - but before he could begin testing the company's theory, he first needed the right data to train the model.

For a model to build up its learning this usually requires about 5,000 labelled data examples which can take months to gather for acceptable accuracy. But Sean was able to slash both the amount of data and time needed by using a technique called "transfer learning" - which takes a pre-trained model and makes clever adjustments so it is able to re-learn another task. It also meant a much smaller dataset could be used.

"There's quite a lot going on in legal documents so we went through each PDF page and marked up all of the different data areas, and there was somewhere between 15-30 entries on each page," said Sean. "Once the data labelling was complete it was super easy - the IBM box did the hard work.

"The model we chose to use was 'Faster R-CNN'; it takes it a little bit longer to analyse images but it understands what is in the image much more accurately and that's what we wanted."

The data was split, with 80 per cent used for training and 20 per cent for

validation. This means for every training 'pass', the model learns features to detect on a randomised 80 per cent of the documents and the accuracy is then tested against the remaining 20 per cent.

"We ran 4,000 iterations on the IBM server and a NVIDIA Tesla V100 graphics card was dedicated to the process which allowed the training to be completed very quickly," said Sean. "Without the IBM power box it would have taken a month to generate, train, and test the deep learning model. Doing it this way, we were able to upload and train the model in just over an hour with up to an 86% accuracy."

Steven said Sean led the project with 'great enthusiasm', adding: "He rapidly found ways to use IBM Watson (a suite of enterprise-ready AI services) to produce a full proof of concept. We have since moved on and found other uses of Watson to meet other client needs."

Sean said the outcome was a great result: "In a very short time the AMRC was able to provide the company with the proof of concept it needed to proceed with commercialising the new Casefunnel feature. By using the power of AI, which is a cornerstone of Industry 4.0 technologies, we helped an SME to do rapid innovation, testing their ideas in hours rather than weeks so they could determine if it was an idea worth pursuing further."

The AMRC is part of the High Value Manufacturing (HVM) Catapult and the project was paid for using funds from the HVM Catapult as part of a commitment to working with small and medium-sized businesses.

For more information on the Casefunnel product or about this project contact Steven Shinn, CEO at DISPUTED.IO, by emailing: steve@disputed.io



UK joins hands with Canada to do the Salsa

The AMRC has joined forces with a UK tech start-up and a global engineering giant in a transatlantic bid to disrupt the \$3 billion metal additive manufacture (AM) market by using Artificial Intelligence and robotics to carry out the labour intensive removal of the support structures essential in AM. Katia Harston reports.

The research team behind Project SALSA (Separation of Additive-Layer Supports by Automation) is developing an agile and dexterous tool that will use robotics and machine vision to detect and remove supports from metal-additive parts, to ramp up productivity.

The Innovate UK-funded programme is part of a UK-Canada collaboration for research and development projects and follows a recent visit to Canada by the AMRC's Head of Digital, Professor Rab Scott, as part of the High Value Manufacturing (HVM) Catapult research mission to the country.

Led by Bristol-based tech start-up Additive Automations, SALSA involves partners Renishaw Canada, the National Research Council Canada and the University of Sheffield Advanced Manufacturing Research Centre.

Ben Fisher, senior project engineer for the AMRC's Integrated Manufacturing Group (IMG), says that when a part is created using AM, it is often necessary to add support structures to build the piece successfully. About 95 per cent of parts produced in the metal additive manufacturing industry involve this time-consuming activity, often involving the use of chisels and grinders, making

process control very difficult.

SALSA will build on the transatlantic consortium's wealth of AM and AI expertise to develop and test a small-scale prototype that automates support removal and transfer this to an operational prototype.

"Support removal is a necessity for metal additive manufacturing," explains Ben. "The aim of this project is to reduce the time it takes to do that. The current method is manual, very time consuming and can be a hazardous and toxic process for workers. This project will develop a tool that can separate



additive-layer supports using robotics and machine vision, freeing up skilled technicians for higher-value tasks.”

Metal AM offers enormous potential as a method for manufacture: it can be cheaper, takes less time and offers unlimited design freedom. A leading aircraft engine supplier has already produced more than 30,000 fuel nozzles using metal AM for its new engine, but the big challenge is to enable small companies to access the same benefits.

To do this, the complexities, cost and risks associated with the technology need to be reduced to give SME manufacturers the confidence that metal AM is ready for full-scale production and capable of saving them time and money.

Post-processing can account for between 35 per cent and 65 per cent of the part costs and take a skilled technician several working days to remove the supports on a single part. Mistakes can also be costly - one instance reported was £17k on a single component – and in some cases removing the supports and finishing can be more expensive than the actual AM build process.

The project’s goal is to develop a tool that can remove all types of supports on all types of metal AM materials and ensure process time and cost is at least half of that offered by current methods. It also needs to make certain the process does not use or generate toxic substances and is a safe environment for people.

A report by Robert Bush, company founder of the consortium’s lead partner Additive Automations, says a lab-scale proof-of-concept for automating support removal has already proven that time and cost reductions up to 66% and 62% respectively are possible, with huge productivity gains estimated - 98% uptime, compared to 21% when done manually.

The consortium will explore two streams of work: the design and build of the end effector for removing the support material, being undertaken by Additive Automations, and the artificial intelligence and machine vision system to detect the removable support material, which will be developed by IMG.

Ben said: “We are deploying our expertise in collaborative robotics for this project; we do a lot of complex integration work and we have done a number of cobot projects. The work that IMG will be doing in this programme is the integration of the end effectors onto a cobot such that an operator can teach the routines to the part for the robot to remove the material. It’s about making these systems talk to each other.”

Ben added: “For additive to become competitive as a manufacturing method, you need to remove or reduce the non-value added time, in this case the process for removing the support material. You need to have that support material to build the part, but there is a lot of post-processing time with AM parts, so it is shredding that time and automating that process of the removal.

“As AM is used in a huge range of applications – aerospace, automotive, energy, industrial, medical – it means the opportunities and the potential impact of this project is massive. It has the power to lower the barriers to adoption.”

Additive Automations’ founder Robert Bush says SALSA has the potential to be a major disruptor.

“The collaborative robotics market size is \$1bn and growing at 50 per cent. Artificial Intelligence in manufacturing

market size is \$1bn and growing at 25 per cent. Metal additive manufacturing is an industry worth \$3bn and growing at 80 per cent, one of the fastest growing areas in engineering,” says Robert.

“The benefits of additive manufacturing read like an engineer’s wish list; the ability to produce unitised parts with complete design freedom, novel geometries and graded materials at both reduced cost (no tooling) and reduced waste (near net shape solution).

“Moreover this can be achieved with a high-degree of customisation at the point-of-use (local manufacture) with leads times far less than current methods. The UK has world class additive manufacture machine manufacturing capability, a well-established national centre and is among the world leaders in research and innovation within high-performance applications such as aerospace and medical.

“However, the UK is seeing significantly slower adoption and use of additive manufacture than Germany, China, USA and South Korea. UK manufacturing companies view it currently as having too many barriers to entry for full-scale production.

“Project SALSA’s objective is to develop a post-processing machine that gives the UK industry the confidence, control and economics it needs to adopt this technology in full-scale production. SALSA will help make metal additive manufacturing cost effective, not just in the thousands of parts but into the tens of thousands.

“Since 1970 the UK’s manufacturing sector has had the most severe decline in output as a percentage of GDP. In 2015 manufacturing output was ten per cent of GDP, down from 28 per cent in 1970. To create wealth and build an economy something needs to be created, and manufacturing is the wealth generating industry.

“By adopting technologies that form part of the fourth industrial revolution, such as metal AM, machine learning and cobots, Britain will ensure a competitive, stable economy with sustainable innovation and jobs generation for decades to come.”

Photo: An early concept of the type of hardware that project SALSA will be developing.



‘The time is now’ for manufacturers to go digital

Jamie Hinton talks to James Crossling about leading the charge in the Digital Meet Manufacturing crusade, playing saxophone with Supertramp, motor racing and being a finalist in the Young Jazz Musician of the Year.



Razor CEO Jamie Hinton.

You wouldn’t expect one of the men leading the charge in Sheffield’s digital manufacturing crusade to have run racing teams, played saxophone with Supertramp and be a former Young Jazz Musician of the Year finalist, but then Jamie Hinton isn’t like most CEOs.

The father-of-two founded his digital tech company Razor in January 2009 with co-founder, Steve Trotter, initially as a side project after flirtations with the music industry,

the British Racing and Sports Car Club (BRSCC) Championships and one of Sheffield’s earliest web agencies, Technophobia.

Now in charge of 24 members of staff at their offices on Sydney Street, Jamie is unwavering in his aspiration for Sheffield’s future: “I want Sheffield to become as well known for digital manufacturing as it is for steel. Like the forges we still have in parts of Sheffield, I want digital tech companies to be spilling out of the city so that it breeds into Leeds, Manchester and Newcastle to create this powerhouse in the north.”

When it comes to working with manufacturing firms though, those

inspiring words come with a warning: “A lot of it is out of our control, we need manufacturers to embrace what we have to offer them. We are here, we are excited, we want to work with them, but it is up to them to take the challenge on. It’s never too late for any manufacturer to embrace digital technology, they can catch up and even leapfrog their competitors, but the time to act is now.

“Many businesses are just scared of failure. A lot of the challenge for us is getting rid of that fear and convincing manufacturers that they don’t need to be terrified of change.

“It is almost the polar opposite of our attitude at Razor because we don’t have a great fear of failure. We love taking on challenges and if it goes wrong, we pick ourselves up, learn from it and choose a different path. If you can’t take failure, you won’t last five minutes here.”

The mind-set of Razor comes directly from Jamie, which itself is born out of his time playing the alto saxophone, racing cars and working at Technophobia.

“As a teenager I was always fascinated by engineering. One summer we took an old Fletcher speedboat hull, stuck a Hollis jet drive and a Suzuki Swift engine inside, and then tested it on the canal in Sheffield. I just loved creating things and doing the stuff people said we couldn’t.”

Boats progressed to cars and a job, when he was 18, as a mechanic for a racing team: “We ran open-wheel single seaters in the BRSCC Championships. It was a fantastic life lesson for me, it built

“We are not scared by competition, we relish it. It keeps us on our toes and keeps us pushing. As I see it, the more people who can talk to manufacturers and make that difference, the better. The more people we can get on the bandwagon, the faster it is going to grow.”

Jamie Hinton, Razor.



that mind-set of ‘it is ok to get it wrong, let’s try something else and get it right’”

Being a finalist in the Young Jazz Musician of the Year prize led to a degree in music technology at the University of Sheffield, playing with 70s rock band Supertramp, jamming with the Ronnie Scott Band and even releasing dance records.

Eventually, after suggestions from his future wife to ‘get a proper job’, Jamie found himself doing a masters degree in multimedia and internet at Sheffield Hallam University and, in 2005, securing that ‘proper job’ as a junior uploader at Technophobia.

“Working with computers is a lot like engineering in that you are creating something and immediately making a difference. There were some incredible people working at Technophobia and the mentality was always people first. We never did the easy stuff, if it was easy we considered it boring; we wanted the hard challenges and the culture was ‘let’s get things wrong, but just like anything, with

practice, became really good at them.”

Never one to sit still, Jamie took on freelance work in his spare time, first helping a small model business in Heely to digitally transform, then a branded golfing manufacturer in Meersbrook. In 2014, with the help of business partner Steve Trotter, Jamie took Razor full time, moved into Sheffield Tech Parks and employed their first member of staff.

“Even then we weren’t interested in just doing websites, we realised pretty early on that we loved helping people fight the big boys; in a way, help them, with technology, become real challengers and better than they could ever imagine. There is a humble brilliance of manufacturers in Sheffield and we wanted to amplify that by pushing the boundaries.”

Fast forward just six years and Razor has become, by reputation, one of the go-to places for businesses seeking digital transformation. A team of software engineers, usability designers, data scientists, testers and project managers

help businesses prosper through delivering leading edge technology. That technology could be machine learning, mobile apps, integrations or software engineering and everything in between, but in many cases it doesn’t exist and needs to be invented.

“We ask businesses about their objectives, their strategies and their problems and then we go in and we explore. We might find a couple of things we can work on, do some research and explore some other sectors, then we think about what technology could fix those issues.

“What we always boil it down to for businesses is something that is possible technically, achievable financially and gives them the biggest returns. Then we make a prototype for them - it could be a machine learning model or a mobile app, the possibilities are endless.

“What we want to present companies with is something tangible, which they can make a business case from, present to their board and hopefully come back



to us asking: 'Where do I sign?'"

Razor's mission statement, to 'stay on the bleeding edge so our customers don't have to', is so aligned with that of the University of Sheffield Advanced Manufacturing Research Centre (AMRC), that collaboration on the Digital Meet Manufacturing (DMM) campaign was inevitable.

DMM is the AMRC's programme to connect the Sheffield City Region's manufacturing and digital sectors in a way that benefits both, but Jamie says what is currently holding it back is manufacturing firms' reluctance to change their ways.

"A lot of businesses know they need to do something different, but have no clue what it is. They are on top of a cliff surrounded by fog and because they can't see where the route is they are paralysed by fear. What we want to do is raise that fog and give them clarity to know what direction they need to take.

"Bigger firms get it, they have profitability and the time to invest in new technology, but I see a huge amount of fear from smaller firms. If smaller companies, with smaller margins, are going to make an investment like this it has to work, they need guarantees which we can't offer them, so they end up doing nothing which could result in them failing to exist.

"There is also an element of entropy, the old boys saying 'we have always done it this way', and that is where the messaging and the language we use is so important. If we tell manufacturers we are going to turn their worlds upside down, they're going to dig their heels in, but if we say we want to make what they do even better, they might be more receptive – it's the psychology.

"It comes back to fear and us removing that fear. Some manufacturers might want a cobot, some might need automation on the shop floor, but others might see just as much benefit in their back office by automating their purchase orders."

The commoditisation of digital technology, says Jamie, means that concepts like the Internet of Things (IoT) and Industry 4.0, which were once far too advanced and expensive for small manufacturing firms to consider, are now very much within their grasp. But he's warned that the opportunity needs to be grasped.

"It is not too late for any manufacturer but now is the time to strike. Other people have gone through the pain of testing out these technologies, so there is the opportunity for companies to start now and leapfrog their competitors. Because of the commoditisation, it is a lot more financially viable and businesses can take a few more risks because they can learn from others.


"The ball is in the manufacturers' court though; what happens next is up to them.

"DMM has massive potential to transform this area but we need some smaller manufacturing companies to put their head on the block and take a risk; once one does the rest will follow. It comes back to that fear, no one wants to be the first to go for it. I know these companies have a lot to lose by investing in digital technology, but they have a lot to lose by not doing it as well."

Jamie is not only incredibly passionate about energising the manufacturing sector with Razor, he wants more companies to take on the challenge as well so that Sheffield can become that 'powerhouse of digital manufacturing' he desperately wants to see.

"We are not scared by competition, we relish it. It keeps us on our toes and keeps us pushing. As I see it, the more people who can talk to manufacturers and make that difference, the better. The more people we can get on the bandwagon, the faster it is going to grow.

"When people look at knives and forks and see the 'Made in Sheffield' mark they know it is of a certain quality. I want people to look at a digital manufacturing firm, see that it is based in Sheffield and think 'they know what they're doing, these guys can help my business'"



"It is not too late for any manufacturer but now is the time to strike. Other people have gone through the pain of testing out these technologies, so there is the opportunity for companies to start now and leapfrog their competitors."

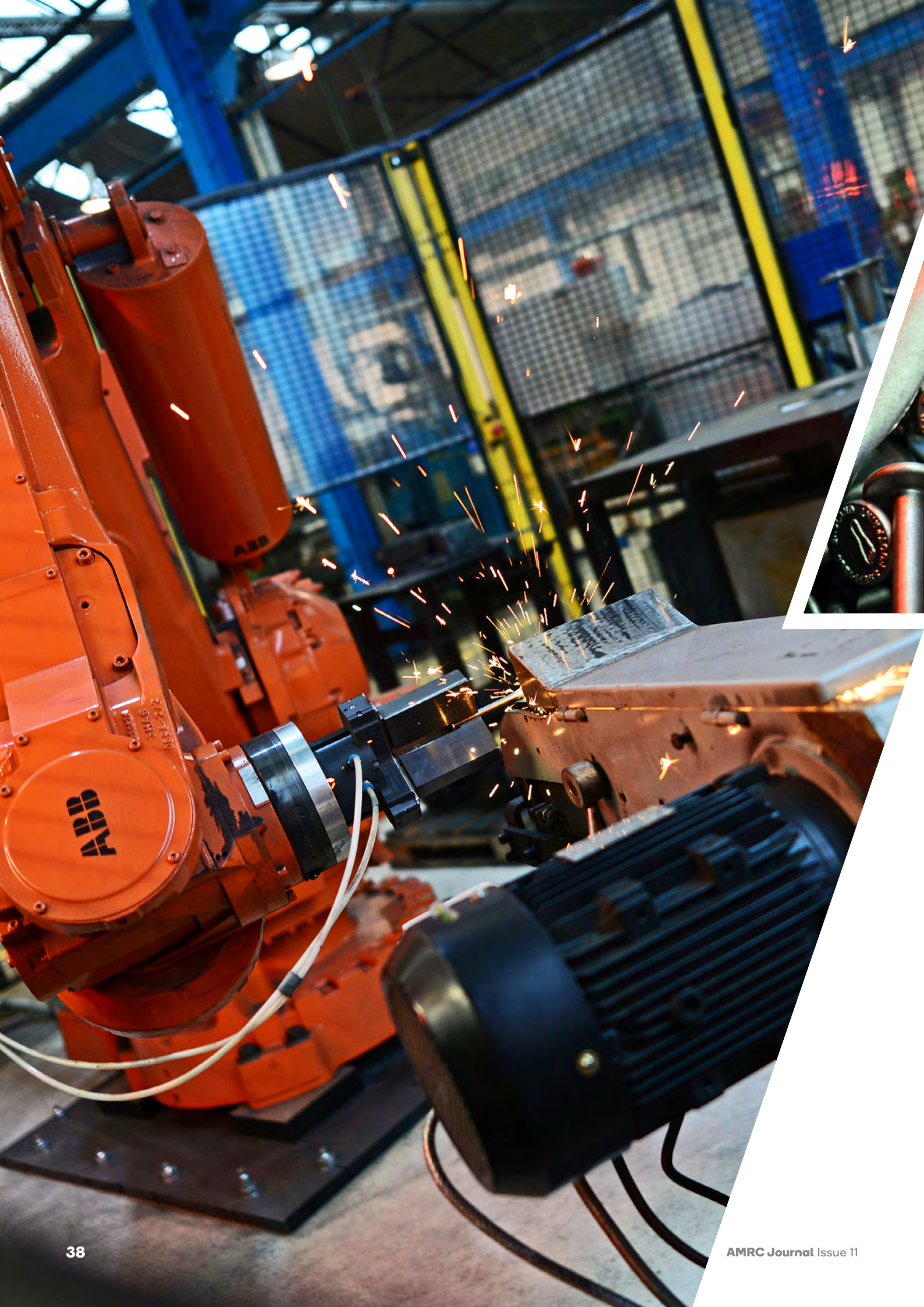


The Razor team at their office on Sidney Street, Sheffield and below, Jamie Hinton at a round table event at the AMRC's Factory 2050.



RAZOR

The Technology Works





Footprint Tools: Rise of the robot

Robots, we hear, are taking our jobs: replacing skilled craftsmen with tireless automatons that don't need lunch or comfort breaks and are as happy working in the dead of night as they are through the day. But not at Footprint Tools, where the installation of a secondhand robot has given a new lease of life to its skilled craftsmen, boosting productivity three-fold.

The Jewitt family know a thing or two about economic adversity. Footprint Tools, the 150-year-old Sheffield firm that has been in the family for four generations, enjoyed huge success during the hey-day of coal and steel, at one point employing more than 300 people. But the relentless rise of the low-wage economies in the Far East and the almost complete collapse of two of the North's staple industries, changed the market completely.

By 2007, Christopher Jewitt and his son Richard, decided it was time to rationalise the business. Plans were made to relocate to a smaller and more efficient facility. "We could not have picked a worse time," says Richard, who runs the operations side of Footprint. "We were in the middle of the move from West Bar to Owlerton when the financial crash happened. It was the perfect storm, everything that could go wrong, did go wrong," he added.

Footprint's builder's line pin, found in construction workers' toolboxes around the world, is a bellwether of the business. "Where we would normally be producing 15,000 line pins a month, it dropped almost overnight to just 3,000. The world just stopped," said Richard.

For a brief moment it looked like the company would become yet another casualty of the financial crash; but the Jewitts are not quitters. "Our customers were telling us they still wanted our

Robo-power: Left, the robot carrying out the finishing process on Footprint Tools' iconic builder's line pin, seen above centre, and top right brothers Tim and Richard Jewitt on the factory floor.

products, so we knew we had a market to serve,” says Richard’s brother Tim, who now handles marketing and finance. With the move to the new premises complete, the brothers pressed ahead with the rationalisation of the business – reducing head count to just six people while pruning back on the product range.

The challenge was to develop a recovery plan that maintained the quality of the products while improving productivity. “We were conscious that we needed to modernise our manufacturing processes using automation. But we didn’t want to lose our skills base. We did some basic research and came to the conclusion that to justify investment in robotics we should focus on a high volume product,” Richard added.

The humble line pin, first launched by Footprint in 1969 was the standout candidate. At 200,000 units a year, this high volume relatively low value item is critical to Footprint Tools visibility in the marketplace, but its production tied up two very skilled craftsmen who could be deployed better elsewhere to unlock bottlenecks that were delaying product delivery to customers.

Having a longstanding relationship with the University of Sheffield AMRC – until recently, Chris chaired an industry advisory board at the AMRC – it was natural that Tim and Richard should reach out to the robotics and automation team at Factory 2050.

The contrast between the two facilities could not be more stark. “Footprint is what you might call a proper factory, hot and noisy with sparks flying, metal glowing red and the boom of the drop

forging hammer filling the air,” says Ben Morgan, Director of Research at the AMRC. Factory 2050, by contrast, looks more like an Apple Store, quiet and cool with much of the work being carried out silently in the virtual world.

When the two worlds meet, however, work gets done. And fast. A week or two on the shop floor, watching two seasoned operatives, Brian and Mick, perform the edging and finishing/polishing process, gave AMRC Project Engineer, George Sleath, a clear picture of the challenges ahead. “Watching Brian and Mick with their noses literally to the grind stone was really important to developing the solution. I knew what the line pin started out like in life, and I knew what it needed to end up like,” says George. “The edging process was relatively straightforward, but it proved much more difficult to get the required quality of finished product from the finishing process.”

The use of slow motion films and close observation of Brian and Mick enabled George to quickly ‘teach’ the robot how to become a very skilled operative in a matter of two weeks. “The beauty of maths is that you can isolate different types of motions and then tell the robot to do all of them at the same time: it just evaluates the coordinates that it is trying to hit. Once you have worked out what is meant to happen, you can programme in the coordinates for a circle, programme for left right tilt and up down tilt and a gradual release. It performs these tasks time after time, with total accuracy,” said George.

For Footprint Tools – including Mick and Brian – the robot cell has been a “win-

win all round,” according to Tim and Richard, who have doubled the size of the workforce to 12 since the dark days of the crash. “We were concerned that this kind of project was too small to be of interest to the AMRC,” says Richard. “We couldn’t have been more wrong. They have been with us at every step of the way; even helping source a second hand robot and introducing us to an AMRC spin out to integrate the robot on the production line and to upskill two of our younger operatives in robot programming.”

With a few inevitable teething problems behind them, the benefits of the robot cell are glaringly obvious. “It has had a massive impact,” says Richard. “While the quantity of pins per day is actually less than before, we now have one person doing what three people were doing before; and this is where the biggest improvement in productivity comes from. The time Brian and Mick would have spent doing line pins, is now spent on other products; which means we can get products through the factory quicker, it is on the shelf quicker, which means when our customers place their order they get them so much quicker.

“The robot cell has enabled us to unblock bottlenecks by freeing up resource. We can now fulfil orders a lot quicker than we have ever done before. In the past our average days-to-despatch was 21 days. Since the introduction of the robot cell that has come down to just seven days. It’s a massive impact for an SME like Footprint Tools, and we could not have done it without the R&D and innovation talents of the AMRC.”



How the AMRC helped

- Created a virtual model of the robotic manufacture of line pins
- Carried out factory-based, slow motion video of complex manual finishing process
- Programmed a robot to carry out this subtle but hot, repetitive and dirty activity
- Designed and 3D printed a robot fixture to accurately hold the raw line pin
- Ensured the quality of finished product is comparable to skilled craftsman
- Sourced second-hand robot capable of performing the task
- Identified trusted local SME to integrate the robot on the factory floor for seamless transition
- Supported integrator through shop floor teething problems
- Freed craftsmen to perform more value-added activities.



The glider undergoing scanning at the AMRC's Composite Centre.



Director at Avian Hang Gliders, Dr Tim Swait, tests a hang glider in the Peak District.

AMRC helps hang glider design take 'first step forward' in years

Hang glider design could take its first significant step forward in two decades, thanks to a collaboration between the UK's only manufacturer of the aircraft and the University of Sheffield's Advanced Manufacturing Research Centre (AMRC).

Peak District-based Avian Hang Gliders approached the AMRC for help in developing a precise 3D model of the wing, which could be fed back into analysis to lead to a more aerodynamically optimised design.

The AMRC is part of the High Value Manufacturing (HVM) Catapult and the project was paid for using funds from the HVM Catapult as part of a commitment to working with small and medium-sized manufacturers.

Director at Avian Hang Gliders, Dr Tim Swait, said: "In the early 2000s hang gliders became 'topless'; they lost the king post, the top rigging went and the stability systems were all integrated into the wing. Since then, there has been incremental developments but there has not been any real step changes.

"What we are trying to achieve at Avian is identify where we can make real significant difference in hang glider design. There are some interesting gaps that we can see and we know the efficiency of a hang glider can be quite a bit higher than it is at the moment.

"Really, having an accurate 3D representation of what the glider truly is, will be the first step to going forwards."

A glider, supplied by Avian, was scanned in the AMRC's Composite Centre using a Hexagon ROMER Arm and analysed using Verisurf software.

The scan was carried out with the glider hanging upside down to make the aircraft more representative of being flown. In flight, airflow over the wing creates pressure differences which produce lift, but also changes the shape of the fabric sail. This couldn't be replicated when scanning, so AMRC engineers utilised the force of gravity to create tension in the glider which acted as an appropriate approximation.

Development engineer at the AMRC, James Grigalis, said: "You don't realise how much sails get put under tension. When you pull the sail tight, all the struts inside the wing bend and tension up; it is very hard to get a computer-aided design (CAD) model of that without doing something like a scan.

"We could have hung weights off the wings to create the tension, but then you're not tensioning the sails in the right way.

"In the 3D scan, a point was taken every 3mm so a data cloud was produced that had around five million points. Avian was provided with the initial point cloud in a

comma-separated values (CSV) file and a surface, so they could work off both."

"What we're really trying to do is get the shape that the glider has in the air because that is different to what it is on the ground," said Tim. "Hang gliders are fundamentally flexible; you have flexible fabric, a sail, even the carbon fibre frame isn't rigid over that scale. Sections can be metres long and fairly thin, so there is quite a significant curvature in everything.

"We're also developing an analytical model of the glider. Now we have this data, we can feed the computer model with the current shape of the glider and use the model to optimise what shape it should be. Then we can reverse back from that ideal shape to what we make, to get it back to being that ideal shape when it is in the air."

James added: "The equipment we use here is worth tens of thousands of pounds, so it just doesn't make sense for a small business like Avian Hang Gliders to purchase it. Coming to the AMRC for this project has helped Tim make progress he might not be able to make otherwise."

Tim continued: "Accurate measurement is crucial to further development; having a really accurate starting point of known geometry, that I can absolutely trust, is vital for what I am trying to achieve."

Satellite system getting ready for launch

A former soldier in the Parachute Regiment has taken a giant leap towards creating a novel launching system using balloons to put satellites into space following a collaboration with design engineers at the University of Sheffield Advanced Manufacturing Research Centre (AMRC).

Sean Ardron set up Rotherham-based Arkeik in 2017 to explore how high altitude balloons could be used to take a small payload up to an altitude, where they could be orientated and then launched into Low Earth Orbit (LEO).

With the help of the AMRC, he now believes his innovative High Elevation Launch Platform (HELP) could be operational within 12 months and might even replace ground-based rockets to give UK industry a doorway into space exploration.

The AMRC is part of the High Value Manufacturing (HVM) Catapult and the project was paid for using funds from the HVM Catapult as part of a commitment to working with small and medium-sized manufacturers.

“Although my background is not in this industry, I had worked on land based

projects with BAE Systems while I was in the military, but I could not have got to this stage without the support of the AMRC in visualising the idea behind the launch system,” said Sean, who was in the 1st Battalion Parachute Regiment.

“High altitude balloons using the free lift with lighter-than-air gas had not been looked at for a long time because the surrounding technologies to make them efficient just wasn’t available. Recently, there has been a massive increase in small technology for the use of rotary drones so we have repurposed a lot of that for what we need.

“I just needed to develop a computer system that can take a small payload up to a certain altitude, orientate and then launch into LEO.”

Arkeik has already carried out test flights reaching 5km above sea level and the next step is to create a working prototype, which starts with a design the company can show to potential investors.

Billy Redpath, Senior Project Manager at the AMRC’s Design and Prototyping Group, said: “The system Sean has is similar to a weather balloon which has a drone attached to it. It gets to an appropriate altitude, orientates, launches a satellite and then you guide it back to the ground.

“The designs they were using for presentations to potential funders had been created in-house and didn’t necessarily convey the project accurately, so we visualised it for them.”

Billy and his team of engineers were not given specific dimensions or criteria for designing the prototype, but they were able to use a healthy dose of artistic license to capture the essence of the novel launching system: “There are certainly engineering elements to it. We had to consider how it would be able to launch at a set elevation and how it would orientate at altitude. Essentially though, the task was understanding an idea in someone’s head and attempting to visualise it.”

The images will form an important part of Arkeik’s marketing strategy as the company applies for funding and grants to pay for research into housing larger payloads, building fully reusable ballonets and developing their Unmanned Aerial System.

“I am really pleased with what Billy and the AMRC have produced, I wouldn’t have had the capacity to do what they have done. Quality designs are something you really need for projects, especially when you are trying to get people to fork out money,” said Sean.

“We know all the individual parts work, we have tested them, we just need to get a working prototype that hopefully looks like the design created by the AMRC. That is what the investment will help us with.”

The ability to put satellites into orbit is limited due to the necessity of ground launching from a rocket. Small satellites, such as the ones Arkeik hope to work with, are classed as secondary cargo which means they cannot commission a rocket nor dictate the orbit that they launch to.

At present, that means companies using micro-satellites must either compromise on their preferred orbit or wait an undetermined amount of time until the right rocket launches.

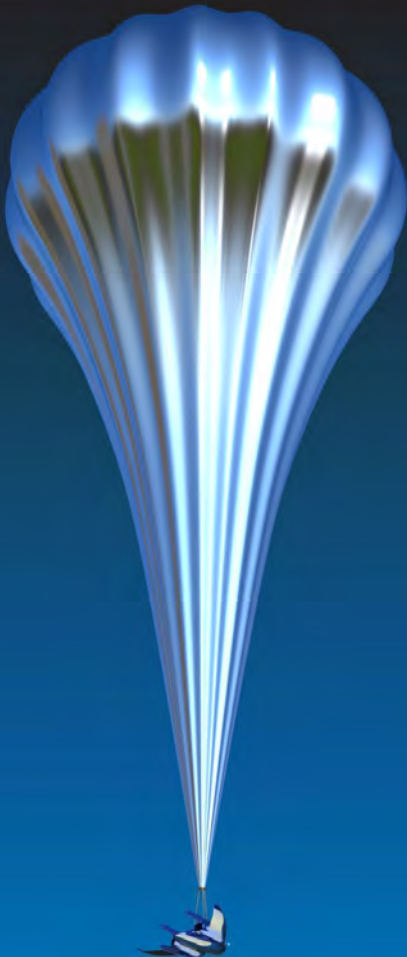
Sean continued: “We can certainly sell this technology. Currently, the UK doesn’t have a launch capability which means companies here have to send their satellites to India or piggyback off rockets in the USA.

“A standard cube satellite is 13x10cm and weigh a kilogram so I can quite confidently say we could launch them from HELP. Once operational, it would be weather dependant, but we could send a platform up to the right altitude and launch all in just three hours.

“If everything went perfectly and we got the money we needed, we could quite easily have this operational within 12 months. Eventually, it could replace ground-based rockets and give UK business and industry a doorway into space exploration.”



The AMRC design for Arkeik’s High Elevation Launch Platform (HELP) is shown above the clouds in orbit.



Spaceman Prof Brian Cox on mission to inspire Rotherham

World renowned physicist and TV astronomer Professor Brian Cox will be the star of a stellar new education event being supported by the AMRC which aims to inspire the north's next generation of scientists and engineers.

Particle physicist Prof Cox is coming to Rotherham this year for a northern leg of his London-based Science Summer School, which was founded nine years ago through a partnership created with social entrepreneur Lord Andrew Mawson.

The eminent scientist, writer and broadcaster is passionate about paving the way for future generations of scientists and engineers and it was always his and Lord Mawson's intention to launch a northern satellite event.

Rotherham has been chosen to host the northern expansion which takes place in November, led by Well Rotherham and supported by the University of Sheffield Advanced Manufacturing Research Centre (AMRC), Rotherham and Sheffield councils and the Harworth Group.

Jack Forrest, from the AMRC STEM and Outreach team, is helping plan for the science extravaganza. He says it is a fantastic opportunity for the AMRC – at the heart of advanced manufacturing in the region - to be involved in helping

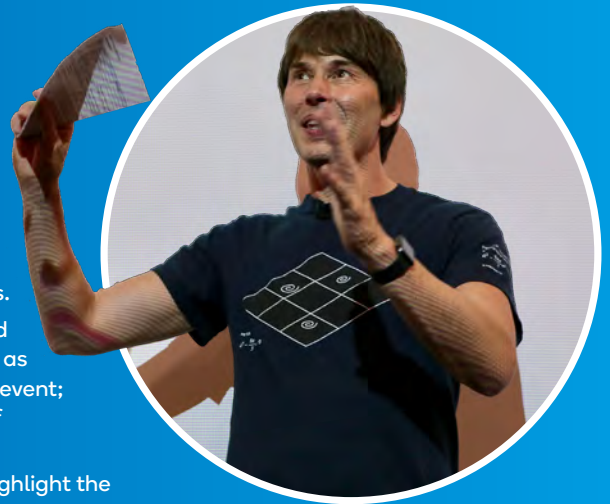
inspire the next generation of researchers and innovators.

He said: "We're really pleased Rotherham has been chosen as the location for this satellite event; it brings it to the heartland of advanced manufacturing.

"This event will allow us to highlight the opportunities that are right there on the doorstep of young people in Rotherham with the AMRC Training Centre and shows we are a region committed to nurturing the future talent that is vital to ensuring the engineering and manufacturing sectors can thrive."

The announcement follows a trip last summer organised by Well Rotherham which saw 23 pupils from local schools Wath Academy, Wales High and Maltby Academy journey down to London to take part in Prof Cox's science summer school, joining hundreds of other young people from across the country.

Kris MacKay, programme manager for Well Rotherham, said: "It was such a fantastic experience to be able to go to London. Watching these young people



who are so passionate about the world of science start their journey as ambassadors was an incredible opportunity.

"Over the coming months they'll be working together to help us co-produce the satellite event. This will be happening in November and it will be such a joy and privilege to have Professor Brian Cox come and join us."

It promises to be an out-of-this-world experience for young people, mixing the best of the STEAM (science, technology, engineering, art, and mathematics) subjects through TED-style talks from special guest speakers, industry and academic leaders, and lots of hands-on workshops and experiments.

As part of the event an exposition will be held at the Advanced Manufacturing Park working in partnership with local businesses including Rolls Royce, McLaren, and Gulliver's which is developing a theme park in Rotherham.

Kris added: "This isn't going to be a one-off event. Throughout the year we'll be working with our partner schools Wath Academy, Maltby Academy and Wales High to organise activities and events that continue to inspire the students."

If you'd like to support the event, through financial support, delivering project activities or as a parent, school or young person who would like to get involved, email K.Mackay@syha.co.uk or call 07493 868 057.



Professor Brian Cox talking to students from Rotherham at the Science Summer School in London.



Dr Rahul Mandal, STEM ambassador and Great British Bake Off 2018 winner, with Jack Forrest from the AMRC STEM and Outreach team presenting the 3D pens to teacher Helen Hiley and a young patient.

Drawing on creativity

The University of Sheffield AMRC has donated 3D pens to the teaching team at a Sheffield children's hospital for its young patients to draw on their creativity and discover their inner engineer.

The University of Sheffield Advanced Manufacturing Research Centre (AMRC) has gifted ten of the high-tech pens to the teaching team, which work just like regular pens but instead of ink they use plastic filament, allowing shapes, models and structures to be drawn on a surface or in the air.

Great British Bake Off 2018 champion Dr Rahul Mandal, a STEM ambassador and research engineer for Nuclear AMRC, visited the hospital with Jack Forrest from the AMRC's STEM and Outreach team to hand over the pens and meet some of the young patients.

Jack said: "The AMRC Group has long been a supporter of the children's hospital and the AMRC STEM team has been working with the teaching team to promote science, technology, engineering and maths (STEM) activities. To be able to give them this resource is another way of continuing that support. We really hope the children enjoy using the pens and discover how fun and creative engineering can be."



Helen Hiley, a teacher at Sheffield Children's NHS Foundation Trust, said: "Providing the teaching team with these resources will allow us to work with the children individually and in small groups on Design Technology activities. We are really grateful for the donations and support that have been given to us and the children we work with in the hospital

by the team at the AMRC.

"Using the 3D pens, patients can design their own 2D shapes or follow templates and then combine them to make 3D models. We've had children making everything from bridges to houses. They really enjoy it and the designs are so colourful."



The students are shown the Virtual Reality (VR) Wall during their tour of Nuclear AMRC.

AMRC inspires next generation of female engineers

More than 100 schoolgirls from across the Sheffield City Region have now been shown the huge potential of a career in engineering thanks to the University of Sheffield Advanced Manufacturing Research Centre's #AMRCtribe campaign.

Fifty-four pupils, from schools in Sheffield, Rotherham and Barnsley, were invited to the AMRC, part of the High Value Manufacturing (HVM) Catapult, in the latest event of a programme which aims to inspire young girls to pursue a career in STEM (science, technology, engineering and maths).

Attracting more women into engineering is one of the most serious challenges facing the industry and a large part of #AMRCtribe, which launched in June 2019, is to create a supportive network for teenagers to talk openly about their interest in STEM subjects and

STEM-related careers. An exclusive social media group provides a safe environment for young women to talk in confidence to like-minded peers who may attend different schools.

"We want to connect young girls from the Sheffield City Region so they feel they're not isolated," said Ami Swales, the AMRC's STEM and Outreach Coordinator. "Often they can be the only one in their friendship group that is interested in engineering, but with #AMRCtribe they can meet other people who have similar interests and it might empower them to pursue that career.

"We invited five schools to this event and each has had tours of the AMRC Training Centre, the Design and Prototyping Centre, Factory of the Future, Nuclear AMRC and our Manufacturing Transporter (MANTRA)."

Following the tours the schoolgirls were then set an engineering group activity, working in mixed teams, to build a model Ferris wheel using little more than paper, masking tape, string and bolts.

Asha Spruce, 16, from UTC Sheffield, said: "I think #AMRCtribe is such a good initiative because women feel intimidated going into such a male-

dominated industry. Having the tribe means there is support there and it gives us women a chance to meet others doing the same thing.

“Seeing the Digital Operating Theatre in the Design and Prototyping Centre was so impressive, I have never seen anything like that before; it was the best part of the tour. I knew I wanted to be an engineer before coming to the AMRC but until I saw the Digital Operating Theatre, I didn’t know medical engineering was an option.”

Speakers at the event, held at the AMRC’s Knowledge Transfer Centre, included Fellow of the Institute of Physics, Mark Wrigley and second year apprentice machinist at Boeing Sheffield, Rosie Davies.

Asha added: “Hearing from people like Rosie and seeing other female engineers working on the shop floor really inspires me; it shows that it can be done.”

Sam Booth, Head of Design Technology at Bradfield School in Worrall, said #AMRCtribe is key to promoting engineering to students at school: “One of the top ways to get girls into the industry is to show them inspirational female engineers and that is very difficult for us to do at school when there are just two engineering teachers, both

of whom are male. When you bring them to an environment like the AMRC, straight away they can see that there are females in engineering and female apprentices at the AMRC Training Centre.

“Seeing the Design and Prototyping Centre was great because it is spotless and not what you think an engineering environment would look like. It is very, very high-end with engineers working on projects which these students found fascinating.

“Some of the girls have found it quite surprising really, they didn’t expect it to be exactly what it is, which has been really good. We just need to change parents’ misconceptions now because for the students it definitely has.”

On the exclusive social media group, Sam continued: “Having that continuation after today’s event, where hopefully the girls can speak to each other, could actually be something quite powerful. The key is that teachers are not involved, the pupils support each other.”

#AMRCtribe will continue throughout 2020, with further events

for schools at the AMRC and STEM-inspired social events for those girls who are involved in the social media group.

“It is wonderful to show these girls things like the Digital Operating Theatre, Nuclear AMRC and Virtual Reality because that isn’t what they would be able to access on a normal day at school,” said Ami.

“A lot of girls do come to us with the mind-set that STEM isn’t for them. We want to challenge stereotypes and show the girls that they can achieve anything they put their mind to.”

“We want to challenge stereotypes and show the girls that they can achieve anything they put their minds.”



AMRC plays key role engineering new world record

The University of Sheffield Advanced Manufacturing Research Centre (AMRC) has scaled new heights, playing a key role in a new world record for the number of people playing the same piano at the same time.

At the opening ceremony of the 69th CIRP (The International Academy for Production Engineering) General Assembly in Birmingham, 88 school children played a newly-commissioned piece of music composed and conducted by pianist Martin Riley, smashing the previous record of 21.

The '88 Pianists' project was launched in 2018, with budding engineers from across the country asked to solve the problem of fitting 88 people around a piano by designing mechanical extendable fingers which could work from seven metres away and allow 88 pupils to each play a separate note. In total 2,500 designs were submitted, of which 88 were shortlisted to be created.

The AMRC worked with Brockwell

Junior School in Chesterfield, Greenside Primary School in Leeds and Woodthorpe Community Primary School in Sheffield, with engineers initially introducing the children to the project, then helping them with their imaginative designs before finally turning seven winning designs into real-life extendable fingers.

Senior Technical Fellow, Dr Erdem Ozturk, who led the AMRC's involvement in the project, said: "We created three teams to go into the three schools, each with two engineers and one musician.

"We collected the children's designs and then the steering committee, along with 50 engineers and musicians, selected the 88 designs that would then be manufactured. Engineers at the AMRC

helped build the prototypes and then returned to the schools to receive some more input from pupils."

Each design was given a name, with Brockwell's 'The Metal Cog Thingie', Greenside's 'The Monkey Machine' and Woodthorpe's 'Water Whirler!' among the 88 chosen to help break the world record.

"I have been so impressed with the students, they were excited about the challenge and keen to find original solutions. The main aim was not the breaking of the world record but to inspire future generations to use their creativity to solve this challenge," said Erdem.

'88 Pianists' is the brainchild of

The metallic C-plate adaptor, designed by the team at the University of Cambridge and produced at the AMRC's Factory of the Future.



University of Cambridge Professor of Engineering and the Environment, Julian Allwood, who wanted to mark the 500th anniversary of the death of inventor, engineer and artist Leonardo da Vinci by answering a simple question: has the smart phone killed invention?

Professor Allwood said: "I'm really captivated by the opportunity that this project has revealed to explore the space for expansive imagination between the creative arts and technology.

"The reaction from the audience was overwhelming. To my surprise, the statement I heard most often from what I thought were my hard-headed academic colleagues was that they were moved to tears."

AMRC engineers not only helped the children with their designs and manufactured their individual extendable fingers, the AMRC's Factory of the Future also played a vital role in bringing the whole project together, as Erdem explained: "We recognised quite early in the project that it would not be possible for the 88 mechanisms, designed by the students, to actually hit the keys so it was decided a metallic C-plate adapter was needed on top of the piano to connect them.

"It was designed by the team at the University of Cambridge but is a very large piece so needed specialist machine tools like that available at the AMRC's Factory of the Future, so we produced it for them in the composite workshop."

Academics and students from the University of Sheffield's Faculty of Engineering helped pupils at Hallam Primary School and Lydgate Junior School to develop six designs used in the final performance.

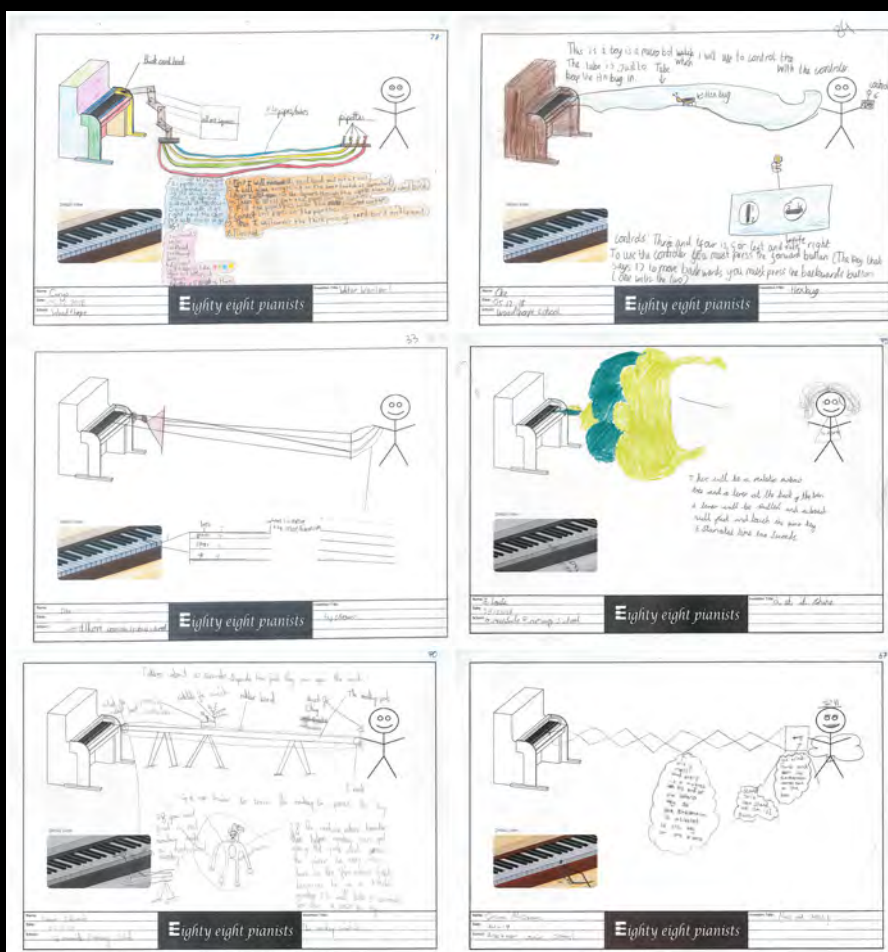
Dr Candice Majewski, from the University's Department of Mechanical Engineering, who co-ordinated the Faculty of Engineering's involvement in the project, said: "This whole experience has been incredible from start to finish.

"The enthusiasm and creativity of the school children has been way beyond what we expected, and we're very grateful to the teachers who so willingly welcomed us into their classrooms.

"The final event was spectacular, but more than anything I hope we've left a lasting passion for engineering with the school children we've worked with."



School children and engineers take to the stage at the International Convention Centre in Birmingham.



The original designs by students at Woodthorpe Community Primary School in Sheffield, some of the 88 mechanisms used to break the world record.

SKILLS

Awards 2020

As we gear up for the 2020 AMRC Training Centre Apprentice of the Year Awards, we take a look back at some of the 2019 winners.

The annual awards ceremony is an important event for the AMRC Training Centre, recognising the achievement, innovation, passion, fresh thinking and contribution apprentices make to industry.

Now in its sixth year, the awards will be held on March 20. The University of Sheffield's Firth Hall will once again provide the stunning backdrop for the glittering event which includes categories for excellence in fabrication and welding; maintenance, technical support, first year; HNC achiever of the year; and degree apprentice of the year. An overall winner will be named Apprentice of the Year 2020.

Nikki Jones, Director of the AMRC Training Centre, said the awards night is the highlight of the year for apprentices, employers and staff.

"The awards allow us the perfect opportunity to shine a much deserved light on the many talents of our apprentices and to acknowledge the passionate and positive impact they are having on their employers' productivity and profitability," she said.

"Our apprentices are the future of engineering, that's why we believe it is important for us to recognise this with a wonderful evening dedicated to their hard work and efforts, and the vital role they are playing in driving innovation."

Previous ceremonies have produced a cluster of worthy overall winners who have gone on to have a great impact in their companies. Let's take a look at some of those who won in 2019.



Smart factory knowledge the big prize for Shivan

Shivan Morkar - the 2019 AMRC Training Centre Apprentice of the Year - is eager to use the knowledge gained from his visit to Siemens' industry-leading Smart Factory in Germany to help improve productivity at his own workplace back home in Leeds.

Shivan's 'mind blowing' trip to Siemens' Industry 4.0 Smart Factory in Amberg and its Digital Industries headquarters in Nuremberg was the prize for being named the University of Sheffield's AMRC Training Centre 'Apprentice of the Year 2019'.

The Bradford-born 22-year-old is an Apprentice Manufacturing Engineer at William Cook Rail and has completed the first year of his degree apprenticeship. "I was told that the automation was the big thing about the Siemens factory so that is what I was looking forward to seeing most. Pretty much all factories in the UK have some aspect of automation and I wanted to see what made Siemens so special," said Shivan. "My mind was blown!"

Shivan was accompanied on the visit by Alan Norbury, Siemens Digital Industries Chief Technologist, who inspired the young apprentice to think about how to apply what he saw when he returned home. "Alan said that the Siemens software they use allows a computer to simulate how a machine would run and how it could do certain jobs, any company working with the AMRC would have free access to the software as part of Siemens Tier One membership contributions," said Shivan.

"It means you can see the improvements to make before you have to spend the money and make the improvements in the real world. It was one of the things I suggested at work to see if we could implement it in some way. They were really up for the idea, so they'll be looking into it soon.

"In our factory at William Cook Rail, if we want to move components from one area of the factory to another site we use forklifts and pallet trucks; but they had electronic conveyers, it would come off a machine, go down into a basement and come up somewhere else to the next machine. I didn't expect



Look North presenter and ceremony host for the 2019 AMRC Training Centre Apprentice of the Year Awards Harry Gratton with Shivan Morkar and Brian Holliday, managing director for Siemens Digital Factory.

that, seeing all the packs coming up and going somewhere else, it was really impressive."

The visit is just one aspect of the 'life changing' impact an apprenticeship has had on Shivan over the past year. "My life has changed massively. Winning the Apprentice of the Year award has solidified my position at work and I feel like they appreciate me more now. More doors have opened and managers want to develop me, they know I have potential and that they can trust me to do the job."

It wasn't just ideas for his workplace and the knowledge gained from Alan Norbury that Shivan brought home with him either, he also brought back memories of sharing a beer and receiving some words of wisdom from the Managing Director at Siemens Mike Houghton. "He told me 'take your risks now, don't put yourself where you are comfortable, put yourself in a place where you are uncomfortable. You'll appreciate it when you're older,'" said Shivan.

Alan Norbury added: "I started my career with Siemens as an apprentice 40-plus years ago. I'm thrilled to now

be in a position where I can share some of my experiences working in Industry and support others as they start on their career journey.

"I was absolutely delighted to host Shivan's visit to Germany. I was so impressed with his attitude to work, thirst for knowledge and self-development and I hope his visit inspires him in his future career. Shivan's impressive developments to-date will definitely stand him in great stead for the future and I am truly looking forward to following his progression in the coming years."

Nikki Jones, Director of the AMRC Training Centre, said: "Shivan is a worthy winner of the Apprentice of the Year award and it is fantastic to see him grasping the opportunity of going to Germany with both hands.

"The AMRC Training Centre provides the manufacturing and engineering industry with young people who have both the practical skills and academic qualifications businesses are crying out for. All our apprentices work hard for their companies and Shivan's success is a great example of how they can make a real difference to their workplace."



Winners of the Siddall Achievement Award, Craig Horton and Mary Stickland, on a tour of the Museum of Flight in Seattle.

Award-winning apprentices fly out to Boeing

Two ambitious apprentices, who won big at the University of Sheffield AMRC Training Centre’s annual awards, have returned from the trip of a lifetime touring Boeing’s state-of-the-art factories in Portland and Seattle. By James Crossling

Mary Stickland and Craig Horton, who are both from Rotherham, earned the opportunity to spend eight days in Oregon and Washington by winning the Siddall Achievement Award.

The prize, which was new to the 2019 AMRC Training Centre Apprentice of the Year Awards ceremony, was donated by retired Silicon Valley CEO Graham Siddall. From Attercliffe, Graham was an apprentice himself and attributes the skills he learned as a young apprentice to laying the foundation for a successful career in precision engineering and semiconductor technology.

“As a former student apprentice, I have been enormously impressed with

the AMRC Training Centre initiative and what it has given to the local community. I wanted to express my thanks and appreciation by giving the awardees a unique experience,” said Graham.

Nominations for the annual awards are made by employers and trainers to recognise the achievement or contribution apprentices have made to industry, and are judged by a panel of AMRC Training Centre staff and award sponsors.

“It was such a shock to win the award because I had no idea that I was even nominated,” said Mary, 22. “Graham stood in front of everyone, explained

who he was and about his background, then he called my name out as one of the two winners.”

Craig, 24, said the evening then got even better: “We went up on stage to meet Graham where he told us he had made plans for this trip to Boeing.”

Mary and Craig, joined by Skills Manager at the AMRC Training Centre Gareth Wilkinson, began their trip at the Boeing factory in Renton, Washington where the 737 aeroplanes are built, followed by a tour of Boeing’s Composite Wing Center in Everett.

At the University of Washington campus in Seattle there were visits to the College of Engineering and the Boeing

Advanced Research Center where the company's instructors work with faculty and students on joint research projects.

It was the time spent at Boeing that sparked Mary's imagination: "The factory tours were unbelievable, you can't appreciate the size of the buildings until you are there and being driven around in a golf buggy.

"We were also shown Boeing's Oregon Manufacturing Innovation Center (OMIC) Training Academy, which is based on the AMRC Training Centre, where they are trying to recreate the successful apprenticeship programme we have in Rotherham.

"You can read a lot about Boeing in a magazine, but there is no substitute for meeting people and actually seeing what happens. Graham didn't just give us a tour, he took us for meals and introduced us to lots of people there, so it was a great opportunity."

The week-long stay in the north west of the US concluded with a tour of the Boeing factory in Portland, Oregon by Global Program Manager Bill Gerry and then the chance to sit in a Concorde during a VIP tour of the Museum of Flight in Seattle.

"That was my favourite part of the trip. The number of planes they have on show there is amazing. As well as Concorde, we had a look around Air Force One and their space shuttle trainer; the thought of the people who had been on those planes is incredible," said Craig.

Associate Dean at the University of Washington, Brian Fabien, said: "Our College of Engineering places high value on opportunities to study and research abroad, which prepares students for a global engineering career. We were delighted to be a small part of Mary and Craig's exchange."

Graham added: "It was such a fun week and as much a learning experience for myself and my wife Brenda as it was for our visitors. Mary and Craig were a little nervous at first but it was good to see them relaxing and growing in confidence as the week progressed."

James Needham, senior operations manager at Boeing Sheffield, said having apprentices travel to the United States is an important part of their development.

"Taking UK apprentices to Boeing's factories in the US to see where the parts they build will be used, builds

connections, broadens horizons and makes a difference in how they approach what they do," Needham said.

Craig, a Research and Development Engineer at Technicut in Sheffield, said he will use his experience in the US back home: "At Boeing's Customer Engagement Centre I saw how they interact with customers on a more personal level by making their visit particular to each individual. Communication with customers is definitely my weak point so I will certainly take what I have learnt and apply it at Technicut."

Jennie Mitchell, HR Manager at Technicut, said: "Through his learning and hard work at the AMRC Training Centre, from advanced apprenticeship to degree level study, Craig has become an excellent engineer.

"He is a great ambassador for Technicut and for our apprenticeship programme and as he continues to grow, he will be able to draw on his experience from his prize visit to the United States. He

is testament to the value we place on apprentices and the key role they play in developing the future of our business together with our talented workforce."

Mary started a Mechanical Maintenance Engineering apprenticeship in April 2018, working at Pryor in Sheffield. Simon Dunn, Operations Director at Pryor, said: "This award is testament to Mary's dedication and how hard she has worked during her apprenticeship.

"I am really pleased with the success of Pryor apprentices which reflects not only the determination of the individual apprentices but also the dedication of the experienced Pryor team members who are mentoring and developing the skills of our future workforce."

The 2020 AMRC Training Centre Apprentice of the Year Awards will be held on 20 March 2020, in the University of Sheffield's Firth Hall.



Doing it the Wright way

AMRC engineer-in-training Rebecca Wright – a teenage tearaway who turned her life around with an apprenticeship – says she is proud to have reached the final of the National Apprenticeship Awards. She spoke to Katia Harston.

Rebecca, who celebrated her 21st birthday the day after the ceremony, works for the AMRC’s Integrated Manufacturing Group (IMG) at the University of Sheffield Advanced Manufacturing Research Centre. She was a finalist in the Royal Navy Award for Advanced Apprentice of the Year at the London ceremony, competing against other apprentices who, like her, had triumphed at regional ceremonies.

She may have missed out on being crowned winner at the national final but Rebecca says being there, and in the top nine advanced apprentices in the country, has only made her more determined to succeed.

“The competition was tough and I’m so proud to have made it to the national final and to have been there in London with all these amazing apprentices from across the country,” she said.

“I had the best night ever, it’s so lovely to be able to dress up and have a good time with your colleagues and family. Of course it’s always a little bit gutting

when you don’t win but I’m not going to get too disheartened. I got this far and I’m proud of myself for that and I’m sure others are too.

“This is my biggest achievement yet. I’ve never felt good enough for any job, especially when it comes down to qualifications and experience. This apprenticeship has made my life and I’m more motivated than ever now.

“The AMRC and AMRC Training Centre have been a big part in my life so far, they’ve helped me to achieve things that I wouldn’t have dreamed possible three-years-ago. I really do look forward to the many years to come with the AMRC family, I couldn’t ask for more.”

Rebecca is in the second year of a technical support apprenticeship at the AMRC Training Centre. Her main focus at IMG, based at the AMRC’s Factory 2050, is computer-aided design, business improvements and maintenance in the workshop. She also manages the 3D printer to ensure everything operates efficiently,

prolonging the life of the machine.

Her work to improve the efficiency of the Factory 2050 workshop has yielded results, having been tasked to improve workshop productivity by implementing ‘5S’ lean manufacturing into the workshop, which resulted in the average cleaning time improving by 13 minutes each week, increasing working time.

Rebecca’s mentor at IMG, project engineer James Lindsay, believes Rebecca has a bright future ahead of her. He said: “We’re all immensely proud of what Rebecca has achieved, from starting at the AMRC with no experience or knowledge of engineering to becoming a national finalist in just over a year shows her credentials to become a highly accomplished engineer in the future.

“Mentoring Rebecca is a dream due to her strong work ethic and has allowed her to become a model for future apprentices to follow, representing everything we stand for here at the University of Sheffield AMRC.”



“This is my biggest achievement yet. I’ve never felt good enough for any job, especially when it comes down to qualifications and experience. This apprenticeship has made my life and I’m more motivated than ever now.”



The high praise was echoed by Chris Greaves, head of IMG and Factory 2050. He said: “I am absolutely delighted that Rebecca was a finalist for Advanced Apprentice of the Year. The University of Sheffield AMRC is full of outstanding people, with a real passion for engineering and innovation. Rebecca is one of those people.

“She has worked incredibly hard since joining the company. Everyone at the University of Sheffield AMRC is incredibly proud of what she has achieved in her relatively short career and to be recognised like this is testament to her drive and passion to succeed.

“She has quickly become an integral part of our team, and we are certain she will continue to develop and grow in her role over the coming years. Her story most definitely does not end here, there are many more chapters to come in her career.”

Rebecca is the second apprentice produced by the AMRC Training Centre to reach the national final, following the success of Oliver Marsh in 2018 who was recognised for having a gift for taking the waste out of wheelie bin production, getting council crest plate changes down to 34 seconds from ten minutes and saving his company MGB Plastics in excess of £137k-a-year in production process costs.

Director of the training centre, Nikki Jones, said the whole team is incredibly proud of Rebecca’s achievement, praising her ‘attitude, passion and commitment’ valued so highly by industry.

“Rebecca has flourished as an apprentice and we’re tremendously proud of her and what she has achieved in such a short space of time as a technical support apprentice,” said

Nikki. “It’s wonderful to see her at such a respected ceremony standing shoulder-to-shoulder alongside a stellar cast of talented young people.

“Our apprentices reaching national finals like this sends out a very clear message – our apprenticeships work. Rebecca and others like her are being equipped with the right blend of high-level skills and work-based learning they need to grow and bring meaningful value to their companies from the get-go. We’re certain Rebecca’s story doesn’t end here and are certain she will continue to succeed in what will no doubt be a very rewarding career.”

Now in their 16th year, the National Apprenticeship Awards showcase the diverse and growing range of sectors engaged with apprenticeships, whilst celebrating the achievements of outstanding apprentices, apprentice employers and individuals to inspire others to follow in their footsteps and champion apprenticeships across England.

The recognition rounds off a successful year of nominations for Rebecca who was also a finalist in the 2019 AMRC Training Centre Apprentice of the Year Awards and was also shortlisted for the GTA Awards held this year. She was nominated alongside degree apprentice Beth Cousins who works for the AMRC Machining Group.

Rebecca says ambition, aspiration and confidence were not words that featured heavily in her vocabulary before her apprenticeship. She admits she was ‘a bit of a teenage tearaway’ at school and was told she would ‘never get anywhere’ looking like she does with her colourful hair and piercings.

But she’s proved herself through her engineering apprenticeship and says

winning the Yorkshire and Humber Advanced Apprentice of the Year Award and making the finals of the National Apprentice Awards boosted her confidence.

“It’s so strange for me being noticed like this because I’m not used to it. I never got on well with education; I got kicked out of a lot of lessons at school and was a bit of a rebel.

“I did go to college to do art and design but that way of learning just wasn’t for me. Then I worked in a chippy, got a job in a shop and a call centre; I didn’t know what I wanted to do.

“It was when I met my boyfriend that things changed. He’d been to the AMRC Training Centre and that’s when I looked into an engineering apprenticeship.”

With support from the training centre, Rebecca secured a place with the Integrated Manufacturing Group at Factory 2050, the place where digital meets manufacturing.

“My apprenticeship has changed my life so much,” she said. “The confidence it has given me has made a big difference; my dad said I was always that little girl who was too scared to talk to the shop keeper and now I’ll talk to anyone.

“I came into the job with knowledge and skills because of the AMRC Training Centre and my mentor, IMG project engineer James Lindsay, has taught me a lot too, building on my skills to help me grow and become more independent.

“My apprenticeship has given me ambition and aspiration and made me realise there’s a world of opportunities open to me. Something I would really like to do is progress and go on to do a degree. I also want to carry on my work to promote STEM and Women in Engineering, and being an ambassador for the AMRC.”



Close encounter of the AMRC kind

A chance meeting in a pub with AMRC co-founder Adrian Allen proved to be a life-changing encounter for a Doncaster teenager – he’s now an apprentice engineer sponsored by one of the world’s largest industrial trade shows. Katia Harston writes.

Sean Delaney, who is employed by the University of Sheffield AMRC’s Advanced Structural Testing Centre (ASTC) as an apprentice test technician, is in the first months of his advanced apprenticeship with the AMRC Training Centre, which is being supported by IMTS – The International Manufacturing Technology Show in America.

The 18-year-old says had it not been for Adrian - the machine tool entrepreneur who helped set up the hugely successful University of Sheffield Advanced Manufacturing

Research Centre (AMRC) with Professor Keith Ridgway and Boeing – he wouldn’t be where he is now, fast on his way to becoming a talented engineer of the future.

“I only discovered the AMRC Training Centre after meeting Adrian in the pub by chance,” said Sean. “He dropped something, I picked it up and gave it to him and we started to chat. It all started there. Adrian invited me to come for a tour of the AMRC and I took him up on the offer. I came away thinking how much, if it was possible, that I would like to work at the AMRC.”

He soon found out it was possible – with an apprenticeship – and that opportunity came about through Adrian and his longstanding relationship with AMT – The Association for Manufacturing Technology, the leading American manufacturing trade association which owns and organises IMTS and agreed to sponsor Sean.

Peter Eelman, AMT Vice President and CXO, said: “AMT and IMTS believe in building a network of strategic partners to establish a community of practice in which manufacturing



Hard work: Apprentice Sean Delaney carrying out machining work in the AMRC Training Centre workshop.

research, technology, and education are at the forefront.

“The University of Sheffield Advanced Manufacturing Research Centre has a legacy of educational excellence and a breadth of industrial partners who are united in advancing our industry. The alignment between the IMTS Apprentice program and the AMRC presented a unique opportunity and a natural extension of our ongoing mission to elevate the value we bring to our members and events in this global economy.”

As part of his sponsorship, Sean is posting a weekly blog on what he is learning and this is published on the IMTS website and across its social media channels. Sean says the blog is good preparation for when he travels to Chicago next year where he will give a speech about his apprenticeship to guests attending IMTS 2020.

“It’s a fantastic opportunity and I’m very excited for what the future holds,” Sean said. “I definitely intend to go as far as I possibly can both in terms of career and education.”

He began his apprenticeship last September and will study for 36 weeks at the AMRC Training Centre’s real-world manufacturing environment

before going into a company, gaining hands-on experience with industry-standard equipment and learning the fundamentals of engineering theory and manufacturing processes.

He said: “I’m learning how to use CNC machines and tools to cut, drill and finish components; milling; fitting and programming. I’m very happy with how we’ve got straight into it. I was expecting a lengthy time where we would be eased into things but they’ve thrown us straight in which I think is really good because I like to be challenged.”

In his role as an apprentice test technician with the ASTC, he will assist the team with the setting up of tests and use his newly-acquired machining skills to create jigs and test coupons. He will also be involved with producing validation and certification reports.

Head of the ASTC, Phil Spiers, said: “It’s these chance meetings on which the world spins. Sean is a great lad, hardworking, clever and conscientious. He will be a real boost to the Advanced Structural Testing Centre. His apprenticeship will also deepen our relationship with our friends across the pond at the AMT and IMTS.”

Sean was in the final year of studying for his maths, physics and history A-Levels when he crossed paths with Adrian. And while Sean has always chosen subjects geared towards engineering, he says he’d never given much thought to pursuing it as a profession.

“I’ve always taken engineering-related subjects at school and although it has always been there in the background, I’d never considered engineering as being a career path,” he said. “Originally I tried to join Welbeck (Defence Sixth Form College) but broke my leg playing rugby and I didn’t get in because of that injury.

“So I kind of ‘fell’ into studying A-Levels not really wanting to do it. If I knew about the training centre two years ago I would have come here rather than go to sixth form college. It’s not that I don’t like classroom work, I can do it and I can enjoy it but not five days a week. I want to be doing something hands-on too.

“I did two weeks working with the ASTC before starting my apprenticeship, just to get a feel for the place, and I was so impressed. The working environment across the AMRC is unbelievable.”



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Apprenticeships make sense from day one

A Sheffield-based sensing technology company has hailed the impact of AMRC Training Centre apprentices, saying they add significant value to the business from day one, with their level of technical training, their energy and engagement and their innovative ways of working. James Crossling reports.

Tribosonics has seven AMRC Training Centre apprentices, including two new apprentices who started in September last year.

“We had always taken on placement students from universities in the past, the support from government funding triggered our thinking about the potential of apprenticeships,” said Engineering Manager, Tom Chaldecott.

“We were surprised at what the AMRC Training Centre gave us. The apprentices in mechanical manufacture do nine months training which covers everything from turning and milling to computer numerical control (CNC). What is most impressive is that as soon as they start, they are immediately adding value to the company.”

Tribosonics works in the transport, power generation and manufacturing industries and helps its customers drive transformation by developing new value streams through strategic partnership, using its unique sensing technology to extract and digitise data on, for example, fluid properties, contact pressures, friction or wear.

Trainee engineer Will Morton, 19, started at Tribosonics in 2016 and finished his Advanced Apprenticeship (Level 3) before embarking on a Degree Apprenticeship. In 2017 he was named both ‘AMRC First Year Apprentice of the Year’ and ‘Made in Sheffield Apprentice of the Year’.

Will said: “As well as a specialism, the AMRC Training Centre gives you an overview of all aspects of engineering, which I have found extremely useful in the workplace. For example, I was able to do some computer-aided design (CAD) at the training centre and having that background now helps me communicate with design engineers.”

Tom added: “Having the machining background Will gained at the AMRC Training Centre impacts his approach to engineering design, how he talks to suppliers, and the way he engages with customers. Without that, I don’t think he would have progressed as well as he has.”

In January 2019 the government launched a new ‘Fire It Up’ campaign, to promote the benefits of apprenticeships to young people, parents and employers with a particular emphasis on ensuring that students are aware of them.

“When I finished my GCSEs I knew I didn’t want to proceed down a purely academic route; I enjoyed practical hands-on learning. I took one look at A-Levels and knew they weren’t for me,” said Will. “I just felt that getting experience with a company and a qualification was ideal.

“When I was at school, there was very little information or publicity around apprenticeships and they were seen as second-rate. Now there is more support for students and apprenticeships are

almost becoming the norm.

“Two of my friends at school went on to do A-Levels and couldn’t understand why I would want to do anything else; they both held negative views of apprenticeships. Halfway through their course they said to me ‘We don’t want to do A-Levels anymore, we wish we had done what you did’ and now they are starting a Level 3 apprenticeship.”

With seven apprentices now employed by Tribosonics, the company is getting extremely good value out of their relationship with the AMRC, which is part of the High Value Manufacturing (HVM) Catapult. Tom added: “I wish the AMRC Training Centre offering had been an option for me at the point that I was looking into university education.”

Nikki Jones, Director of the University of Sheffield AMRC Training Centre, said: “It’s wonderful to hear comments like this from employers and apprentices. Our model works because we take time to listen to the needs of employers and our industry board plays a key role in shaping the curriculum.

“Apprentices who train with us are work-ready and able to hit the ground running. They add value from day one. And they continue to add value. Our employer partners frequently tell us about the impact our apprentices are having on their companies; they bring new ways of thinking and smarter ways of working.”

Some of the ‘work-ready’ AMRC Training Centre apprentices employed by Tribosonics.



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- **Digital Meet Manufacturing Lunch & Learn**
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- **AMRC Castings Technology International**
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- **Digital Meet Manufacturing Lunch & Learn**
Industrial Internet of Things
- **9th CIRP Conference on**
High Performance Cutting
- **Tech Board 2020**
- **Roadmapping 2020**
- **Offsite Expo 2020**

Courses at the AMRC Training Centre

- **Metallurgy for Non-Metallurgists**
24 March 2020 to 25 March 2020 (Bristol)
- **Quality & Quality Control**
10 March 2020 (AMRC Training Centre, Rotherham), 11 March 2020 (Coventry)
- **Metallurgical Failure Analysis and Prevention**
07 April 2020 (Bristol), 23 April 2020 (Preston)

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